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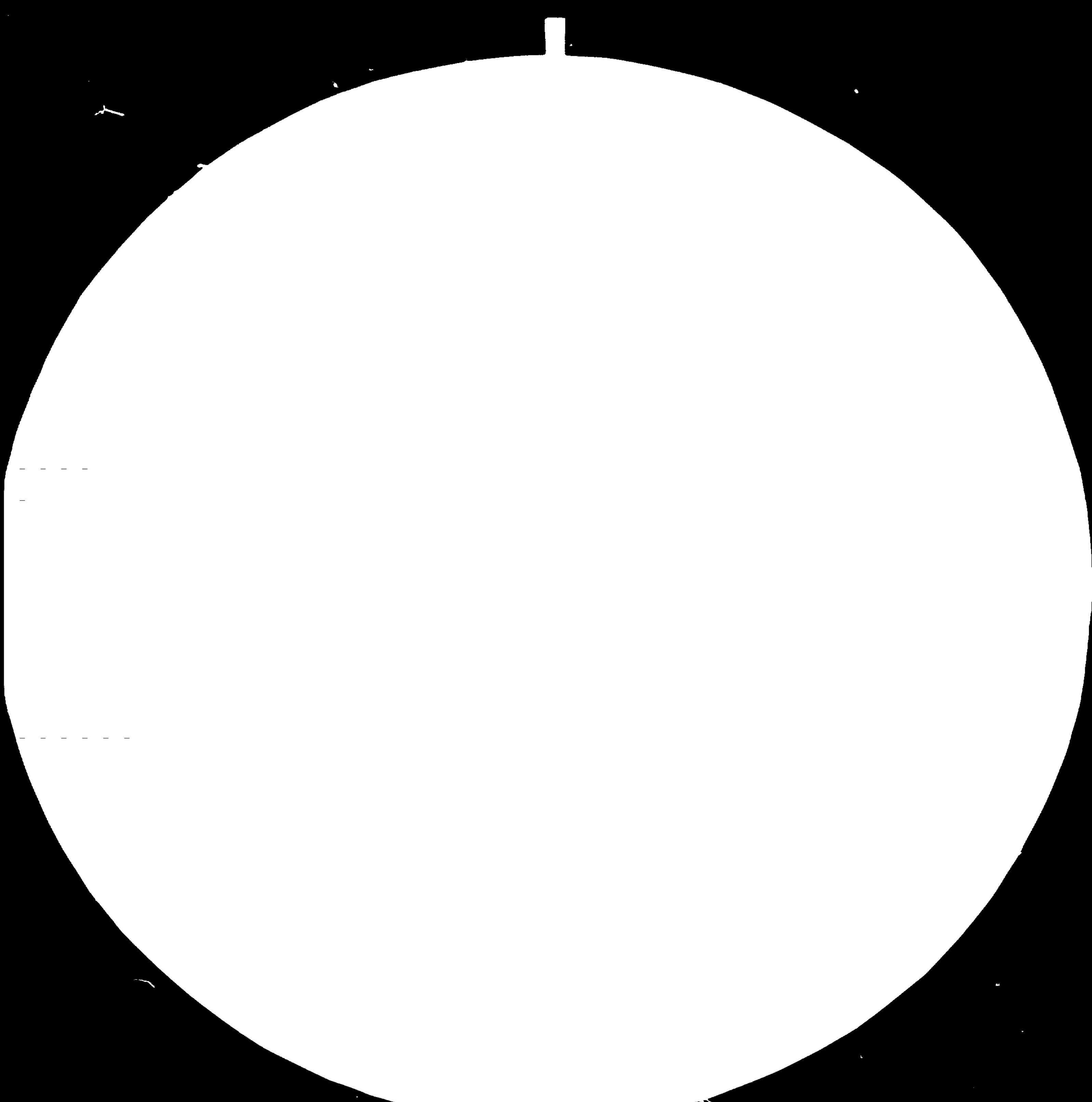

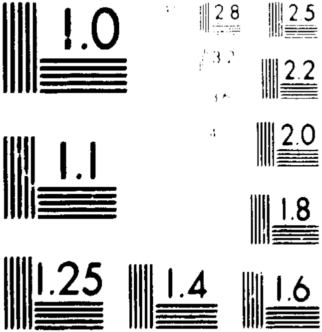

MICROCOPY RESOLUTION TEST CHART

FINAL REPORT

TO

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION

ON

STUDY ON MINIMUM ECONOMIC SIZE PLANTS FOR STEEL PROCESSES IN ASEAN COUNTRIES

DP/RAS/78/047

VOL I - TEXT

DECEMBER 1980

M. N. DASTUR & COMPANY (P) LTD

CONSULTING ENGINEERS

CALCUTTA

10180 (A)

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3rd December 1980
5480-185A

Mr D.F. Mant
Chief, Purchase & Contracts
Services Section
UNIDO
Vienna International Centre
P.O. Box 300, A-1400 Vienna
Austria

Re: UNIDO Project DP/RAS/78/047 Contract 79/105 and Amendment No 1 to Contract - Study on Minimum Economic Size Plants for Steel Processes in the ASEAN countries

Dear Sir,

We thank you for your letter MK/kb of 3rd November 1980 and have pleasure in submitting fifty (50) copies of our Final Report covering the work performed in accordance with para 2.01 and Annexes E and F of the Contract. The report is presented in two volumes:

Volume I - Text

Volume II - Appendices and Drawings

It may please be noted that while finalising the report, the comments given in your letter of 3rd November 1980 have been taken into account. It is expected that this study will prove useful and provide an appropriate basis to the ASEAN countries for development of steel industry in the region.

We take this opportunity of expressing our thanks for the assistance and co-operation extended by UNIDO and the representatives of the ASEAN countries.

Respectfully submitted
M.N. DASTUR & COMPANY (P) LTD
by

M.N. Dastur, Managing Director

MND:rvg

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FIGURES

SUMMARY

The salient features of the study concerning the minimum economic size for selected steel processes, steel situation in the ASEAN countries vis-a-vis the minimum economic size, suggestions for consideration and an action-oriented programme are discussed. The twelve steel processes selected by the ASEAN countries for the study are:

i) Billet plant
ii) Wire rod mill
iii) Structural shape mill
iv) Bright bar plant
vv) Seamless pipe plant
vi) GI wire plant
vii) Stainless steel plant
viii) Special steels plant
ix) Hot strip mill
x) Cold strip mill
xi) Plate mill
xii) Electrolytic tinning line

MINIMUM ECONOMIC SIZE

Taking into account the prices of input materials and the finished products as prevailing in early 1980 and the plant capacities considered, the internal rate of return (IRR) has been indicated in Table-1 for steel processes in different countries. An IRR of 15 per cent is desired by the ASEAN countries for the minimum economic size for different steel processes.

SECTION 1

TABLE-1 - SUMMARY OF MINIMUM ECONOMIC SIZE FOR STEEL PROCESSES

	Thailand	Malaysia	Singapore	Indonesia	Philippines
Billet Plant					
Input price of scrap, US $/ton ..	133	105	123	130	123
Selling price of billet, US $/ton ..	300	300	300	295	275
Minimum economic size, tons/year ..	150,000	60,000	150,000	150,000	500,000
IRR, % ..	15	15	15	15	12.2
Wire Rod Mill					
Input price of billet, US $/ton ..	320	310	300	300	300
Selling price of wire rod, US $/ton ..	390	390	390	390	375
Minimum economic size, tons/year ..	450,000	450,000	450,000	450,000	450,000
IRR, % ..	6	6.6	9.4	14.9	3.3
Structural Shape Mill					
Input price of billet/bloom, US $/ton ..	320	310	300	300	300
Selling price of structurals, US $/ton ..	405	405	405	405	450
Minimum economic size, tons/year ..	600,000	600,000	600,000	600,000	400,000
IRR, % ..	6.5	8.5	10	14.5	18.1
Bright Bar Plant					
Input price of wire rod, US $/ton ..	400	390	375	387.5	404
Selling price of bright bars, US $/ton ..	560	560	560	565	560
Minimum economic size, tons/year ..	20,000	20,000	20,000	20,000	20,000
IRR, % ..	20.3	21.6	21.4	25	18.7
Seamless Tube Plant					
Input price of billet/bloom, US $/ton ..	320	310	300	300	300
Selling price of seamless tube, US $/ton	860	860	860	860	860
Minimum economic size, tons/year ..	62,000	62,000	62,000	62,000	62,000
IRR, % ..	13.7	13.7	12.4	15.8	14.4
GI Wire Plant					
Input price of wire rod, US $/ton ..	415	405	390	410	400
Selling price of wire, US $/ton ..	575	575	575	575	575
Minimum economic size, tons/year ..	34,500	34,500	34,500	34,500	34,500
IRR, % ..	12.6	14.1	13	15	14.7
Special Steels Plant					
Input price of scrap, US $/ton ..	133	105	123	130	123
Selling price of bars & rods, US $/ton ..	620	620	620	620	620
Minimum economic size, tons/year ..	70,000	35,000	70,000	35,000	70,000
IRR, % ..	17.9	15.9	16.9	14.8	15.6
Stainless Steel Plant					
Input price of scrap, US $/ton ..	133	105	123	130	123
Selling price of SS strip, US $/ton ..	2,090	2,090	2,090	2,315	2,090
[illegible]	30,000	30,000	30,000	30,000	30,000

Minimum economic size, tons/year ..	30,000

Bright Bar Plant

Input price of wire rod, US $/ton ..	400
Selling price of bright bars, US $/ton ..	560
Minimum economic size, tons/year ..	20,000
IRR, % ..	20.3

Seamless Tube Plant

Input price of billet/bloom, US $/ton ..	320
Selling price of seamless tube, US $/ton	860
Minimum economic size, tons/year ..	62,000
IRR, % ..	13.7

[illegible] Wire Plant

Input price of wire rod, US $/ton ..	415
Selling price of wire, US $/ton ..	575
Minimum economic size, tons/year ..	34,500
IRR, % ..	12.6

Special Steels Plant

Input price of scrap, US $/ton ..	133
Selling price of bars & rods, US $/ton ..	620
Minimum economic size, tons/year ..	70,000
IRR, % ..	17.9

Stainless Steel Plant

Input price of scrap, US $/ton ..	133
Selling price of SS strip, US $/ton ..	2,090
Minimum economic size, tons/year ..	30,000
IRR, % ..	3

Hot Strip Mill

Input price of slab, US $/ton ..	260
Selling price of HR sheet/coils, US $/ton	350
Minimum economic size, tons/year ..	1,500,000
IRR, % ..	14

Cold Strip Mill

Input price of HR coil, US $/ton ..	360
Selling price of CR sheet/coil, US $/ton	423
Minimum economic size, tons/year ..	1,000,000
IRR, % ..	–

Plate Mill

Input price of slab, US $/ton ..	260
Selling price of plate, US $/ton ..	370
Minimum economic size, tons/year ..	600,000
IRR, % ..	8

Tinning Line

Input price of CR coil, US $/ton ..	445
Selling price of tin plates, US $/ton ..	700
Minimum economic size, tons/year ..	150,000
IRR, % ..	13.5

SECTION 2

40,000	[illegible]	[illegible]	[illegible]
390	375	387.5	404
560	560	565	560
20,000	20,000	20,000	20,000
21.6	21.4	25	16.7
310	300	300	300
860	860	860	860
62,000	62,000	62,000	62,000
13.7	12.4	15.8	14.4
405	390	410	400
575	575	575	575
34,500	34,500	34,500	34,500
14.1	13	15	14.7
105	123	130	123
620	620	620	620
35,000	70,000	35,000	70,000
15.9	16.9	14.8	15.6
105	123	130	123
2,090	2,090	2,315	2,090
30,000	30,000	30,000	30,000
3.7	1.5	7.8	2.4
255	245	250	255
350	350	352.5	357.5
1,500,000	1,500,000	1,500,000	1,500,000
14.5	15.8	16.7	15.9
350	340	350	355
423	423	420	475
1,000,000	1,000,000	1,000,000	1,000,000
-	0.4	-	10.4
255	245	250	255
370	370	365	390
600,000	600,000	600,000	600,000
6.8	9.8	12.9	13.9
430	415	425	500
700	700	700	700
150,000	150,000	150,000	150,000
14.9	16	16.4	2.8

Summary (cont'd)

Considering the above, the minimum economic size is about 1.5 million tons per year capacity hot strip mill, 20,000 tons per year capacity bright bar plant, 62,000 tons per year capacity seamless tube plant, and 34,500 tons per year capacity GI wire plant for all the ASEAN countries. In the case of billet plant, the minimum size is 60,000 tons per year for Malaysia, 150,000 tons per year for Thailand, Singapore and Indonesia and 500,000 tons per year for Philippines. The minimum size for special steels plant indicated is 35,000 tons per year for Malaysia and Indonesia and 70,000 tons per year for other ASEAN countries; and for the tinning line 150,000 tons per year for all the ASEAN countries excepting Philippines.

In the case of wire rod mill, a plant of 450,000 tons per year is the minimum economic size only for Indonesia. Large capacity structural mills of 600,000 tons per year for Indonesia and 400,000 tons per year for Philippines are indicated as the minimum size. Even a large capacity plate mill of 600,000 tons per year and cold strip mill of 1 million tons per year do not appear to be viable in any of the ASEAN countries, because the difference between the prices of input materials and the finished products is small.

Summary (cont'd)

It is thus noted that fairly large size plants have to be considered for most of the steel processes. The main reason for this is that the capital investment on new projects is quite high at present due to frequent oil price hikes and the consequent world wide inflation. Also the selling prices of finished products considered for the study are generally on par with the international export prices which are normally lower than the home prices of the countries concerned such as Japan. Further, an IRR of 15 per cent desired by ASEAN countries, specially for such steel based processes is on the high side.

The ASEAN countries, therefore, will have to carefully review the minimum desirable IRR as well as the selling prices of finished products for domestic production.

STEEL SITUATION VIS-A-VIS MINIMUM ECONOMIC SIZE

The steel situation for each ASEAN country as regards the installed capacity, present imports, projected shortfall by 1985, 1990 and 2000, the minimum economic size for each steel processes etc is presented in Tables-2 to 6. For products such as bright bars, seamless steel tubes, GI wires, special steels, and stainless steel sheets, the present demand and future shortfall have not been indicated for want of data.

...mary (cont'd)

TABLE-2 - STEEL SITUATION VIS-A-VIS MINIMUM ECONOMIC SI...

OVERALL STEEL SITUATION

Year		Crude steel capacity mill tons	Imports mill tons
1978	..	0.62	1.18
		Crude steel demand mill tons	Anticipated shortfall mill tons
1985	..	2.8	2.2
1990	..	4.0	3.4
2000	..	6.5	5.9

SITUATION FOR SPECIFIC PRODUCTS

Product		Anticipated shortfall			Minimum economic size		
		1985 tons	1990 tons	200 tons	Steel process		Capacity tons/year
Bars, rods and wire rods	..	315,000	485,000	1,065,000	i) ii)	Billet plant Wire rod mill	150,000 450,000
Sections/structurals	..	200,000	290,000	445,000	iii)	Structural mill	600,000
Plates	..	20,000	30,000	100,000	iv)	Plate mill	600,000
H. sheets/strips	..	1,280,000	1,960,000	3,300,000	v)	Hot strip mill	1,500,000
CR sheets/strips	..	590,000	940,000	1,675,000	vi)	Cold strip mill	1,000,000
Tinplates	..	110,000	200,000	465,000	vii)	Tinning line	150,000
Bright bars	..	Data not available			viii)	Bright bar plant	20,000
Seamless tubes	..	Data not available			ix)	Seamless tube plant	62,000
G.I. wires	..	Data not available			x)	GI wire plant	34,500
Special steels	..	Data not available			xi)	Special steels plant	70,000
Stainless steel	..	Data not available			xii)	Stainless steel plant	30,000

SECTION 1

	Minimum economic size		
	Steel process	Capacity tons/year	IRR %
i)	Billet plant	150,000	15.0
ii)	Wire rod mill	450,000	6.0
iii)	Structural mill	600,000	6.5
iv)	Plate mill	600,000	8.9
v)	Hot strip mill	1,500,000	14.0
vi)	Cold strip mill	1,000,000	-
vii)	Tinning line	150,000	13.5
viii)	Bright bar plant	20,000	20.3
ix)	Seamless tube plant	62,000	13.7
x)	GI wire plant	34,500	12.6
xi)	Special steels plant	70,000	17.9
xii)	Stainless steel plant	30,000	3.0

Comments

Keeping in view the shortfall by 1990 and an IRR of 15%, billet plants of 150,000 tons per year, a hot strip mill of 1.5 million tons per year and a tinning line of 150,000 tons per year can be considered. A cold strip mill of 1 million tons per year is justified considering the shortfall by 1990.

However, considering the input prices of the materials and selling prices of the finished products and 15% IRR, even fairly large size units of plate mill of 600,000 tons per year, cold strip mill of 1 million tons per year, wire rod mill of 450,000 tons per year and structural mill of 600,000 tons per year do not appear to be viable.

For other steel process units, minimum economic size units have been indicated. However, market survey will have to be carried out to ascertain the demand for these products in the country and the region.

SECTION 2

TABLE-3 - STEEL SITUATION VIS-A-VIS MINIMUM ECONOMIC SIZE ...

OVERALL STEEL SITUATION

Year		Crude steel capacity mill tons	Imports mill tons
1978	..	0.31	Data not available
		Crude steel demand mill tons	**Anticipated shortfall mill tons**
1985	..	1.8	1.5
1990	..	2.3	2.0
2000	..	4.1	3.8

SITUATION FOR SPECIFIC PRODUCTS

Product		Anticipated shortfall 1985 tons	1990 tons	2000 tons	Minimum economic si... Steel process	Ca... to...
Bars, rods and wire rods	..	100,000	130,000	720,000	i) Billet plant ii) Wire rod mill	
Sections/structurals	..	170,000	185,000	230,000	iii) Structural mill	
Plates	..	160,000	220,000	410,000	iv) Plate mill	
HR sheets/strips	..	615,000	825,000	1,580,000	v) Hot strip mill	1,
CR sheets/strips	..	340,000	465,000	895,000	vi) Cold strip mill	1,
Tinplates	..	125,000	165,000	310,000	vii) Tinning line	
Bright bars	..	Data not available			viii) Bright bar plant	
Seamless tubes	..	Data not available			ix) Seamless tube plant	
G.I. wires	..	Data not available			x) GI wire plant	
Special steels	..	Data not available			xi) Special steels plant	
Stainless steel	..	Data not available			xii) Stainless steel plant	

SECTION 1

	Steel process	Minimum economic size: Capacity tons/year	IRR %
i)	Billet plant	60,000	15.0
ii)	Wire rod mill	450,000	8.6
iii)	Structural mill	600,000	8.5
iv)	Plate mill	600,000	6.8
v)	Hot strip mill	1,500,000	14.5
vi)	Cold strip mill	1,000,000	-
vii)	Tinning line	150,000	14.9
viii)	Bright bar plant	20,000	21.6
ix)	Seamless tube plant	62,000	13.7
x)	GI wire plant	34,500	14.1
xi)	Special steels plant	35,000	15.9
xii)	Stainless steel plant	30,000	3.7

Comments

Keeping in view the shortfall by 1990 and an IRR of 15%, billet plants of 60,000 tons per year and a tinning line of 150,000 tons per year can be considered. The minimum economic size of hot strip mill indicated is 1.5 million tons per year. Considering the shortfall of about 825,000 tons by 1990 for HR products, a hot strip mill of 1.5 million tons per year capacity can meet part of the requirements of the ASEAN region.

Considering the input prices of materials, selling prices of finished products and 15% IRR, even fairly large size units (compared to the shortfall by 1990) of wire rod mill 450,000 tons per year, plate mill 600,000 tons per year, cold strip mill 1,000,000 tons per year, structural mill 600,000 tons pear year, do not appear to be viable.

For other steel process units, minimum economic size units have been indicated. However, market survey will have to be carried out to ascertain the demand for these products in the country and the region.

SECTION 2

TABLE-5 - STEEL SITUATION VIS-A-VIS MINIMUM ECONOMIC SIZE FO[illegible]

OVERALL STEEL SITUATION

Year		Crude steel capacity mill tons	Imports mill tons
1978	..	1.24	1.27
		Crude steel demand mill tons	Anticipated shortfall mill tons
1985	..	3.5	2.3
1990	..	5.0	3.8
2000	..	9.2	8.0

SITUATION FOR SPECIFIC PRODUCTS

Product		Anticipated shortfall 1985 tons	1990 tons	2000 tons	Minimum econom[illegible] Steel process
Bars, rods and wire rods	..	365,000	650,000	1,915,000	i) Billet plant ii) Wire rod mill
Sections/structurals	..	220,000	285,000	470,000	iii) Structural mill
Plates	..	245,000	390,000	810,000	iv) Plate mill
HR sheets/strips	..	615,000	870,000	2,290,000	v) Hot strip mill
CR sheets/strips	..	570,000	840,000	1,625,000	vi) Cold strip mill
Tinplates	..	160,000	225,000	445,000	vii) Tinning line
Bright bars	..	Data not available			viii) Bright bar plant
Seamless tubes	..	Data not available			ix) Seamless tube plant
G.I. wires	..	Data not available			x) GI wire plant
Special steels	..	Data not available			xi) Special steels plant
Stainless steel	..	Data not available			xii) Stainless steel plant

SECTION 1

	Minimum economic size		
	Steel process	Capacity tons/year	IRR %
i)	Billet plant	150,000	15.0
ii)	Wire rod mill	450,000	14.9
iii)	Structural mill	600,000	14.5
iv)	Plate mill	600,000	12.9
v)	Hot strip mill	1,500,000	18.7
vi)	Cold strip mill	1,000,000	-
vii)	Tinning line	150,000	16.4
viii)	Bright bar plant	20,000	25.0
ix)	Seamless tube plant	62,000	15.8
x)	GI wire plant	34,500	15.0
xi)	Special steels plant	35,000	14.8
xii)	Stainless steel plant	30,000	7.8

Comments

Keeping in view the shortfall bu 1990 and an IRR of 15%, billet plants of 150,000 tons per year, wire rod mill of 450,000 tons per year and tinning line of 150,000 tons per year could be considered. Keeping in view the shortfall by 1990 as well as the regional demand, the minimum economic size plants for hot strip mill, plate mill and structural mill could also be considered.

A substantial shortfall for cold strips is indicated by 1990. However, a large capacity cold strip mill of 1 million tons per year is not viable because of the very small difference between the input price of HR coils and the selling prices of CR sheet/strips. Hence, the price aspect needs to be reviewed.

For products like bright bars, seamless tubes, GI wires, special steels, minimum economic size plants have been indicated. However, market survey needs to be carried out to ascertain the demand for these products in the country and the region.

SECTION 2

TABLE-4 - STEEL SITUATION VIS-A-VIS MINIMUM ECONOMIC SIZE FOR SI

OVERALL STEEL SITUATION

Year		Crude steel capacity mill tons	Imports mill tons
1978	..	0.40	0.76
		Crude steel demand mill tons	**Anticipated shortfall mill tons**
1985	..	1.7	1.3
1990	..	2.0	1.6
2000	..	2.6	2.2

SITUATION FOR SPECIFIC PRODUCTS

Product		Anticipated shortfall 1985 tons	1990 tons	2000 tons		Minimum eco Steel process
Bars, rods and wire rods	..	-	-	70,000	i) ii)	Billet plant Wire rod mill
Sections/structurals	..	230,000	260,000	335,000	iii)	Structural mill
Plates	..	315,000	385,000	575,000	iv)	Plate mill
HR sheets/strips	..	565,000	695,000	1,000,000	v)	Hot strip mill
CR sheets/strips	..	275,000	310,000	415,000	vi)	Cold strip mill
Tinplates	..	100,000	100,000	120,000	vii)	Tinning line
Bright bars	..	Data not available			viii)	Bright bar plant
Seamless tubes	..	Data not available			ix)	Seamless tube plant
G.I. wires	..	Data not available			x)	GI wire plant
Special steels	..	Data not available			xi)	Special steels plant
Stainless steel	..	Data not available			xii)	Stainless steel plant

SECTION 1

	Minimum economic size		
	Steel process	Capacity tons/year	IRR %
i)	Billet plant	150,000	15.0
ii)	Wire rod mill	450,000	9.4
iii)	Structural mill	600,000	10.0
iv)	Plate mill	600,000	9.8
v)	Hot strip mill	1,500,000	15.8
vi)	Cold strip mill	1,000,000	0.4
vii)	Tinning line	150,000	16.0
viii)	Bright bar plant	20,000	21.4
ix)	Seamless tube plant	62,000	12.4
x)	GI wire plant	34,500	13.0
xi)	Special steels plant	70,000	16.9
xii)	Stainless steel plant	30,000	1.5

Comments

Considering about 15% IRR, the minimum economic size for billet plant is 150,000 tons per year, for hot strip mill 1,500,000 tons per year and for tinning line 150,000 tons per year. However, the shortfall by 1990 for these products is less than the minimum size.

Taking into account the prices of input materials, selling prices of finished products and 15% IRR, even fairly large size units of wire rod mill of 450,000 tons per year, structural mill of 600,000 tons per year, plate mill of 600,000 tons per year and cold strip mill 1 million tons per year, do not appear to be viable.

Other steel processes such as special steels, stainless steel and seamless tubes may be considered in Singapore. The demand in the ASEAN region for these products needs to be established.

SECTION 2

TABLE-6 - STEEL SITUATION VIS-A-VIS MINIMUM ECONOMIC SIZE FOR PHILI

OVERALL STEEL SITUATION

Year		Crude steel capacity mill tons	Imports mill tons
1978	..	0.59	0.99
		Crude steel demand mill tons	**Anticipated shortfall mill tons**
1985	..	2.5	1.9
1990	..	3.4	2.8
2000	..	5.6	5.0

SITUATION FOR SPECIFIC PRODUCTS

Product		Anticipated shortfall 1985 tons	1990 tons	2000 tons	Minimum econo... Steel process
Bars, rods and wire rods	..	-	115,000	785,000	i) Billet plant ii) Wire rod mill
Sections/structurals	..	120,000	175,000	255,000	iii) Structural mill
Plates	..	95,000	180,000	385,000	iv) Plate mill
HR sheets/strips	..	660,000	935,000	1,895,000	v) Hot strip mill
CR sheets/strips	..	245,000	330,000	840,000	vi) Cold strip mill
Tinplates	..	105,000	130,000	250,000	vii) Tinning line
Bright bars	..	Data not available			viii) Bright bar plant
Seamless tubes	..	Data not available			ix) Seamless tube plant
G.I. wires	..	Data not available			x) GI wire plant
Special steels	..	Data not available			xi) Special steels plant
Stainless steel	..	Data not available			xii) Stainless steel plant

SECTION 1

	Minimum economic size		
	Steel process	Capacity tons/year	IRR %
i)	Billet plant	500,000	12.2
ii)	Wire rod mill	450,000	3.3
iii)	Structural mill	400,000	18.1
iv)	Plate mill	600,000	13.9
v)	Hot strip mill	1,500,000	15.9
vi)	Cold strip mill	1,000,000	10.4
vii)	Tinning line	150,000	2.8
viii)	Bright bar plant	20,000	18.7
ix)	Seamless tube plant	62,000	14.4
x)	GI wire plant	34,500	14.7
xi)	Special steels plant	70,000	15.6
xii)	Stainless steel plant	30,000	2.4

Comments

The minimum economic size plants with about 15% IRR indicated are structural mill of 400,000 tons per year, plate mill of 600,000 tons per year and hot strip mill of 1.5 million tons per year. Considering the shortfall by 1990, these plants could be considered keeping in view the country's requirements and the ASEAN region in the initial years.

Considering the input prices of materials, the selling prices of finished products and 15% IRR, even large size units of wire rod mill of 450,000 tons per year, cold strip mill of 1 million tons per year and tinning line of 150,000 tons per year do not appear to be viable.

For products like bright bars, seamless tubes, GI wires and special steels, minimum economic size units have been indicated. However, market survey will have to be carried out to ascertain the demand for these products in the country and the region.

SECTION 2

Summary (cont'd)

ASEAN countries' present production of crude steel is about 1.4 million tons per year whereas the total installed capacity is about 3.2 million tons per year. As against this, the total requirement of crude steel of the ASEAN countries is about 7.8 million tons per year. Consequently, these countries currently import about 6.4 million tons per year of steelconstituting about 1 million tons of semis and the balance as finished products.

The poor utilisation of the present installed capacity appears to be mainly due to the availability of imported steel at prices more competitive vis-a-vis local production and the limited availability of domestic scrap. Thus, measures to make available scrap or sponge iron at prices competitive to imported scrap requires attention.

There is substantial capacity of about 1.4 million tons per year in the region for mainly rerolling of bars and rods based on imported billets. The utilisation of the rerolling mills and consequently the availability of bars and rods can be substantially improved, provided adequate availability of billets at a competitive price is assured.

Summary (cont'd)

Based on preliminary projections, the total shortfall of finished products for the region is about 8.9 million tons by 1985 and 12.7 million tons by 1990, with a break-down as given below.

		National '000 tons	Regional mill tons
Shortfall by 1985			
Bars, rods and wire rods	..	100 to 365	0.765
Sections	..	120 to 230	0.940
Plates	..	20 to 315	0.835
HR sheet/strip	..	565 to 1280	3.735
CR sheet/strip	..	245 to 590	2.020
Tin plates	..	100 to 160	0.600
			8.895
Shortfall by 1990			
Bars, rods and wire rods	..	115 to 650	1.300
Sections	..	175 to 290	1.195
Plates	..	30 to 390	1.205
HR sheet/strip	..	695 to 1960	5.285
CR sheet/strip	..	310 to 940	2.885
Tin plates	..	100 to 225	0.820
			12.690

SUGGESTIONS FOR CONSIDERATION

Taking into account the minimum economic size for steel processes and the steel situation reviewed above, the following are the suggestions for different steel processes.

Summary (cont'd)

Billets

A billet plant of 150,000 tons annual capacity can generally be considered in all ASEAN countries, keeping the shortfalls in view. However, to maintain large billet production, an assured supply of melting stock is essential. Due to limited availability of steel scrap, sponge iron production will have to be taken up in Malaysia, Indonesia and Thailand where natural gas is available.

Wire Rods

Based on the prices of billets and wire rods considered, the minimum economic size for wire rod plant indicated is about 450,000 tons per year. At present, the domestic producers of bars, rods and wire rods are protected by duty on imported products in some ASEAN countries. If this protection is extended, wire rod mills with a smaller capacity of 125,000 to 150,000 tons per year may be possible in ASEAN countries consistent with demand.

Structurals/Sections

For light, medium and heavy structurals/sections, a shortfall of 1.2 million tons is indicated by 1990 in the ASEAN region. For medium sections which will be mostly required by the developing countries initially, two plants each of 400,000 to 600,000 tons per year capacity may be considered in the ASEAN region.

Summary (cont'd)

Plates

The total shortfall for plates in the ASEAN region is indicated at about 1.2 million tons by 1990. Hence, two plate mills each of about 600,00 tons per year can be considered in the ASEAN region.

HR Strips/Sheets

The total shortfall for hot rolled strips/sheets indicated is at about 5.25 million tons by 1990 for the ASEAN region. Considering the minimum economic size of about 1.5 million tons per year for hot strip mill, 3 or 4 such plants, each of 1.5 million tons capacity can be considered for the ASEAN countries.

CR Strips/Sheets

The total shortfall of cold rolled strips/sheets indicated is about 2.9 million tons by 1990. For meeting this shortfall, three cold rolling mills each of 1 million tons per year capacity can be considered for the ASEAN region.

Tinplates

The total shortfall for tinplates in the ASEAN region is indicated at about 820,000 tons by 1990. Considering the minimum economic size of about 150,000 tons per year, 5 or 6 tinplates plants each of 150,000 tons per year, can be considered in ASEAN countries.

Summary (cont'd)

Other Products

The minimum economic size plants for bright bars, seamless tubes, GI wires and special steels can be justified only after establishing the demand for these products in ASEAN countries. For stainless steel sheets of 600 mm width, 30,000 tons capacity plant considered is fairly large, but is not found economical in ASEAN countries. Therefore, the possibilities of rolling stainless steel slabs to hot rolled coils in a hot strip mill in one of the integrated steel plants in the region will have to be examined at the appropriate time.

Besides the study on minimum economic size for steel processes as discussed above, the economics of integrated steel plants for production of semis and finished products by the direct reduction-electric furnace (DR-EF) route and the blast furnace-basic oxygen furnace (BF-BOF) route has been examined. The study reveals the following:

Production of Semis

DR-EF route (1)		BF-BOF route (1)	
Capacity mill tons	Production cost US $/ton	Capacity mill tons	Production cost US $/ton
0.425	281-292(billets) 299-310(slab)	0.95	281-290 (billets) 285-294 (slabs)
1.275	253-263(billets) 267-277(slabs)	1.90	254-264 (billets) 257-267 (slabs)
1.900	247-256(billets) 252-262(slabs)	2.85	235-245 (billets) 235-244 (slabs)

NOTE
(1) Including 20 per cent interest and depreciation charges

Summary (cont'd)

Production of Finished Products

		Integrated steel plant	
		Production '000 t/yr.	Production cost US $/ton
Plates	..	600	353
HR strip/sheets	..	2,000	310
CR strip/sheets	..	1,000	428
Wire rods	..	600	334
Structurals	..	600	361

The study indicates that the production of semis by integrated plants could be competitive vis-a-vis imported semis. Therefore, even if steel processing units for production of hot rolled and cold rolled sheets, plates, structurals etc are established, these will have to be ultimately linked to integrated steel plants producing semis.

The study further indicates that the production of various categories of steel in integrated steelworks in the region would be competitive, even though major raw materials have to be imported.

Summary (cont'd)

ACTION ORIENTED PROGRAMME

Considering the above, the action oriented programme comprising short-term and long-term measures, is suggested as follows.

Short-term Measures

In order to increase the steel production and to take up implementation of various steel processing units expeditiously, the following short-term measures are suggested.

1. Merchant sponge iron plants should be set up in Indonesia, Malaysia and Thailand where natural gas is available. These could initially supply sponge iron to the existing and new arc furnace semi-integrated steel plants, to be expanded later to integrated steel plants for production of semis and finished products.

2. The price of gas obtained during field investigations is US $ 2.6 per Gcal in Indonesia, US $ 5.6 per Gcal in Thailand and US $ 8.0 per Gcal in Malaysia. For sponge iron to be competitive with the international price of scrap, natural gas which is one of the major inputs for sponge iron plant, will have to be reasonably priced.

Summary (cont'd)

3. With adequate availability of steel from electric arc furnaces, production of billets, wire rods, wire products, cold finished bars, GI wires etc can be taken up as national plants in the ASEAN countries. However, detailed feasibility studies will be necessary for determining the minimum economic size for these units.

4. The projects for medium structural mill and seamless pipe plant can also be considered in the short-term programme. However, adequate data on demand are not available to establish the product-mix and the capacity for these units. These projects can be taken up either as national projects or as regional projects after establishing the demand of each country based on proper market survey.

5. No information is available in regard to the demand for special steel and stainless steel products. However, these projects may be taken up in the short-term programme after establishing the demand of each country based on proper market survey. As the demand for special steel and stainless steel products may not be large enough for each country, these plants could be set up as regional plants.

Summary (cont'd)

Long-term Measures

The long-term measures involve setting up of large integrated steel plants for semis and finished products involving development of infrastructure, transport and communication facilities etc as discussed below.

1. Considering the regional demand of about 16.7 million tons per year by 1990 and 28.0 million tons per year by 2000, all the four ASEAN countries except Singapore will ultimately have one or two large integrated steel plants. Singapore will, however, be better placed for production of stainless steel, special steels etc.

2. At present, the production of steel in the ASEAN countries is mainly confined to bars and rods. Hence, bulk of the flat products in the form of hot rolled coils, cold rolled coils, plates and tin plates are being imported. It is, therefore, essential that the steel plants for manufacture of flat products should be established on a priority basis.

3. Philippines has hot and cold rolling mills but their utilisation is extremely poor because of the uncertain availability of semis and their fluctuating price in the international market. Therefore, it would be

Summary (cont'd)

prudent to tie up units for hot strip mill, cold strip mill, plate mill and tinning line with integrated steel projects as far as possible. Even if facilities for such products are established as steel processing units based on imported semis, their backward integration with iron and steelmaking facilities should be taken up immediately.

4. As the large integrated steel plant will have to depend upon imported raw materials for iron and steelmaking, and as the products of these plants will be distributed to the various ASEAN countries, it is essential that these plants should have port based locations.

5. The product-mix of the various integrated steel plants to be set up in the ASEAN countries should be complementary to each other so that the fast growing demand for various categories of steel can be largely met from these plants.

6. For efficient distribution of steel products to the various ASEAN countries from the steel plants, suitable shipping facilities will have to be established.

7. ASEAN countries should give preference to steel products from steel plants in the region so that fairly large capacity plants can be set up.

Summary (cont'd)

The success of the various short-term and long-term measures indicated above will, however, depend upon the seriousness of the ASEAN countries to work together and come to a proper understanding specially in regard to marketing, financing, pricing policy, shipping and product distribution, development of infrastructure, sharing of benefits and responsibilities etc.

1 - INTRODUCTION

The growth of the steel industry in the ASEAN countries has not kept pace with the increasing demand for steel in the region. In 1977, the estimated import of steel by the ASEAN countries was placed at 5 million tons crude steel equivalent. In 1978, compared to the domestic production of about 1.4 million tons of crude steel, the consumption was estimated at 7.8 million tons; and the deficit of 6.4 million tons had to be met by imports. This large and increasing deficit in domestic steel supply serves to emphasise the urgent need for the speedy expansion of the steel industry in the ASEAN countries, in order to reduce their present dependence on imports.

The economic size of the steel plant depends not only on the technological route employed but also on several other techno-economic factors. As multi-million steelworks require large capital resources, the ASEAN member countries are contemplating steel process units to restirct the initial capital investment, with possibilities for future backward integration.

1 - Introduction (cont'd)

OBJECTIVES OF THE STUDY

Keeping in view the above factors, this study on the minimum economic size plants for steel processes has been commissioned by UNIDO with a view to providing the ASEAN countries with broad techno-economic guidelines, which may assist them in making judicious decisions for capital investment in the steel industry, including the possibilities of establishing regional steel plants.

The selected steel processes for which the minimum economic size plants need to be determined are:

1. Billet plant
2. Wire rod mill
3. Structural shape mill
4. Bright bar plant
5. Seamless pipe plant
6. GI wire plant
7. Special steels plant
8. Stainless steel plant
9. Hot strip mill
10. Cold strip mill
11. Plate mill
12. Electrolytic tinning line

The major objectives and scope of this study are:

i) Identification of the minimum economic size plants for the individual steel processes, taking into account the specific local and working conditions obtaining in each ASEAN country.

1 - Introduction (cont'd)

ii) Determination of the minimum economic size iron and steel plants for meeting the semis (billets, blooms and slabs) requirements of the 'steel process' units in each country. The analysis will take into account the specific local and working conditions; the present status and likely future developments of the national steel industry; available technological alternatives; and the availability of raw materials, energy and other resources in each country.

iii) Comparison of the economics of installing the minimum economic size plants in each country with that of large regional plants for some selected 'steel processes', as well as multi-million ton integrated steel plants at hypothetical locations.

iv) Development of an action-oriented follow-up programme for individual ASEAN countries and for the region as a whole, taking into consideration the possibilities of integration of the ASEAN steel market, upward and downward integration of existing capacities as well as speedy implementation of planned projects in the various member countries.

FIELD INVESTIGATIONS

Keeping in view the objectives and scope of the study, the Consulting Engineers deputed a team of experts to the ASEAN countries to collect the relevant data/information and also to familiarise themselves with the conditions prevailing in the region. The team spent about five weeks in the project area meeting representatives of various Government agencies, planning bodies, iron and steel industry and also visited a number of steel producing/processing units.

On completion of the field work, the Consulting Engineers compiled the data/information made available by each country during the field visits and identified the gaps in the information. The consolidated information was forwarded to each country, requesting them to confirm the data collected by the field team and also to furnish the additional information, so that further work on the study may proceed on that basis.

INTERIM REPORT NO. 1

The Consulting Engineers submitted an Interim Report (No 1) in the first week of March 1980, outlining the work completed on the study till that time and identifying the areas in which further discussions with ASEAN representatives were necessary.

Subsequently, during the follow-up meeting held at Bangkok in March 1980 with the representatives of UNDP/UNIDO and the ASEAN countries, some clarifications/additional information were furnished by a few ASEAN countries. It was agreed that all the necessary information requested by the

1 - Introduction (cont'd)

Consulting Engineers in their questionnaires would be forwarded by the ASEAN countries so as to reach the home office of the Consulting Engineers latest by 15th April 1980. It was also decided that the Consulting Engineers will then take such information into consideration and make additional assumptions wherever necessary, while preparing the study.

INTERIM REPORT NO. 2

The Interim Report No 2 was submitted in July 1980 in accordance with Amendment No 1 to Contract. The Report was based on the data collected by the field team, additional information received from the ASEAN countries till 15th May 1980 and other published information available with the Consulting Engineers. The Report covered the basic assumptions made and logic used for determining the minimum economic size plants; and the preliminary findings with respect to plant capacities and production processes. UNIDO conveyed their acceptance of the Interim Report No 2 on 8th September 1980 by a cable, and requested Consulting Engineers to submit the Draft Final Report.

DRAFT FINAL REPORT

The Draft Final Report was submitted by Consulting Engineers in October 1980 in accordance with Amendment No 1 to Contract. UNIDO conveyed their acceptance of the Draft Final Report by a cable dated 4th November 1980. UNIDO also furnished their comments on the Draft Final Report vide their letter of 3rd November 1980. UNIDO's comments are summarised below:

i) A country-wise outline of the current situation of the iron and steel industry vis-a-vis minimum economic size plants for steel processes in ASEAN countries be presented as a summary.

ii) The computing process of IRR be furnished as well as a discussion of the factors influencing IRR be included.

STRUCTURE OF THE FINAL REPORT

The Final Report is now being submitted and takes into account the comments received from UNIDO. The report contains 22 chapters supported by appendices, charts and drawings and is presented in two volumes. Following this introductory chapter, the steel situation is discussed in Chapter 2. The raw materials and energy situation in the ASEAN countries is reviewed in Chapter 3; and the unit

1 - Introduction (cont'd)

prices of raw materials/energy/utilities/services and various finished/semi-finished steel products are discussed in Chapters 4 and 5 respectively. The economics of integrated plants for semis is discussed in Chapter 6. The criteria and logic adopted for determining the minimum economic size plants are set out in Chapter 7 and the minimum economic size plants for each of the 12 selected steel processes are determined in Chapters 8 to 19. The economics of steel production in large regional plants is discussed in Chapter 20 and an action-oriented programme to meet the growing demand of steel in the region, covering short-term and long-term measures is given in Chapter 21.

ACKNOWLEDGMENT

The Consulting Engineers gratefully acknowledge the invaluable guidance and cooperation extended by Dr C. Newman of UNDP (Bangkok), Dr B.R. Nijhawan of UNIDO (Vienna) and the UNDP/UNIDO representatives in the various ASEAN countries in the preparation of this study. The co-operation of the ASEAN Secretariat, Ministry of Industry as well as the various Government and private agencies in each country is also acknowledged.

2 - STEEL SITUATION IN THE ASEAN COUNTRIES

The iron and steel industry in the ASEAN countries is characterised by limited primary production of steel and sizeable secondary steel processing and finishing capacity, which is largely underutilised. These countries depend on large imports of semi-finished and finished steel products. The salient features of the present status of the iron and steel industry as well as the likely future situation in the individual ASEAN countries are reviewed, based on the available information. Also, in the light of future steel demand, the selected steel processes for different products as suggested by the ASEAN countries have been examined in this chapter.

PRESENT STATUS

At present there are two small integrated steel plants in the region; one in Malaysia with a crude steel capacity of 186,000 tons per year and another in Indonesia with a crude steel capacity of 540,000 tons per year. There are a number of semi-integrated plants with electric arc furnaces in the region with an aggregate annual capacity of about 3 million

2 - Steel situation in the Asean countries (cont'd)

tons of finished products. There are also a very large number of rerolling mills and other secondary processing units such as for production of welded pipes, galvanised sheets, wire and wire products.

Bars and rods are produced in all the countries. Only Philippines has facilities for production of hot and cold rolled sheets from imported slabs. Thailand and Philippines have tinning lines. Galvanised iron sheets are produced in all the countries except Singapore. The installed capacity in the region for the various steel products is given in Appendix 2-4 and summarised below:

		Production capacity tons/year
Bars & rods and sections	..	4,024,000
Hot and cold rolled sheets	..	1,102,000
Galvanised sheets	..	1,095,000
Welded pipes	..	1,003,000
Tin plates	..	180,000
Wire products	..	395,000[1]

NOTE
(1) Does not include Thailand and Philippines for which data is not available.

2 - Steel situation in the Asean countries (cont'd)

Thailand

There are five semi-integrated steel plants with a total steelmaking capacity of about 0.622 million tons per year and a rolling capacity of 0.605 million tons per year as given in Appendix 2-1. Although, one of these plants namely, the Siam Iron and Steel Co Ltd at Saraburi, has charcoal fired blast furnaces, the pig iron produced from these is used for foundries and the steelmaking is based on scrap melting.

There are eight rerollers in Thailand. Besides, there are five welded pipe plants, three galvanised sheet plants, one tinning line and six wire and wire product making units. The total production capacity and the number of producers are given in Table 2-1.

TABLE 2-1 - STEELMAKING AND PROCESSING UNITS IN THAILAND

Category	Number	Finished product capacity tons/year
Semi-integrated steel plants	5	605,000
Re-rolling mills ..	8	200,000
Welded pipe plants ..	5	154,000
Galvanised sheet plants ..	3	226,000
Tinning line ..	1	60,000
Wire and wire product manufacturers ..	6	...

Source: SEAISI Directory, 1979.

2 - Steel situation in the Asean countries (cont'd)

Malaysia

The major steel producer is the integrated steel plant of Malayawata Steel Berhad, with a crude steel capacity of 186,000 tons per year and a finished steel capacity of 157,000 tons per year of bars and rods. The major facilities installed in this plant are blast furnaces (one of 148 cu m and another of 240 cu m) using charcoal, two 15-ton LD converters, one 10-ton arc furnace, one 2-strand continuous billet casting machine and a bar mill.

There are three arc furnace based semi-integrated steel plants in Malaysia as listed below:

Plant	Steelmaking capacity tons/year	Rolling capacity tons/year
Dah Yung Steel Mfg Co (M), Kuala Lumpur ..	40,000	35,000
Malaysia Steel Works (KL), Petaling Jaya ..	30,000	24,000
United Malaysian Steel Mills Bhd, Selangor ..	55,000	48,000
Total ..	125,000	107,000

In addition, there are two re-rolling mills, ten welded pipe plants, six galvanised sheet plants and seven wire producers, with capacities as given in Table 2-2.

2 - Steel situation in the Asean countries (cont'd)

TABLE 2-2 - STEELMAKING AND PROCESSING UNITS IN MALAYSIA

Category	Number	Finished product capacity tons/year
Integrated steel plant ..	1	157,000
Semi-integrated steel plants	3	107,000
Re-rolling mills ..	2	128,000
Welded pipe plants ..	10	105,000
Galvanised sheet plants ..	6	135,000
Wire product plants ..	7	61,000

Source: SEAISI Directory, 1979.

Singapore

Bulk of the steel production in Singapore is accounted for by the National Iron and Steel Mill Limited, which has an arc furnace based steelmaking capacity of about 400,000 tons per year and a rolling capacity of 365,000 tons per year of bars and rods. Besides, Singapore has one re-rolling mill, two welded pipe plants and four units for the production of wire and wire products with capacities as given in Table 2-3. There is also one unit producing cold formed sections with a capacity of 50,000 tons per year.

2 - Steel situation in the Asean countries (cont'd)

TABLE 2-3 - STEELMAKING AND PROCESSING UNITS IN SINGAPORE

Category	Number	Finished product capacity tons/year
Semi-integrated steel plant	1	365,000
Re-rolling mill ..	1	12,000
Welded pipe plants ..	2	45,000
Wire product plants ..	4	60,000

Source: SEAISI Directory, 1979.

Indonesia

The Government owned plant of P.T. Krakatau Steel at Cilegon, which is an integrated steel works, is the major steel producer. This plant is based on the direct reduction arc furnace route. The direct reduction plant will have four HyL modules with a total capacity of 2 million tons per year and one of the modules has already gone into production. At present, the steelmaking capacity of this plant is 540,000 tons per year. There is a bar mill of 150,000 tons per year capacity, a wire rod mill of 250,000 tons per year capacity and a section mill of 80,000 tons per year capacity. Additional steel-making and rolling facilities for hot rolled flat products are under implementation.

2 - Steel situation in the Asean countries (cont'd)

There are eleven semi-integrated steel plants with arc furnaces for scrap melting, having a total steelmaking capacity of 698,000 tons per year as given in Appendix 2-2. In addition, Indonesia has a number of re-rolling mills mainly for production of bars and rods. There are also plants producing pipes, G.I. sheets, wire products etc. The number and capacities of the various steelmaking and processing units are summarised in Table 2-4.

TABLE 2-4 - STEELMAKING AND PROCESSING UNITS IN INDONESIA

Category	Number	Finished product capacity tons/year
Integrated steel plant ..	1	480,000
Semi-integrated steel plants	11	528,000
Re-rolling mills ..	15	297,000
Welded pipe plants ..	21	394,000
Galvanised sheet plants ..	13	267,000
Wire product plants ..	17	274,000

Source: SEAISI Directory, 1979.

Philippines

There are nine semi-integrated units in Philippines, eight with arc furnaces and one with open-hearth steelmaking facilities. The combined capacity of these units is about

2 – Steel situation in the Asean countries (cont'd)

1.53 million tons per year. Details of these units are given in Appendix 2-3. The most important of these units is the Government owned National Steel Corporation (NSC) which is the only flat product producer in the ASEAN region. NSC operates two rolling mills, one in Iligan City, Mindanao, and the other in Pasig, Manila. The Iligan plant has a capacity to produce about 962,000 tons per year of hot and cold rolled products, essentially based on imported slabs as the steelmaking capacity is very small. The major facilities installed in this plant are a steckel mill, a tandem cold rolling mill and a temper mill. The other unit, Pasig Steel Corporation, Pasig, has a cold rolling mill with a capacity of 140,000 tons per year.

Besides, there are twentyseven re-rolling mills, eight welded pipe plants, ten galvanised sheet plants and one tinning line. The number and capacity of the various steelmaking and processing units are given in Table 2-5.

TABLE 2-5 – STEELMAKING AND PROCESSING UNITS IN THE PHILIPPINES

Category	Number	Finished product capacity tons/year
Semi-integrated steel plants	9	1,525,000
Re-rolling mills ..	27	722,000
Welded pipe plants ..	8	305,000
Galvanised sheet plants ..	10	467,000
Tinplate manufacturer ..	1	120,000

Source: SEAISI Directory, 1979.

2 - Steel situation in the Asean countries (cont'd)

FUTURE PLANNING

The substantial gap between the demand and production capacity as well as future requirement of steel have prompted the member countries to draw up plants for augmenting steel production, as discussed below.

Thailand

Various studies relating to the development of the steel industry have been prepared. The latest study, commissioned by UNIDO was for a "Master Plan" on the development of steel industry in Thailand up to the year 2000. The study recommends the creation of an additional crude steel capacity of about 1.6 million tons per annum for production of 1.34 million tons of hot and cold rolled flat products, either by direct reduction arc furnace or the blast furnace-LD route.

A feasibility study for an integrated steelworks based on the direct reduction-arc furnace route has also been prepared by a West German consortium, which visualises the production of 1.5 to 1.8 million tons per year of sections and flats.

A sponge iron company, the Siam Ferro Industry Company, has been set up for production of sponge iron. This company is considering a merchant sponge iron plant of 400,000 tons per year capacity based on natural gas. The plant is expected to be located in Sattahip area.

2 - Steel situation in the Asean countries (cont'd)

There is also a proposal for setting up a billet plant by Rerollers Association to produce about 200,000 tons per year of billets for feeding the re-rolling mills. The plant envisages steelmaking with two 50-ton furnaces, one 4-strand billet caster to produce 100 to 150 mm square billets and a 3-hi cogging mill to roll 50 mm square billets for feeding the existing re-rolling mills. Thai Tinplate Manufacturing Co proposes to install a second tinning line of 60,000 tons per year capacity. An Indo-Thai joint venture to produce 16,600 tons per year of wire and wire ropes is also expected to come up. Thus, there are numerous development plans for the Thai steel industry. However, there are no known programmes for implementing any plan in the near future.

Malaysia

Malayawata Steel Bhd is going ahead with its plans for expanding the capacity to about 400,000 tons per year. Steel making capacity will be augmented by installing two arc furnaces of 50 and 60 tons capacities. A second continuous caster and a second bar mill of 270,000 tons per year are also proposed to be installed. The mill, which is being installed first, is scheduled for commissioning by late 1982 and will roll imported semis. Malayawata is also considering building of

2 - Steel situation in the Asean countries (cont'd)

a DR plant to feed the proposed expansion of its works and also supply sponge iron to an electric arc furnace plant envisaged by the Malaysian Government.

It is learnt that Malaysia's first direct reduction plant proposed to be located at Labuan may come up as a joint venture between the State of Sabah and a South Korean company. The project calls for the construction of a 600,000 tons per year sponge iron plant based on natural gas. A second DR project currently under consideration is the one being promoted by the Malaysian Industrial Development Agency. The project concept includes a 600,000 tons per year gas-based DR plant at Trengganu, along with an electric steelmaking shop and billet casting facilities.

Further, ten steel mills have been reportedly approved by the Government with a total capacity of 566,400 tons per year. Malaysian Tinplate Corporation, a joint venture of Malaysia and Japan, proposes to set up Malaysia's first electrolytic tinning line having a capacity of 90,000 tons per year. The plant, to be built by Kawasaki Steel Corporation at a cost of US $ 22 million at Pasir Gudang, is expected to start by mid 1982.

2 - Steel situation in the Asean countries (cont'd)

Singapore

At the National Iron and Steel Mills, oxy-fuel burners are being installed to improve the melting capacity of the arc furnaces and correct the imbalance in capacity between the melt shops and the rolling mills. The company is also installing a new wire rod mill of about 250,000 tons per year capacity, which is expected to be commissioned in 1983/84. This mill will raise the total rolling capacity of the plant to about 650,000 tons per annum.

Singapore will have two new steel pipe plants with more than 10,000 tons per month capacity. The first of the two units in Jurong Industrial Estate with a capacity of 4,000 to 5,000 tons per month went into production in early 1979. The second plant in its first phase was expected to be ready by the year end. The plants will be producing steel pipes for furniture making and galvanised iron pipes for the construction industry in the size from 12.7 to 406.4 mm outer diameter.

Indonesia

The second stage of development of the Cilegon plant of P.T. Krakatau Steel, now being implemented, is based on steelmaking in four 130-ton furnaces, slab casters and a million ton per year semi-continuous hot strip mill. On completion of this expansion programme scheduled for 1982-83, the plant will have a total capacity of over 1.5 million tons of crude steel per annum. The feasibility of installing cold rolling mills for the production of sheets and strip is also being examined. An electrolytic tinning line of 120,000 tons per year capacity, proposed as a joint venture of the State Tin Company, P.T. Tambang Timah and P.T. Krakatau Steel, is expected to be operational by 1985.

Philippines

An integrated steelworks at Mindanao is under consideration. The conventional blast furnace-LD route is suggested for adoption. Stage I of the proposed complex will have a crude steel capacity of 1.5 million tons per annum comprising 1.2 million tons of slabs and 0.3 million tons of billets/blooms. Rolling facilities will comprise a 1 million ton per annum hot strip mill and a billet mill. According to a Japanese feasibility study completed in February 1980, the 1.5 million ton steelworks is estimated to cost US $ 1,600 million.

2 - Steel situation in the Asean countries (cont'd)

Philippines Plate Mills Inc., a company with Japanese and Philippines interest, is to set up a plate mill with a capacity of 130,000 tons per year of plates. Besides, one 45-ton electric arc furnace and a slab caster are also envisaged as part of the project. The basic design of the plant has been completed and the plate mill of NKK's old Keihin works will be moved. The plant is expected to start by the end of 1983.

PRESENT CONSUMPTION

Trend in Steel Consumption

Steel consumption in the ASEAN countries has been steadily growing during the last decade, as can be seen from Table 2-6.

TABLE 2-6 - PAST CONSUMPTION OF CRUDE STEEL (thousand tons)

	1970	1972	1974	1976	1978
Thailand ..	743	827	1,234	1,377	1,600
Malaysia ..	388	466	987	840	1,300
Singapore ..	800	912	1,762	1,342	1,100
Indonesia ..	432	715	1,280	1,382	2,100
Philippines ..	1,351	798	1,214	1,203	1,700
Total ..	3,714	3,718	6,477	6,144	7,800

Source: Statistical Year Book, United Nations.

2 – Steel situation in the Asean countries (cont'd)

From Table 2-6, it will be seen that the crude steel consumption in the ASEAN region has registered an average annual growth rate of about 10 per cent during the period 1970-78. The growth rates in the individual countries have, however, varied considerably with Indonesia registering the highest growth rate of about 22 per cent, whereas in Singapore and Philippines the growth rates were only 4 and 3 per cent respectively.

Production and Imports of Steel

Production of crude steel, as well as the imports of semis and finished products, for the years 1977 and 1978 have been compiled in Appendix 2-5 and summarised in Table 2-7.

TABLE 2-7 – PRODUCTION AND IMPORTS OF STEEL IN 1977 AND 1978
(tons)

	Production Crude steel equivalent	Imports Semis	Imports Finished	Imports Total
1977				
Thailand ..	342,532	226,070 (1)	832,613	1,058,683
Malaysia ..	212,000	24,326 (1)	709,710	734,036
Singapore ..	215,000	24,700	977,683	1,002,383
Indonesia ..	250,000	167,800	984,432	1,152,232
Philippines ..	357,000	651,700	349,252	1,000,952
Total ..	1,342,532	1,094,596	3,853,690	4,948,286
1978				
Thailand ..	385,000	385,376 (1)	791,774	1,177,150
Malaysia ..	195,000	22,968 (1)	705,610	728,578
Singapore ..	280,000	55,520	699,550	755,070
Indonesia ..	225,000	180,147 (2)	1,086,497	1,266,644
Philippines ..	276,000	338,529 (2)	647,995	986,524
Total ..	1,361,000	982,540	3,931,426	4,913,966

NOTES
(1) Billets only.
(2) Billets only; Philippines also imports slabs.

2 - Steel situation in the Asean countries (cont'd)

From the above, it is seen that the ASEAN countries import substantial quantities of semis and finished steel products; the finished products amounting to about 75 per cent of the total imports. Considering an average conversion factor of 1.25 from finished steel to equivalent crude steel, the average imports in 1977, 1978 work out to over 5 million tons of equivalent crude steel. This amount represents almost 65 per cent of the crude steel consumption in 1978 and is about four times the total domestic production.

FUTURE DEMAND

Crude Steel

Preliminary projections of future crude steel demand in each ASEAN country have been attempted on the basis of the past trends and likely future growth in per capita steel consumption. The past consumption of crude steel per capita and projected trends are illustrated in Fig 2-1. Based on the future levels of per capita consumption projected in Fig 2-1, and projected population levels, the crude steel demand estimates are presented in Table 2-8.

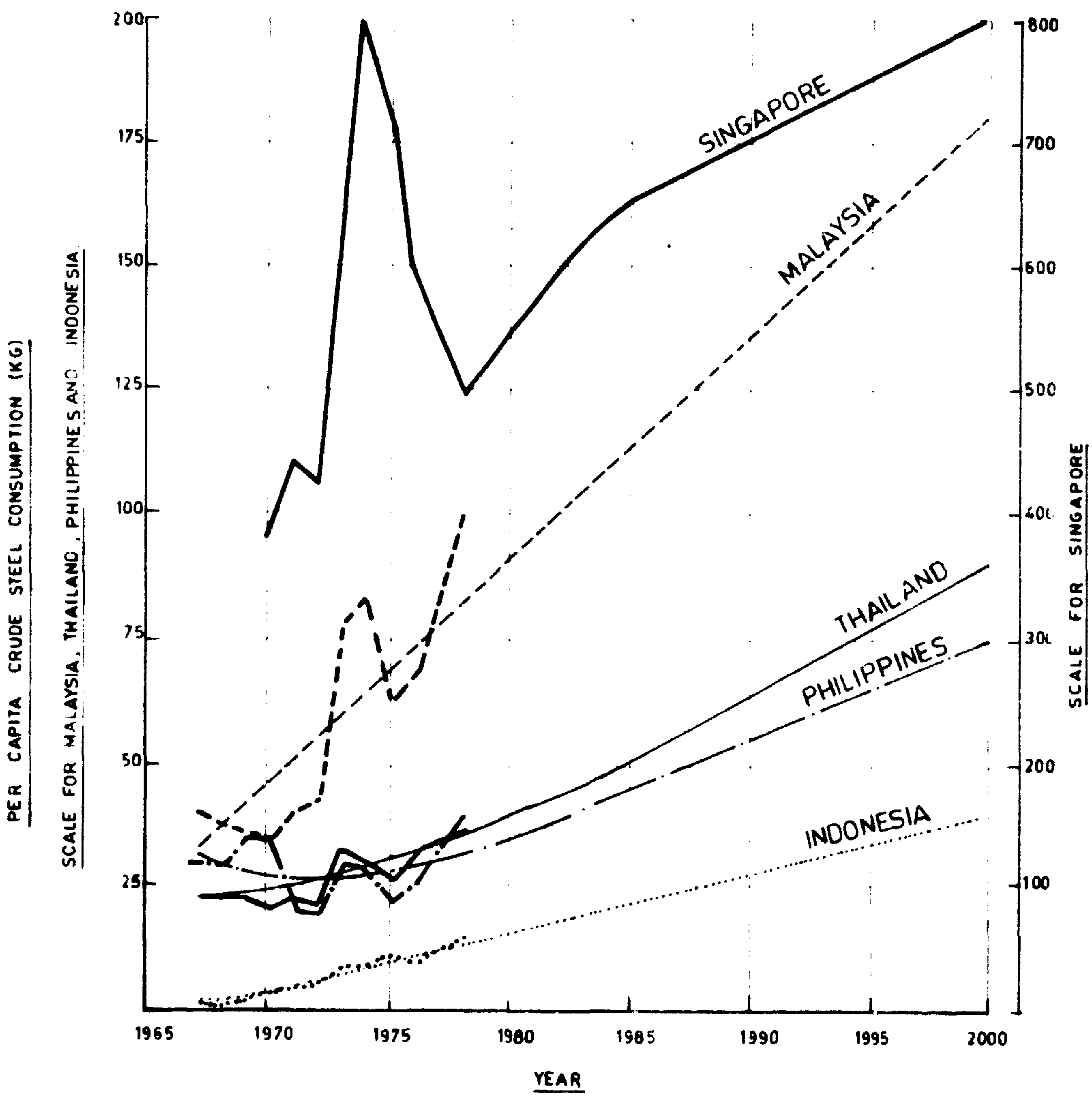


FIG. 2-1 — TREND IN PER CAPITA CRUDE STEEL CONSUMPTION IN ASEAN CONTRIES.

TABLE 2-C - PROJECTED CRUDE STEEL DEMAND

	1985			1990			2000		
	Per capita consumption kg	Population(1) mill.	Crude steel mill. tons	Per capita consumption kg	Population(1) mill.	Crude steel mill. tons	Per capita consumption kg	Population(1) mill.	Crude steel mill. tons
Thailand ..	50	55.0	2.8	65	60.0	4.0	87	75.0	6.5
Malaysia ..	110	16.0	1.8	135	17.0	2.3	180	23.0	4.1
Singapore ..	650	2.6	1.7	700	2.8	2.0	800	3.2	2.6
Indonesia ..	20	170.0	3.5	25	190.0	5.0	40	230.0	9.2
Philippines ..	45	55.0	2.5	55	60.0	3.4	75	75.0	5.6
ASEAN ..	41	298.6	12.3	51	329.8	16.7	69	406.2	28.0

NOTE

(1) Estimated, based on past data and likely future growth rates.

2 - Steel situation in the Asean countries (cont'd)

Demand projections for steel in the ASEAN countries have been attempted by various agencies, including a number of UN experts and study missions. The most recent projections are given below from which it will be observed that the projections made in Table 2-8 are in reasonably good agreement.

		Crude steel demand, mill. tons	
		1985	2000
Thailand	..	2.4	4.2
Malaysia	..	1.8	3.8
Singapore	..	1.2	1.7
Indonesia	..	3.3	8.5
Philippines	..	2.4	4.9
Total	..	11.3	23.1

Source: "Oceania - An emerging international entity" by L.J. Million, The Broken Hill Proprietary Company Limited, Australia, 1979.

Finished Steel

The estimates of crude steel demand have been broken down into various categories of flat and non-flat finished products, based on past consumption patterns in the ASEAN countries and trends observed in other countries with similar economies. The future demand estimates are presented in Table 2-9.

TABLE 2-9 - PROJECTED FINISHED STEEL DEMAND
('000 tons)

Product		Thailand 1985	Thailand 1990	Thailand 2000	Malaysia 1985	Malaysia 1990	Malaysia 2000	Singapore 1985	Singapore 199[illegible]
1. Bars and rods	..	660	900	1,345	355	400	660	315	3[illegible]
2. Wire rods	..	220	320	495	210	330	660	90	1[illegible]
3. Sections	..	200	290	445	170	185	230	230	2[illegible]
4. Others including rails and railway track material	..	20	30	50	15	20	35	15	[illegible]
Sub-total (1 to 4)	..	1,100	1,540	2,335	750	935	1,585	650	7[illegible]
5. Plates	..	20	30	100	160	220	410	315	3[illegible]
6. H.R. Sheets/strip	..	220	385	725	70	110	260	130	1[illegible]
7. C.R. Sheets/strip	..	150	290	620	125	185	380	85	1[illegible]
8. Tinplate	..	150	255	520	125	165	310	100	1[illegible]
9. Galvanised sheet	..	220	290	360	55	70	115	60	[illegible]
Sub-total (5 to 9)	..	760	1,250	2,325	535	750	1,475	690	8[illegible]
10. Pipes and tubes(1)	..	325	410	520	125	145	230	100	1[illegible]
TOTAL	..	2,185	3,200	5,180	1,410	1,830	3,290	1,440	1,7[illegible]

NOTE
(1) Includes welded pipes and seamless tubes.

SECTION 1

PROJECTED FINISHED STEEL DEMAND
('000 tons)

TABLE 2-9

Malaysia			Singapore			Indonesia			Philippines		
[illegible]	1990	2000	1985	1990	2000	1985	1990	2000	1985	1990	2000
5	400	660	315	360	465	900	1,240	2,010	560	810	1,300
[illegible]	330	660	90	100	145	375	580	1,075	190	270	450
0	185	230	230	260	335	320	410	595	130	190	270
15	20	35	15	20	10	30	40	75	20	30	45
50	935	1,585	650	740	955	1,625	2,270	3,755	900	1,300	2,065
160	220	410	315	385	575	245	390	810	225	350	585
70	110	260	130	170	265	115	210	595	110	190	405
25	185	380	85	120	190	205	370	740	95	135	310
125	165	310	100	100	120	160	225	445	190	240	360
55	70	115	60	60	70	145	165	295	225	295	450
35	750	1,475	690	835	1,220	870	1,360	2,885	845	1,210	2,110
25	145	230	100	140	215	405	495	780	130	190	310
10	1,830	3,290	1,440	1,715	2,390	2,900	4,125	7,420	1,875	2,700	4,485

SECTION 2

Anticipated Availability and Shortfall

Based on the review of the steel industry in the ASEAN countries, it will be seen that utilisation of the available steel capacity in the ASEAN countries in the past has been rather low. However, with the increasing awareness of these countries for the need to increase the domestic steel production, and with the various new schemes under implementation, future domestic steel availability is expected to improve considerably. The anticipated availabilities of various categories of finished steel products, in future, are indicated in Table 2-10. The availabilities for the various products are based on fuller utilisation of capacity already existing as well as likely productions from those schemes which are either being implemented or are in an advanced stages of planning.

It is to be noted that the availabilities of hot rolled strip/sheet and cold rolled strip/sheet indicated in Table 2-10 refer to the anticipated productions from hot strip mills and cold strip mills respectively. Since, part of the hot rolled strip is used for the production of cold rolled strip and welded pipes, these quantities cannot be assumed as market availabilities. Similarly, part of the cold rolled strip is used for the production of coated sheets and also for welded pipes.

TABLE 2-10 - ANTICIPATED FUTURE DOMESTIC STEEL AVAI
('000 tons)

Product		Thailand			Malaysia			S
		1985	1990	2000	1985	1990	2000	1985
1. Bars and rods including wire rods	..	565(3)	735(3)	775(3)	465(1)	600(1)	600(1)	420(2)
2. Sections	..	-	-	-	-	-	-	-
3. Plates	..	-	-	-	-	-	-	-
4. H.R. sheets/strip	..	-	-	-	-	-	-	-
5. C.R. sheets/strip	..	-	-	-	-	-	-	-
6. Tinplate	..	40	55	55	-	-	-	-
7. Galvanised sheet	..	160	205	205	95	120	120	-
8. Welded pipes and tubes	..	105	135	135	70	90	90	90

NOTES
(1) Includes production from new rolling mill of Malayawata Steel Bhd.
(2) Includes higher production from National Iron & Steel Mills on account of enhanced steel production in arc furnaces and new rolling mill.
(3) Includes additional production from Siam Iron & Steel Co.
(4) Includes production from new 130,000 tons per year plant of Philippines Plate Mills
(5) Production from new 1 million tons per year hot strip mill at Krakatau.
(6) Includes production from the two new pipe plants of Bee Huat Industries.

SECTION 1

...D FUTURE DOMESTIC STEEL AVAILABILITY
('000 tons)

TABLE 2-10

Malaysia		Singapore			Indonesia			Philippines		
1990	2000	1985	1990	2000	1985	1990	2000	1985	1990	2000
600(1)	600(1)	420(2)	540(2)	540(2)	910	1,170	1,170	750	965	965
..	-	-	-	-	100	125	125	10	15	15
-	-	-	-	-	-	-	-	130(4)	170(4)	200(4)
-	-	-	-	-	500(5)	750(5)	900(5)	295	300	380
-	-	-	-	-	-	-	-	345	440	440
-	-	-	-	-	-	-	-	85	110	110
120	120	-	-	-	185	240	240	300	390	390
90	90	90	125	150	250	325	325	160(6)	210(6)	210(6)

...a Steel Bhd.
... Mills on account of
... lling mill.
... Co.
...nt of Philippines Plate Mills Inc.
...mill at Krakatau.
...e Huat Industries.

SECTION 2

2 - Steel situation in the Asean countries (cont'd)

Keeping in view the above considerations, the likely shortfalls in selected categories of finished steel are given in Table 2-11.

CONCLUSIONS

In the light of the increasing gaps between the demand and supply of steel that are anticipated during the next two decades, the ASEAN countries are now considering various proposals for augmenting domestic steel production, including the installation of steel processing units as listed out in Chapter 1 as well as large integrated complexes with iron and steelmaking facilities. The likely future position with regard to demand and availability of products for each of the twleve selected steel processes are briefly discussed below.

i) Billets for re-rollers: The total re-rolling capacity in the region is put at 1,425,000 tons per annum. The billet requirement for the re-rollers alone would, therefore, amount to about 1.5 million tons per year based on current installed capacities.

ii) Wire rods: Information on past consumption pattern of wire rods, or likely future demand, is not available. The total likely shortfall of bars and rods, including wire rods, for

TABLE 2-11 - LIKELY FUTURE SHORTFALLS FOR SELECTED STEEL

('000 tons)

	Thailand			Malaysia			
	1985	1990	2000	1985	1990	2000	1985
1. Bars and rods including wire rods							
a) Demand ..	880	1,220	1,840	565	730	1,320	405
b) Availability ..	565	735	775	465	600	600	420
c) Shortfall ..	315	485	1,065	100	130	720	(+)15
2. Sections							
a) Demand ..	200	290	445	170	185	230	230
b) Availability ..	-	-	-	-	-	-	-
c) Shortfall ..	200	290	445	170	185	230	230
3. Plates							
a) Demand ..	20	30	100	160	220	410	315
b) Availability ..	-	-	-	-	-	-	-
c) Shortfall ..	20	30	100	160	220	410	315
4. H.R. Sheet/strip							
a) Demand(1) ..	1,280	1,960	3,300	615	825	1,580	565
b) Availability ..	-	-	-	-	-	-	-
c) Shortfall ..	1,280	1,960	3,300	615	825	1,580	565
5. C.R. Sheet/strip							
a) Demand(2) ..	590	940	1,675	340	465	895	275
b) Availability ..	-	-	-	-	-	-	-
c) Shortfall ..	590	940	1,675	340	465	895	275
6. Tinplate							
a) Demand ..	150	255	520	125	165	310	100
b) Availability ..	40	55	55	-	-	-	-
c) Shortfall ..	110	200	465	125	165	310	100
7. Galvanised sheet							
a) Demand ..	220	290	360	55	70	115	60
b) Availability ..	160	205	205	95	120	120	-
c) Shortfall ..	60	85	155	(+)40	(+)50	(+)5	60
8. Pipes and tubes							
a) Demand ..	325	410	520	125	145	230	100
b) Availability(3) ..	105	135	135	70	90	90	90
c) Shortfall ..	220	275	385	55	55	140	10

NOTES

(1) Includes hot rolled coil required for cold rolled products and for welded pipes a
(2) Includes cold rolled strip for tinplate and galvanised sheet.
(3) Refers to welded pipes only as there is no domestic production of seamless tubes.
(+) Denotes surplus.

TABLE 2-11

...RE SHORTFALLS FOR SELECTED STEEL PRODUCTS
('000 tons)

Malaysia			Singapore			Indonesia			Philippines		
1985	1990	2000	1985	1990	2000	1985	1990	2000	1985	1990	2000
565	730	1,320	405	460	610	1,275	1,820	3,085	750	1,080	1,750
465	600	600	420	540	540	910	1,170	1,170	750	965	965
100	130	720	(+)15	(+)80	70	365	650	1,915	-	115	785
170	185	230	230	260	335	320	410	595	130	190	270
-	-	-	-	-	-	100	125	125	10	15	15
170	185	230	230	260	335	220	285	470	120	175	255
160	220	410	315	385	575	245	390	810	225	350	585
-	-	-	-	-	-	-	-	-	130	170	200
160	220	410	315	385	575	245	390	810	95	180	385
615	825	1,580	565	695	1,000	1,115	1,620	3,190	955	1,315	2,275
-	-	-	-	-	-	500	750	900	295	380	380
615	825	1,580	565	695	1,000	615	870	2,290	660	935	1,895
340	465	895	275	310	415	570	840	1,625	590	770	1,280
-	-	-	-	-	-	-	-	-	345	440	440
340	465	895	275	310	415	570	840	1,625	245	330	840
125	165	310	100	100	120	160	225	445	190	240	360
-	-	-	-	-	-	-	-	-	85	110	110
125	165	310	100	100	120	160	225	445	105	130	250
55	70	115	60	60	70	145	165	295	225	295	450
95	120	120	-	-	-	185	240	240	300	390	390
(+)40	(+)50	(+)5	60	60	70	(+)40	(+)75	55	(+)75	(+)95	60
125	145	230	100	140	215	405	495	780	130	190	310
70	90	90	90	125	150	250	325	325	160	210	210
55	55	140	10	15	65	155	170	455	(+)30	(+)20	100

...led products and for welded pipes and tubes.
...alvanised sheet.
...nestic production of seamless tubes.

SECTION 2

the region is estimated at 765,000 tons in 1985 and 4,555,000 tons by the year 2000. Assuming that wire rods would constitute about 20 to 25 per cent of the total, the probable shortfalls in wire rods could be of the order of 150,000 to 175,000 tons in 1985 and about 1 million tons by the year 2000.

iii) Structurals: The demand for structurals in most ASEAN countries, who are still in their initial stages of industrialisation, is likely to be confined mainly to light and medium sections during the next decade. Light sections such as angles up to 50 x 50 mm can be rolled in the existing re-rolling mills producing bars and rods. Subsequently, as the industrial base is established and heavy fabrication work is taken up, the demand for heavier structurals is likely to pick up. The present production capacity for structurals in the region is almost entirely made up by Krakatau which has a capacity of 80,000 tons per year of structurals. Therefore, the total shortfall of about 940,000 tons in 1985 would be almost entirely for light and medium structurals. Of the total projected shortfall of about 1.75 million tons by the year 2000, it is expected that 70 to 80 per cent would be for the light and medium sections.

2 - Steel situation in the Asean countries (cont'd)

iv) HR sheet/strip: At present only Philippines has a plant with a capacity of 962,000 tons per year for HR sheet/strip. The regional shortfall by 1985 is expected to be almost 4 million tons, with the shortfall in Thailand alone being about 1.3 million tons. The shortfalls in each of the other four countries would be of the order of 0.5 million tons per annum. By the year 2000, the regional shortfall is likely to touch the 10 million ton level.

v) CR sheet/strip: At present only Philippines has a plant with a capacity of 140,000 tons per year for cold rolled products. The projected regional shortfalls are about 2.0 million tons and 5.5 million tons in 1985 and 2000 respectively. The countrywise shortfall for CR sheet/strip by 1985 and 2000 is projected as follows:

		1985 '000 tons	1990 '000 tons
Thailand	..	590	1,675
Malaysia	..	340	895
Singapore	..	275	415
Indonesia	..	570	1,625
Philippines	..	245	840

2 - Steel situation in the Asean countries (cont'd)

vi) Plates: There is no regular plate mill in any of the ASEAN countries at present. The steckel mill in Philippines can, however, produce light plates. The total shortfall in the region is estimated at about 0.8 million tons in 1985 and over 2 million tons in the year 2000.

vii) Tinplate: Only Thailand and Philippines have tinning lines at present. The regional shortfall for tin plates is projected at 600,000 tons per year by 1985 and 1.59 million tons per year by 2000.

viii) Others: The other products to be studied for the ASEAN countries are:

1. Cold finished bars
2. Seamless pipes
3. GI wires
4. Special steel bars
5. Stainless steel sheet/strip

Data on past consumption, product sizes and quality etc are not available for these items. Hence, Consulting Engineers have considered the minimum economic size plants for these products based on assumed product-mix.

3 - RAW MATERIALS AND ENERGY SITUATION IN THE ASEAN COUNTRIES

Iron ore ranks as the most important mineral material, as it constitutes the basic source of iron for blast furnace iron making and for direct reduction. Sponge iron and steel scrap form the feedstock for arc furnace steelmaking. Besides, other materials like limestone, dolomite, manganese ore and ferro-alloys are also employed in iron and steelmaking. The industry is a large consumer of energy, which is essentially supplied through coal in the conventional blast furnace-basic oxygen steelmaking route and by natural gas and electric power in the direct reduction-arc furnace route.

In this chapter, a brief review has been made of the raw materials and energy situation in the ASEAN countries, with a view to identify the availability of the inputs in the context of setting up new iron and steelmaking units in these countries. In the case of the major materials which are not available locally, and have to be imported, brief reviews of the world situation on these materials are presented in order to identify the possible sources of supply and estimate their likely costs.

3 - Raw materials and energy situation in the ASEAN countries (cont'd)

RAW MATERIALS

Iron Ore/Pellet

Iron ore occurs in all the ASEAN countries with the exception of Singapore. It has been worked for quite some time, primarily for meeting the domestic requirement for iron making in Malaysia and Thailand, and for export of iron sands of Indonesia. The reserves of iron ore, their grade etc are given in Table 3-1.

TABLE 3-1 - IRON ORE RESERVES IN THE ASEAN COUNTRIES

Country	Reserves (mill. tons)	Location	Fe content %
Thailand	48	Lop Buri, Kanchanburi, Chachoengsao, Loey	34 - 60
Malaysia	Small	Kedah, Perak, Johor, Pahang	52 - 62
Indonesia	32(1)	Kalimantan, Sumatra, Java	40 - 60 (TiO_2 - 10)
Philippines	71 3,800	Bulcan Mindanao and others	10 - 49 20 - 45 (TiO_2 - 10)

NOTE
(1) According to Indonesian Steel Plant Study by Broken Hill Pty Ltd, 1974

Source: Department of Mineral Resources, Bangkok
Department of Mines, Kuala Lumpur
Bureau of Industrial Mines, Jakarta
Bureau of Mines, Manila

3 - Raw materials and energy situation in the ASEAN countries (cont'd)

Of the potential reserves of 48 million tons in Thailand, over 35 million tons are of grades with iron content ranging between 34 and 54 per cent, with high sulphur and base metal contents and hence difficult to beneficiate. In Malaysia, most of the known reserves of iron ore have been exhausted and Malaysia has contracted with India for trial supplies of high grade ore. In Indonesia, large reserves of titaniferous magnetite deposits occur. The possibility of exploiting the Yogya iron sand of Java, through beneficiation, pelletisation and direct reduction for electric steel production has been indicated in a study in 1979 by IRSID, Paris. Philippines has large reserves of lateritic iron ore, containing titanium.

Thailand produced 88,121 tons of iron ore from Lopburi for Siam Iron and Steel Co., Saraburi in 1978. In Malaysia, the production of iron ore mostly from Kedah was 320,034 tons in 1978 and was meant for Malayawata Steel Bhd at Penang. The production of iron sand concentrate in Indonesia from Cilacap, east Java, was 311,519 tons in 1977 and was for export. In Philippines, iron ore production from Bulcan was very small; only 1,741 tons in 1978.

3 - Raw materials and energy situation in the ASEAN countries (cont'd)

It would be seen that none of the countries has any known large reserves of high grade ore. There is also no pellet plant in the ASEAN countries. Therefore, the needs of sized iron ore/pellets required for any large size steel plant in the region will have to be met through imports. Pellets are currently being imported from Brazil and Sweden for the sponge iron plant of P.T. Krakatau Steel in Indonesia. The only large facility for production of sinter (capacity 5 million tons), is the Philippines Sinter Corporation in Mindanao. At present about 3 million tons per year of sinter are produced from imported ore fines and exported to Japan. It is understood that the sinter plant at Mindanao has been set up for export of entire production of sinter to Japan. A brief review of the world iron ore/pellet situation and the likely sources of supply is presented in Appendix 3-1.

<u>Limestone</u>

Limestone is required for iron and steelmaking. The limestone for blast furnace use should have a CaO content of about 48 per cent and insolubles of about 10-11 per cent and that for steelmaking should have a CaO content of about 50 per cent and insolubles of about 4 per cent. Limestone occurs in plenty and is widely distributed in Thailand,

3 - Raw materials and energy situation in the ASEAN countries (cont'd)

Malaysia, Indonesia and Philippines. The current production in the countries is sizeable and is largely for catering to the cement industry. The requisite quality and quantity of limestone to meet the needs of the iron and steel industry is expected to be available locally in these countries; however, Singapore will have to depend on supply from the neighbouring countries.

Dolomite

Dolomite required in ironmaking should have about 29 per cent CaO, 20 per cent MgO and 5 per cent insolubles, while that for steelmaking should analyse about 30 per cent CaO, 21 per cent MgO and 1.5 per cent insolubles. Dolomite occurrences are known to be widespread in all the ASEAN countries, excepting Singapore. The current production is, however, limited. It is understood that local resources would be adequate to meet the requirements of the iron and steel industry in these countries, with the exception of Singapore which will have to rely on supplies from adjacent countries.

3 - Raw materials and energy situation in the ASEAN countries (cont'd)

Manganese Ore

Manganese ore of low grade with about 30 per cent Mn can be used in the blast furnace for ironmaking. High grade manganese ore with 45 to 48 per cent Mn and 6 to 7 per cent Fe is required for the production of standard ferro-manganese which is used in steelmaking. In Indonesia, reserves of 10 million tons of low grade manganese ore with 28 per cent Mn have been reported in central and west Java and Kalimantan. The ore is being worked and is exported in small quantities. The reserves of low grade ore are estimated at about 1.5 million tons in Philippines and at about 0.4 million tons in Thailand. The production of low grade ore in 1978 was 20,500 tons in Philippines and 65,500 tons in Thailand and the export in the same year was 5,800 tons and 46,500 tons respectively. Manganese ore is also available in Malaysia. The requirements of manganese ore in all the countries, except Singapore, could be met from local resources.

Ferro-alloys

Ferro-manganese (high carbon) and ferro-silicon are the two major ferro-alloys required for steelmaking. Other ferro-alloys such as low carbon ferro-manganese, ferro-chromium and ferro-nickel etc are required in small quantities for production of special steels.

3 - Raw materials and energy situation in the ASEAN countries (cont'd)

Malaysia, according to "Bulletin of Statistics, Department of Mines", is the largest producer in the ASEAN countries of ferro-manganese; it produced about 94,100 tons and exported 23,740 tons in 1976. Philippines produced 2,310 tons of ferro-manganese and 7,740 tons of ferro-silicon in 1977. Thailand is a very small producer with about 1,100 tons of ferro-manganese and 1,300 tons of ferro-silicon in 1978. Ferro-nickel is produced in Indonesia by the State Mining Enterprise, P.T. Aneka Tambang, which has capacity of 25,000 tons per year. The production in 1977 was 21,570 tons. The requirements of ferro-alloys for the new projects in ASEAN countries could be met from available local production and augmented by imports.

Steel Scrap

Steel scrap is the traditional melting stock for arc furnace steelmaking, and in view of the predominance of electric steelmaking in the ASEAN countries, it has assumed considerable significance. The requirements of scrap at present are met partly through imports and largely from domestic collection. The imports of scrap by the ASEAN countries for recent years are shown in Table 3-2.

3 - Raw materials and energy situation in the ASEAN countries (cont'd)

TABLE 3-2 - SCRAP IMPORTS BY THE ASEAN COUNTRIES
('000 tons)

	1975	1976	1977	1978
Thailand	257.2	275.6	443.6	802.0
Malaysia	6.1	2.8	2.6	0.6
Singapore	96.1	54.8	23.5	92.9
Indonesia	16.0	29.5	47.1	80.7
Philippines	61.4	106.2	62.2	65.0

Source: Steel Statistics for Member Countries, SEAISI - Summary of Imports and Exports, March 1979.

It may be noted that the scrap imports shown above include re-rollable scrap and iron scrap; hence, it is difficult to estimate the precise quantities of steel scrap imported for use in electric furnace steelmaking. Thailand is the biggest importer of scrap among the ASEAN countries, while Indonesia, Philippines and Singapore import considerably smaller quantities of scrap.

The contribution of domestic scrap to the electric furnace charge has been sizeable in all the ASEAN countries. Malaysia's import of scrap is negligible and hence, domestic collection accounts for the requirement of scrap for electric steelmaking. The share of domestic scrap in the electric furnace charge in steelmaking in the other four ASEAN countries for 1977 is shown in Table 3-3.

TABLE 3-3 - SHARE OF DOMESTIC SCRAP IN ELECTRIC FURNACE CHARGE - 1977

	Electric furnace steel production (1) '000 tons	Total scrap consumption (2) '000 tons	Domestic scrap (3) '000 tons	Share %
Thailand	308.5	328.2	230.0 (4)	70.1
Singapore	215.0	228.8	213.9	93.5
Indonesia	187.5	199.5	152.4	76.4
Philippines	234.4	249.4	187.6	75.2

NOTE
(1) Source: "Steel Statistics for Member Countries" - Production, SEAISI, April 1979.
(2) Based on estimated scrap consumption of 1,064 kg per ton of liquid steel.
(3) Based on total scrap consumption minus net imports.
(4) Figure indicated by Department of Mineral Resources, Bangkok.

It is seen that so far domestic scrap accounts for about 70/76 per cent of the furnace charge in Indonesia, Philippines and Thailand and about 93 per cent in Singapore. This represents the position of domestic scrap availability in relation to the present level of steel production.

However, the demand for steel scrap by the new steel producing units envisaged will be considerable. As domestic scrap generation cannot be expected to increase on a large scale, import of scrap will be necessary.

In this context, it is significant to consider the progressive replacement of scrap by sponge iron. P.T. Krakatau Steel has commenced production of sponge in one of the four modules of the plant, each of 0.5 million tons per year capacity. The sponge has been successfully used in electric steelmaking by Krakatau Steel and in other countries of the region as well. If more sponge iron is available from Indonesia in future, it could alter the position of the import of steel scrap by the ASEAN countries. Due to availability of natural gas, the sponge iron plants based on gaseous reduction are also being planned in Thailand and Malaysia for increasing steel production through arc furnace route.

3 - Raw materials and energy situation in the ASEAN countries (cont'd)

ENERGY SITUATION

Metallurgical Coal

There are no known occurrences of coking coal in the ASEAN countries. Thailand has reserves of 245 million tons of lignite distributed in three provinces. In Malaysia, some blendable coal has been reported in Sarawak. In Indonesia, 500 million tons of non-coking coal reserves have been reported to occur in Sumatra. In Philippines, about 5 million tons of coal are known to occur in Malangas, Cebu.

The requirements of coking coal for the future iron and steel industry in the ASEAN countries will have to be met by imports. In this context, a brief review of the world coal situation is given in Appendix 3-2. Some of the traditional coal exporting countries include Australia, Canada, Poland, USSR and U.S.A. In considering the sources of coal for the ASEAN countries, imports from Australia will have an advantage in terms of the transportation cost.

Oil

Indonesia is endowed with considerable petroleum reserves amounting to 11,265 million barrels. The annual production of crude oil which was about 312 million barrels in 1970, had gone up to 477 million barrels in 1975 and to 615 million barrels in 1977. A large part of the crude is exported, as for example 363 million barrels in 1975, equivalent to about 75 per cent of the country's production. In Malaysia, crude oil production was 60.6 million barrels in 1976, of which 52.6 million barrels were exported. In Philippines, oil has been struck recently off the shore of Palawan, where a reservoir volume of 27,700 barrels per day has been indicated. Offshore oil is also reported in the Gulf of Thailand.

Natural Gas

Natural gas discoveries have been made recently in the ASEAN countries. The natural gas reserves of Indonesia are estimated at 283 million cu m. The sponge iron plant of P.T. Krakatau Steel gets its natural gas supply from the offshore gas fields over a distance of about 200 km. Indonesia has plans for boosting liquid natural gas production by 1984. In Malaysia, offshore reserves of Sarawak are estimated to be in the range of 283 to 566 million cu m as associated gas. The calorific value of the gas is around 8,895 Kcal per cu m but no analysis is available as yet.

In Philippines one gas/condensate discovery in the Reed Bank area has been made, which gives hope of gas availability.

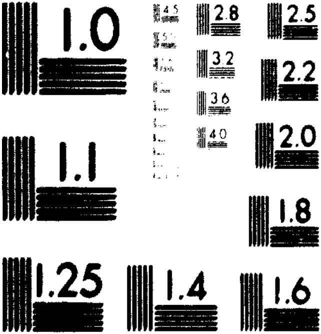
Discoveries of natural gas in commercial quantities have been made in the Gulf of Thailand. In this connection, the Consulting Engineers had discussions with the Petroleum Authority of Thailand. On the basis of information gathered, it is noted that the reserves in Union Oil Co's 'A' structure, located 410 km south of Sattahip, are estimated to be in the range of 28 to 65 million cu m and those in 'B' structure of Texas Pacific to be 28 to 113 million cu m. The Natural Gas Organisation of Thailand has plans to boost the gas on stream by mid 1981 for use in power generation, and by 1983 for sponge iron production. The calorific value of the gas in 'A' structure is 9,428 Kcal per cu m.

SOURCES OF RAW MATERIALS AND ENERGY

Based on a review of the raw materials and energy situation in the ASEAN countries and a review of the world situation for some materials, the possible sources have been identified as shown in Table 3-4. It needs to be mentioned that for certain items which are available in a particular ASEAN country, the possibility of supplying such items to the other ASEAN countries would merit serious consideration.

TABLE 3-4 - SOURCES FOR RAW MATERIALS AND ENERGY FOR THE ASEAN COUNTRIES

Item		Thailand	Malaysia	Singapore	Indonesia	Philippines
Iron ore	..	Imported	Imported	Imported	Imported	Imported
Pellet	..	Imported	Imported	Imported	Imported	Imported
Manganese ore	..	Local	Local	Imported	Local	Local
Limestone/Dolomite	..	Local	Local	Imported	Local	Local
Ferro-alloys	..	Local/ Imported	Local/ Imported	Imported	Local/ Imported	Local/ Imported
Steel scrap	..	Local/ Imported	Local/ Imported	Local/ Imported	Local/ Imported	Local/ Imported
Metallurgical coal	..	Imported	Imported	Imported	Imported	Imported
Oil	..	Imported	Local	Imported	Local	Imported
Natural gas	..	Local	Local	-	Local	-



MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS 1963-A

4 - MATERIALS, ENERGY AND LABOUR COSTS

The possible sources of the raw materials and energy inputs have been indicated in Chapter 3. In this chapter, the prices of the various materials, the energy costs and the wages and salaries have been estimated to serve as a basis for determining the production costs of the various items. The prices of steel products comprising input materials and finished products for the twelve selected steel processes, are separately discussed in Chapter 5. In determining the prices and costs, local conditions prevailing in the ASEAN countries have been taken into consideration. The prices and costs estimated and the basis adopted for arriving at these are discussed below.

MATERIALS

The prices of locally available materials have been determined based on the data collected during the field study in early 1980. These have also been checked against the prevailing international prices. For materials which are not locally available and have to be imported, prices

4 - Materials, energy and labour costs (cont'd)

prevailing in the international market during the first quarter of 1980 have been considered. The prices indicated for imported materials do not include any import duties as it is expected that raw materials for basic industries such as steel will be allowed duty free in all the countries. However, prevailing port charges and business/sales tax have been included wherever applicable. The basis for determining the various prices is given in Appendix 4-1.

The prices estimated by Consulting Engineers were forwarded to the ASEAN countries for their comments and confirmation. Replies received from Indonesia and the Philippines, have been considered. The prices of materials, as adopted in this report, are shown in Table 4-1. It may be observed that the prices of materials vary marginally from country to country. However, the price of domestic steel scrap varies considerably between $ 70 per ton in Malaysia and $ 120 per ton in Indonesia.

4 - Materials, energy and labour costs (cont'd)

TABLE 4-1 - PRICES OF MATERIALS
(US $ per ton)

Item	Thailand	Malaysia	Singapore	Indonesia	Philippines
Sized iron ore - BF grade (63% Fe)	33	33	32	33	32
Sized iron ore - DR grade (65% Fe)	36	36	35	36	36
Pellet - DR grade (66% Fe)	48	48	46	48	41
Steel scrap - domestic	115	70	85	120	95
Steel scrap - imported	150	140	160	140	151
Coal - metallurgical	68	66	64	73	78
Limestone	4	4	7	4	7
Dolomite	12	12	15	14	11
Manganese ore (35% Mn)	36	35	34	33	34
Fluorspar	55	62	60	61	83
High C ferro-manganese	560	545	525	543	540
Ferro-silicon	1,000	970	930	875	1,200
High C ferro-chrome	1,020	990	950	910	1,050
Low C ferro-chrome	2,590	2,500	2,410	2,440	2,650
Nickel	7,700	7,400	7,100	7,300	7,800
Zinc	860	830	800	790	830
Aluminium	1,370	1,370	1,370	1,400	1,370
Tin	17,000	16,500	17,000	16,400	18,000
Graphite electrodes	2,600	2,500	2,400	3,560	2,850

4 - Materials, energy and labour costs (cont'd)

ENERGY

The fuel oil price is the lowest in Indonesia owing to the local crude production, but is the highest in Singapore where the crude oil is entirely imported. Natural gas is already being used at Krakatau steel plant in Indonesia. It may also be made available for the proposed steel plants in Thailand and Malaysia. Based on the prevailing tariff for electrical energy, lowest unit cost is obtained in Indonesia and the highest in Philippines. Based on the data collected during the field study, the following prices are considered in this report for fuel oil, natural gas and electrical energy.

	Fuel oil US $ per ton	Natural gas US $ per G cal	Electric power US $ per kWh
Thailand ..	150	5.6	0.050
Malaysia ..	180	8.0	0.050
Singapore ..	275	-	0.055
Indonesia ..	67	2.6	0.040
Philippines ..	220	-	0.066

It may be noted that the price of natural gas will have bearing on the economics of steel production by the direct reduction arc furnace route. It is reported that natural gas to Krakatau steel plant is being supplied at US $ 2.6 per G cal, but it could not be confirmed. For the proposed steel plants based on direct reduction-arc furnace route, the price of natural gas indicated is US $ 5.6 G cal in Thailand and US $ 8.0 per G cal in Malaysia. However, the Government of Thailand and Malaysia have not decided on the price of natural gas for supply to the future steel plants.

LABOUR

The average wages and salaries for the different categories of managerial and operational staff as obtained during the field visit in each country are given in Table 4-2.

TABLE 4-2 - AVERAGE MONTHLY WAGES AND SALARIES IN THE ASEAN COUNTRIES
(US $)

Category	Thailand	Malaysia	Singapore	Indonesia	Philippines
Superintendent/ Manager	1,000	1,000	1,500	500	750
Senior Engineer	650	800	950	400	340
Engineer	340	400	700	350	290
Skilled worker	195	190	420	175	120
Unskilled worker	100	103	190	100	85

4 - Materials, energy and labour costs (cont'd)

Based on the above, and considering the probable mix of different categories of personnel, the average wages and salaries per man year for each country has been assumed as follows:

		US $ per man year
Thailand	..	2,800
Malaysia	..	2,900
Singapore	..	5,200
Indonesia	..	2,200
Philippines	..	1,900

5 - PRICES OF STEEL PRODUCTS

The prices of the various input materials required for production of steel in integrated steel plants have already been discussed in Chapter 4. This chapter deals with the prices of the various input materials and the finished products for the selected steel processes. In estimating the prices, the prevailing prices of the various steel products in each country during the first quarter of 1980, have been taken into consideration.

In order to adopt realistic prices of the input materials and the finished products reflecting the local conditions in each country, CONSULTING ENGINEERS held discussions with various agencies to gather information on the prevailing price situation. For products whose local prices were not available, prevailing international prices have been adopted.

5 - Prices of steel products (cont'd)

The steel processes with their corresponding input materials and finished products are listed in Table 5-1.

TABLE 5-1 - INPUT MATERIALS AND FINISHED PRODUCTS

Steel process	Input material	Finished product
Billet plant	Steel scrap	Billet
Wire rod mill	Billet	Wire rod
Structural shape mill	Bloom/billet	Structurals
Cold finished bar mill	Bars/wire rod	Bright bars
Seamless tube plant	Bloom	Seamless tubes
GI wire plant	Wire rod	GI wire
Special steels plant	Steel scrap	Bars, rods etc
Stainless steel plant	Steel scrap	HR/CR coil/sheet
Hot strip mill	Slab	HR coil/sheet
Cold strip mill	HR coil	CR coil/sheet
Plate mill	Slab	Plate
Electrolytic tinning line	CR coil	Tinplates

PREVAILING PRICE STRUCTURE

The prices obtained from the different agencies during the field visit were in certain cases at variance. Therefore, after compilation and collation of the field data, CONSULTING ENGINEERS attempted to rationalise the prices.

Preliminary estimates of the prices were forwarded to the respective authorities in each ASEAN country for their comments. Replies were received from Indonesia and Philippines in this regard and the information provided by these two countries have been adopted as the basis for the prices considered in this report. For other countries, prevailing international prices have been considered.

In Singapore, no duty is levied on imported steel products. The applicability of duty on different steel products in Malaysia could not be ascertained. The duties leviable on imported steel products in the other countries are given in Appendix 5-1.

PRICES OF INPUT MATERIALS

Of the various input materials, the price of steel scrap has already been discussed in Chapter 4 and prices of other input materials required for the selected steel processes are discussed below.

Billets/blooms and slabs, though traded, are not currently quoted in the international market, while hot rolled and cold rolled coils, as also bars and wire rods, are regularly quoted on the world markets. An analysis of the

5 - Prices of steel products (cont'd)

data on the prices of these materials, collected during the field investigations, as given in Appendix 5-2, shows wide variations in some cases. Therefore, where necessary, prevailing international prices have been considered as the guide to arrive at rational prices.

The details with regard to estimation of the prices of the various input materials are presented in Appendix 5-3 and summarised in Table 5-2. The prices indicated are inclusive of port charges, sales tax and business tax as applicable, but no import duties have been considered.

TABLE 5-2 - PRICES OF INPUT MATERIALS(1)
(US $ per ton)

Item	Thailand(2)	Malaysia(2)	Singapore(2)	Indonesia(3)	Philippines(4)
Billet/ bloom(5)	320	310	300	300	300
Slab	260	255	245	250	255
HR coil	360	350	340	350	355
CR coil	445	430	415	425	500
Wire rod	415	405	390	410	400
Bars	395	385	370	405	405

NOTES
(1) Including all taxes/levies but excluding import duties.
(2) Based on prevailing international prices.
(3) Based on information from Department Perindustrian R.I, Direktorat Jenderal Industri Logam Dasar, Jakarta.
(4) Based on information received from Metals Industry Research & Development Center, Manila.
(5) Average price of billets and blooms.

5 - Prices of steel products (cont'd)

SELLING PRICES OF FINISHED PRODUCTS

The existing steel industry in the ASEAN countries is mainly confined to the manufacture of bars and rods. Wires and wire products, mainly based on imported wire rods, are also manufactured in all the countries. Galvanized iron sheets and welded pipes are produced in all the countries except Singapore, mainly from imported hot rolled and cold rolled coils and sheets. Besides, bright bars are produced in Malaysia and Thailand; structurals in Indonesia; hot and cold rolled strip and sheets in Philippines; and tinplates in Philippines and Thailand. The selling prices of a few steel products, presently being produced in ASEAN countries, collected during the field study, are given in Appendix 5-4.

Philippines and Indonesia have furnished the selling prices for certain products. While the selling prices furnished by Indonesia are generally conforming to the international prices, the prices furnished by Philippines for certain finished products are higher than the prevailing international prices. For the purpose of the study, the prices furnished by Philippines and Indonesia have been taken as the basis for these countries after making suitable

5 - Prices of steel products (cont'd)

adjustment to exclude the incidence of import duty. For other countries namely, Thailand, Malaysia and Singapore who have not furnished the selling prices of steel products prevailing in the respective countries, these have been estimated based on the current international prices.

Details of the computation of selling prices are shown in Appendix 5-5 and summarised in Table 5-3.

TABLE 5-3 - SELLING PRICES OF FINISHED PRODUCTS[1]
(US $ per ton)

Product	Thailand	Malaysia	Singapore	Indonesia	Philippines
Billets/bloom[2]	300	300	300	295	275
Slab	245	245	245	245	235
Wire rod	390	390	390	390	375
Bright bars	560	560	560	565	560
G I wire	575	575	575	575	575
Structurals	405	405	405	405	450
HR sheet	360	360	360	365	390
HR coils	340	340	340	340	325
CR sheet	430	430	430	425	495
CR coil	415	415	415	415	455
Plates	370	370	370	365	390
Tinplates	700	700	700	700	700
Seamless tubes	860	860	860	860	860
Stainless steel sheet/strip	2,090	2,090	2,090	2,315	2,090
Special steel bars/rods	620	620	620	620	620

NOTES
(1) Net prices excluding taxes and levies.
(2) Average price of billets and blooms.

5 - Prices of steel products (cont'd)

It may be noted that the selling prices considered represent the net sales realisation per ton of products and do not include any government taxes and levies. If the incidences of tax applicable are taken into account, the prices will be equal to the input prices as given in Table 5-2.

As discussed earlier, import duty is levied on steel products in Philippines, Indonesia and Thailand. The duty structure is generally oriented to protect the indigenous producers against competition from imports. For example, the duty on bars, the production of which is substantial, varies between 20 and 50 per cent. In philippines, where hot and cold rolled sheets are produced, there is a duty of 10 and 30 per cent respectively if these items are imported. A comparison of the selling prices with and without the incidence of duty is given in Table 5-4 for Thailand, Indonesia and Philippines. For the purpose of this study, however, no tariff protection is considered and the prices as indicated in Table 5-3 have been adopted.

5 - Prices of steel products (cont'd)

TABLE 5-4 - EFFECT OF IMPORT DUTY ON SELLING PRICES
(US $ per ton)

Product	Indonesia		Philippines		Thailand	
	Without protection	With protection	Without protection	With protection	Without protection	With protection
Billet/bloom	295	295(1)	275	275(1)	300	300(1)
Slab	245	245(1)	235	235(1)	245	245(1)
Wire rod	390	465	375	470	390	395
Bright bar	565	620	560	615	560	570
G I wire	575	600	575	630	575	590
Structurals	405	425	450	570	405	415
HR sheet	365	425	390	430	-	-
HR coil	340	355	325	355	340	345
CR sheet	425	505	495	630	-	-
CR coil	415	435	455	590	415	420
Plates	365	430	390	430	370	380
Tinplate	700	700(1)	700	1,050	-	-
Stainless steel sheet/strip	2,315	2,635	2,090	2,300	2,090	2,105
Seamless tubes	860	945	860	945	860	880
Special steels bars/rods	620	650	620	680	-	-

NOTE
(1) No import duty.

6 - INTEGRATED PLANT FOR SEMIS

Semis like billets, blooms and slabs are the major input materials for production of various finished rolled products such as wire rods, structurals, strip/sheets and plates. Assured availability of adequate quantities of semis at reasonable prices, therefore, largely influences the economics of producing rolled products.

In determining the minimum economic sizes for the various 'process' plants, it has been assumed that semis would be procured from the international market. However, the availability of semis in the international market is prone to wide fluctuations. During periods of steel shortage, when world steel supply is unable to match the heavy demand, the major exporting countries like USA and Japan prefer to export steel as finished products which fetch higher sales revenue and enable better utilisation of installed rolling capacity. This results in restricted availability of semis in the export market. On the other hand, during periods of steel recession, the situation is

6 - Integrated plant for semis (cont'd)

quite the opposite and the major exporters are forced to seek markets for export of steel even in the form of semis so as to utilise atleast a part of the iron and steelmaking capacity. These periodic variations in the availability of semis are also reflected in their prices quoted on the international market.

Keeping in view the fluctuating international market for semis, it is worthwhile to examine the feasibility of creating additional integrated iron and steelmaking capacities in the ASEAN countries, for assured supply of semis at reasonable prices. This would, in turn, reasonably guarantee better utilisation of installed capacity and favourable operational economics of rolling mills that are likely to be installed in these countries, where imported steel products are threatening the very existence of the domestic steel industry.

The choice of technology and the investment economics of the selected routes for production of semis are discussed in this chapter.

6 - Integrated plant for semis (cont'd)

CHOICE OF TECHNOLOGY

The three major routes available for the production of steel are:

i) Scrap based electric arc furnace route
ii) Direct reduction-electric arc furnace (DR-EF) route
iii) Blast furnace-basic oxygen furnace (BF-BOF) route.

The choice of one technology or the other is governed by various techno-economic factors, the more important amongst them being:

a) Availability and price of major raw materials that is, iron ore pellets, coal and flux
b) Availability and price of steel scrap
c) Availability and price of natural gas
d) Availability of infrastructure facilities
e) Availability of manpower
f) Investment and operating costs

The situation in each ASEAN country with respect to major raw materials, steel scrap and natural gas has been reviewed in Chapter 3. From the review, it will be seen that there are no known deposits of suitable quality

6 - Integrated plant for semis (cont'd)

metallurgical coal or iron ore in any of the five countries. The availability of steel scrap is somewhat limited in the region. Hence, adequate steel scrap would not be available to sustain large-scale steel production in electric arc furnaces. Natural gas is already available in Indonesia and Malaysia; and is expected to be available in Thailand in a couple of years. No known reserves of natural gas exist in Philippines and Singapore.

The situation with regard to availability of infrastructure facilities and manpower is generally similar in all the ASEAN countries. However, availability of land, skilled manpower, electric power, water and other infrastructure facilities required for the construction and operation of a large steel complex could pose problems in Singapore. Further, due to limited land and stringent pollution control measures, Singapore may not be suitable for a large integrated steel plant.

6 - Integrated plant for semis (cont'd)

From the above discussion, the following conclusions emerge:

i) Steelmaking in Singapore would primarily have to rely on the scrap based electric furnace route employed in mini steel plants. The economics of such plants has been discussed in Chapter 8.

ii) Large scale steel production in the region will have to be based on integrated iron and steel production due to the shortage of domestic steel scrap availability.

iii) Both the DR-EF and BF-BOF routes would have to be based on imported iron ore/pellets in all the ASEAN countries. The BF-BOF route will necessitate, additionally, imports of coking coal/coke, while the DR-EF route could utilise the locally available natural gas.

iv) As there are no known occurrences of natural gas in Philippines, only the BF-BOF route merits consideration in this country.

v) In the case of Indonesia, Malaysia and Thailand both the DR-EF and BF-BOF routes merit consideration. The ultimate choice of one route over the other will depend upon their relative economics.

The economics of semis production in scrap based mini steel plants, for Singapore, has been evaluated while determining the minimum economic size for billet plant. This chapter, therefore, briefly describes the DR-EF and

BF-BOF routes, indicates the major production facilities and their rated capacities, and presents overall estimates of capital and production cost up to the semis stage for the four countries i.e. Thailand, Malaysia, Indonesia and Philippines.

THE DR-EF ROUTE

The DR-EF process utilises sponge iron together with steel scrap as the metallic charge in electric arc furnace. A schematic flow-sheet of the DR-EF process is presented in Fig 6-1.

Although direct reduction technology has been around for many years, it has become commercially acceptable and attractive only recently. Rapid developments in electric arc furnace steelmaking, concern over the availability of quality metallurgical coal at reasonable prices for the conventional BF-BOF route, unpredictable and fluctuating scrap supply, and availability of alternative energy sources at relatively cheaper prices have resulted in a resurgence of interest in the use of sponge iron for steel-making.

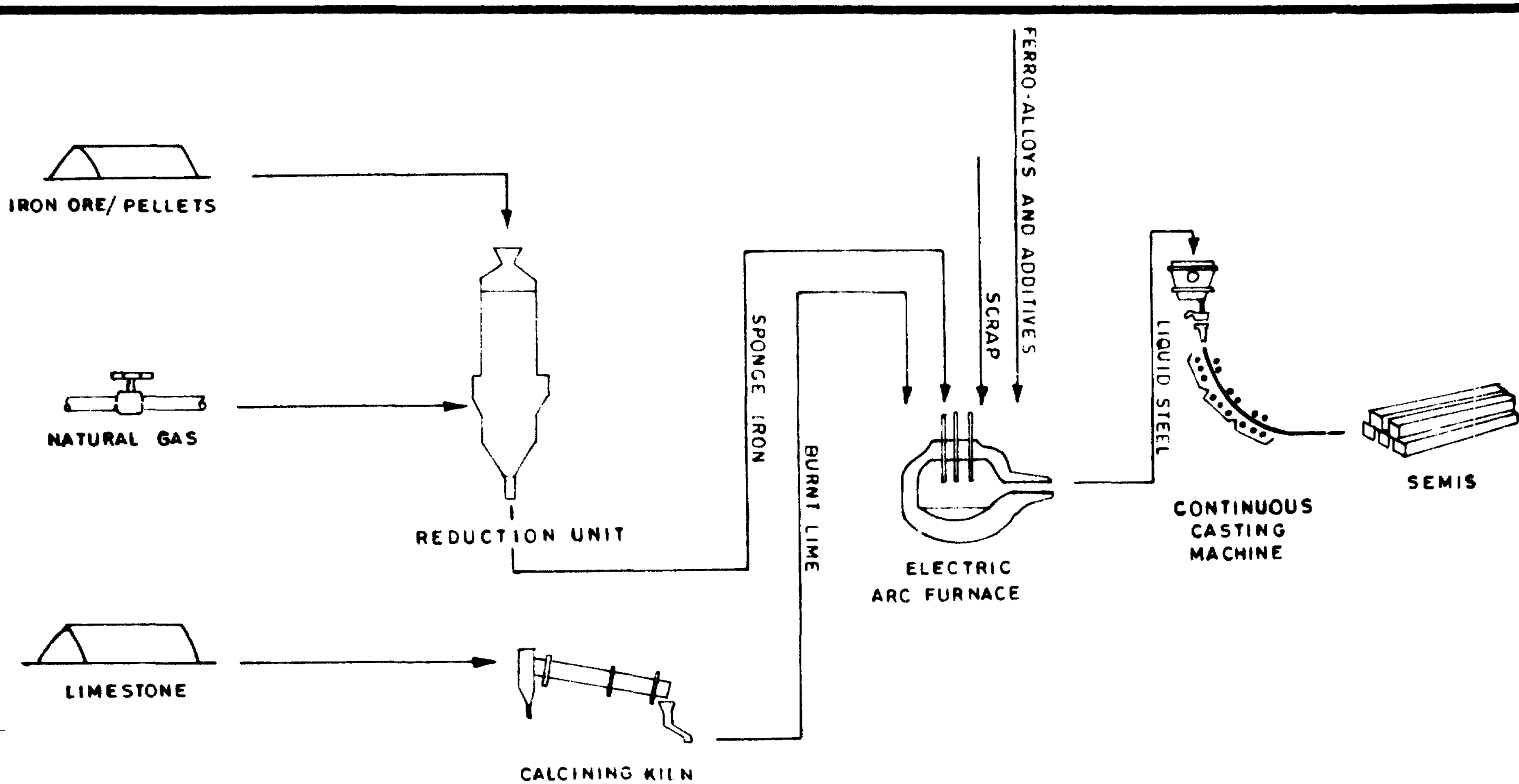


FIG. 6-1 — SCHEMATIC FLOWSHEET OF DR-EF PROCESS

Sponge iron can be produced by direct reduction of iron ore by a suitable reductant, gaseous or solid. Industrial experience with commercial direct processes indicates that processes based on gaseous reductant appear to be techno-economically far more attractive than processes using solid reductant. This contention is borne out by the fact that of the estimated world production of about 6.75 million tons of steelmaking grade sponge iron in 1979, almost 95 per cent was accounted for by the gas based processes.

Plant Capacities and Major Facilities

The plant capacity in the DR-EF route is dependent to a large extent on the capacity of the direct reduction facility and the proportion of sponge iron in the electric arc furnace charge. Two standard modules with annual production ratings of about 400,000 tons and 600,000 tons are presently being offered by the direct reduction process suppliers. Although, theoretically, modules with annual capacities less than 400,000 tons can be designed and fabricated, the specific investment for such non-standard modules

6 - Integrated plant for semis (cont'd)

would be considerably higher than for standard modules on account of the additional costs involved in designing. It is reported that modules with annual capacity ratings of 1 million tons sponge iron are in advanced stages of development and would be offered for commercial sale by a number of process suppliers in the near future.

The proportion of sponge iron in the electric furnace charge is governed by the availability of steel scrap and their relative prices. Normally, most electric furnaces with facilities for continuous charging of sponge iron utilise between 50 and 80 per cent direct reduced material. With favourable prices of sponge iron, maximum usage should be aimed at with a view to obviating the need for purchasing scrap from outside.

For the purpose of evaluating the economics of the DR-EF route in the ASEAN countries, three alternative plant capacities have been considered, as given in Table 6-1 on the next page.

6 - Integrated plant for semis (cont'd)

TABLE 6-1 - ALTERNATIVE PLANT CAPACITIES
FOR DR-EF ROUTE

		Alt. 1	Alt. 2	Alt. 3
Sponge iron, '000 tons/yr	..	400	1,200	1,800
Liquid steel:				
Production, '000 tons/yr	..	450	1,350	2,000
Sponge iron proportion, %	..	80	80	80
Yield from charge, %	..	90	90	90
Continuous cast semis, '000 tons/yr	..	425	1,275	1,900

The major facilities required for meeting the production requirements are given in Table 6-2. The facilities have been separately indicated for a plant producing only continuous cast billets and another plant producing only continuous cast slabs.

TABLE 6-2 - MAJOR PRODUCTION FACILITIES
FOR DR-EF PLANTS

	Alt. 1		Alt. 2		Alt. 3	
	Billets	Slabs	Billets	Slabs	Billets	Slabs
Direct reduction:						
No. of modules	1	1	2	2	3	3
Module capacity, '000 tons/yr	400	400	600	600	600	600
Electric arc furnace:						
No. of furnaces	2	2	6	6	6	6
Heat size, tons	85	85	85	85	130	130
Continuous casting machine:						
No. of machines	2	2	6	6	6	6
Strands for machine	4	1	4	1	6	1

6 - Integrated plant for semis (cont'd)

Capital and Operating Costs

Preliminary estimates of capital cost for the alternative plant capacities are presented in Table 6-3. It is to be emphasised that the cost estimates are tentative and indicate the orders of magnitude involved. The estimates are based on current international prices of similar equipment and facilities, and are assumed to be same for all the three countries under consideration.

TABLE 6-3 - ESTIMATES OF CAPITAL COST FOR DR-EF PLANTS
(million US $)

	Alt. 1		Alt. 2		Alt. 3	
	Billets	Slabs	Billets	Slabs	Billets	Slabs
Direct reduction facilities	75	75	175	175	250	250
Steelmelt shop incl. electric arc furnace, continuous casting machine etc.	46	75	104	170	155	200
Auxiliary and yard facilities	40	40	85	85	120	120
Sub-total ..	161	190	364	430	525	570
Design, engg. and administrative expenses @ 10 per cent of items 1 to 3	16	19	36	43	52	57
Contingencies @ 10 per cent of items 1 to 4	18	21	40	47	58	63
TOTAL ..	195	230	440	520	635	690

6 - Integrated plant for semis (cont'd)

The production costs of sponge iron, liquid steel and continuous cast billets/slabs are estimated in Appendix 6-1 and summarised in Table 6-4 on page 6-12

THE BF-BOF ROUTE

The BF-BOF route of iron and steelmaking utilises iron ore and coke in the blast furnace for the production of hot metal which is subsequently converted to liquid steel in the basic oxygen furnace. A schematic flow-sheet of the BF-BOF process is shown in Fig 6-2.

The BF-BOF process can be considered to be the work-horse of the steel industry and is ideally suited for the production of commercial grades of steel in multi-million ton plants. The share of this process in total world steel production has risen from about 20 per cent in mid-60s to about 40 per cent in 1970 and is presently around 60 per cent. This phenomenal rise in world BF-BOF capacity has been mainly due to two factors, namely (i) the continued growth in the sizes of the iron and steelmaking units which have resulted in better economies of scale, (ii) the improvements in equipment design and operating parameters, resulting in more efficient operation with consequent reductions in operating cost.

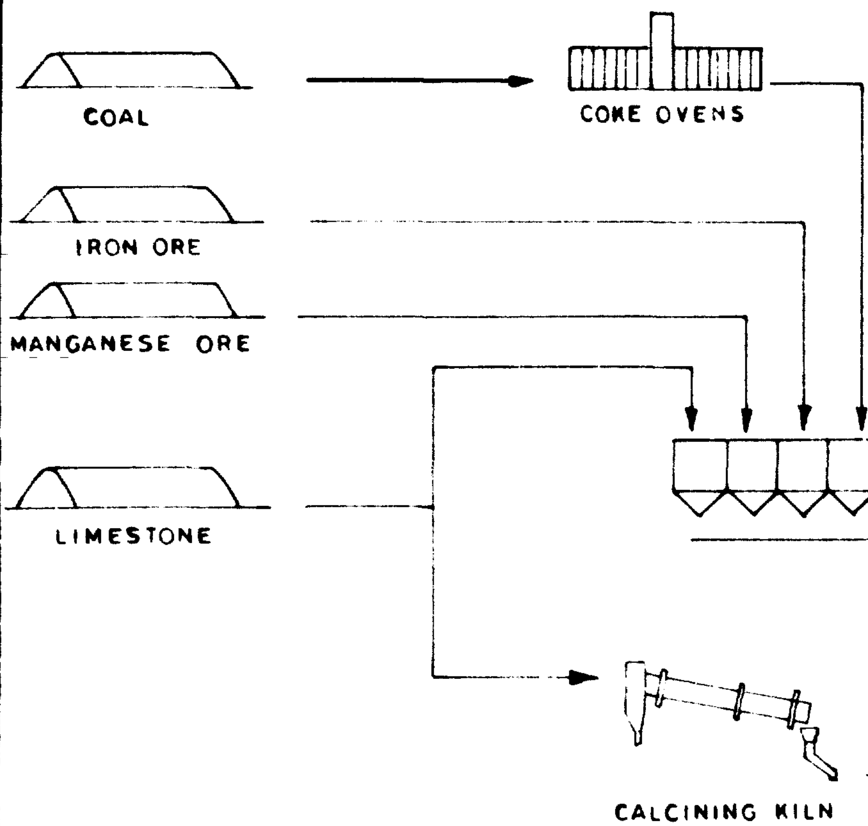
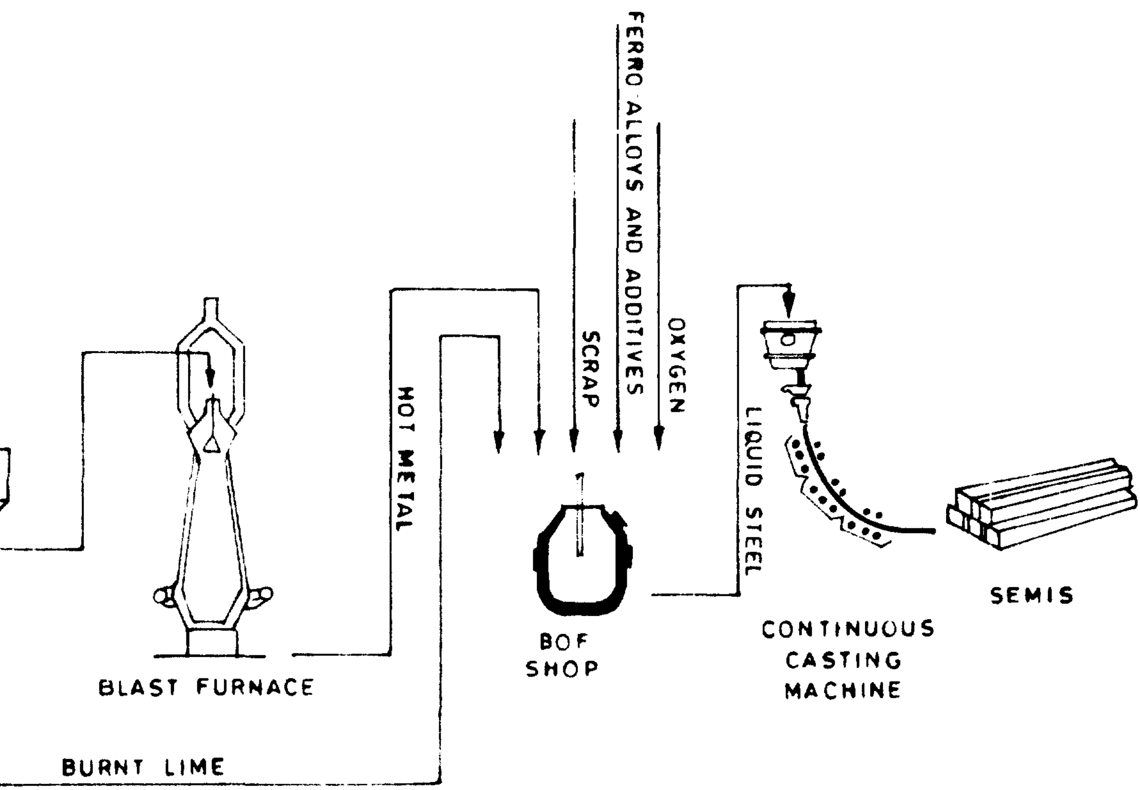


FIG. 6-2 — SCHEMATIC



FLOWSHEET OF BF-BOF PROCESS

TABLE 6-4 - PRODUCTION COST ESTIMATES FOR DR-EF ROUTE
(US $ per ton)

		Thailand			Malaysia			Indonesia		
		Alt.1	Alt.2	Alt.3	Alt.1	Alt.2	Alt.3	Alt.1	Alt.2	Alt.3
Production cost excluding fixed charges										
Sponge iron	..	97	93	92	104	100	99	87	83	83
Liquid steel	..	180	176	172	178	174	169	171	167	163
Billets	..	200	194	190	197	192	187	189	184	180
Slabs	..	201	195	189	199	193	187	191	185	180
Production cost including fixed charges at 20% (1)										
Billets	..	292	263	256	289	261	254	281	253	247
Slabs	..	310	277	262	307	274	259	299	267	252

NOTE
(1) To cover interest charges and depreciation

6 - Integrated plant for semis (cont'd)

Plant Capacities and Major Facilities

The BF-BOF process is versatile in that appropriate size of equipment to meet a wide range of production requirements is easily available in the international market. However, on account of the high rate of inflation in equipment prices and the increasing cost of energy, the trend world-wide is towards the installation of larger plants so as to take maximum advantage of the economies of scale.

For the purpose of evaluating the economics of the BF-BOF route in the ASEAN countries three alternative plant capacities have been considered, as given in Table 6-5.

TABLE 6-5 - ALTERNATIVE PLANT CAPACITIES FOR BF-BOF ROUTE ('000 tons/year)

	Alt.1	Alt.2	Alt.3
BF coke ..	615	1,230	1,845
Hot metal ..	1,000	2,000	3,000
Liquid steel ..	1,000	2,000	3,000
Continuous cast semis ..	950	1,900	2,850

6 - Integrated plant for semis (cont'd)

The major production facilities required for meeting the above production requirements are listed in Table 6-6.

TABLE 6-6 - MAJOR PRODUCTION FACILITIES FOR BF-BOF PLANTS

	Alt. 1		Alt. 2		Alt. 3	
	Billets	Slabs	Billets	Slabs	Billets	Slabs
Coke ovens	65	65	130	130	195	195
Blast furnace:						
Number	1	1	2	2	2	2
Useful volume, cu m	2,000	2,000	2,000	2,000	3,000	3,000
Basic oxygen converter:						
Number	2	2	3	3	3	3
Heat size, tons	130	130	130	130	180	180
Continuous casting machine:						
Number	3	2	6	5	6	3
Strands per machine	6	1	6	1	8	2

Capital and Operating Costs

Preliminary estimates of capital cost for the three alternative plant capacities considered, for the purpose of indicating the order-of-magnitude investments involved, are presented in Table 6-7.

6 - Integrated plant for semis (cont'd)

TABLE 6-7 - ESTIMATES OF CAPITAL COST FOR BF-BOF PLANTS (million US $)

	Alt. 1		Alt. 2		Alt. 3	
	Billets	Slabs	Billets	Slabs	Billets	Slabs
Coke ovens	80	80	140	140	190	190
Blast furnace	95	95	160	160	195	195
Steelmelt shop incl. converters, continuous casting machines etc.	115	125	180	200	220	225
Auxiliary & yard facilities	145	150	205	215	250	255
Sub-total ..	435	450	685	725	855	865
Design, engg. & admin. expenses at 10 per cent of 1 to 4	40	45	70	70	85	85
Contingencies at 10 per cent of 1 to 5	50	50	75	80	95	95
TOTAL ..	525	545	830	865	1,035	1,045

The production costs of coke, hot metal, liquid steel and continuous cast billets/slabs are estimated in Appendix 6-2 and summarised in Table 6-8.

TABLE 6-8 - PRODUCTION COST ESTIMATES FOR BF-BOF ROUTE
(US $ per ton)

	Thailand			Malaysia			Indonesia			Philippines		
	Alt.1	Alt.2	Alt.2	Alt.1	Alt.2	Alt.3	Alt.1	Alt.2	Alt.3	Alt.1	Alt.2	Alt.3
Production cost excluding fixed charges												
BF coke ..	95	92	91	92	90	89	100	98	97	106	104	103
Hot metal ..	119	117	115	116	113	111	123	121	119	112	109	107
Liquid steel ..	159	156	152	153	150	147	162	159	156	153	150	147
Billets ..	177	173	169	171	167	163	180	176	172	171	167	163
Slabs ..	177	172	168	170	166	162	179	175	171	170	166	162
Production cost including fixed charges at 20%(1)												
Cost of billets ..	288	260	241	281	254	235	290	264	245	281	254	235
Cost of slabs ..	291	263	241	285	257	235	294	267	244	285	257	235

NOTE
(1) To cover interest charges and depreciation

6 - Integrated plant for semis (cont'd)

COMPARATIVE EVALUATION OF DR-EF AND BF-BOF ROUTES

Economic Capacities

The production costs of billets and slabs for varying plant capacities are indicated in Tables 6-4 and 6-5 for the two production routes. It will be observed from these two tables that the difference in costs of billets and slabs is marginal in each case. It is also observed that lowering in production cost with increasing plant capacity is more pronounced for the BF-BOF route as compared to the DR-EF route, where limitations in unit sizes of process equipment necessitate installation of a number of identical units for plant capacities beyond a certain limit. Therefore, it is to be expected that depending on the local prevailing unit prices of raw materials, energy and other items of operating cost and the investment requirements per ton of annual capacity, one process route would be more attractive than the other in a certain capacity range.

The average costs of production of semis by the two routes are plotted for Indonesia, Malaysia, Philippines and

6 - Integrated plant for semis (cont'd)

Thailand in Fig 6-3, and the trends in cost variation with plant capacity illustrated. From the figure, it will be seen that DR-EF route is cheaper than the BF-BOF route for annual plant capacities up to about 3 million tons in Indonesia, 2 million tons in Malaysia and about 2.25 million tons in Thailand. For Philippines, however, the BF-BOF route is the only choice for large scale steel production.

Based on the above analysis and findings, the average cost of semis for varying plant capacities are indicated in Table 6-9 for four countries.

TABLE 6-9 - AVERAGE PRODUCTION COST OF SEMIS
(US $ per ton)

Plant capacity mill.tons/yr		Thailand		Malaysia		Indonesia		Philippines	
		Cost	Route	Cost	Route	Cost	Route	Cost	Route
1.0	..	280	DR-EF	275	DR-EF	265	DR-EF	280	BF-BOF
1.5	..	265	DR-EF	260	DR-EF	255	DR-EF	265	BF-BOF
2.0	..	255	DR-EF	255	BF-BOF	250	DR-EF	255	BF-BOF
2.5	..	245	BF-BOF	245	BF-BOF	245	DR-EF	240	BF-BOF
3.0	..	235	BF-BOF	235	BF-BOF	240	DR-EF	230	BF-BOF

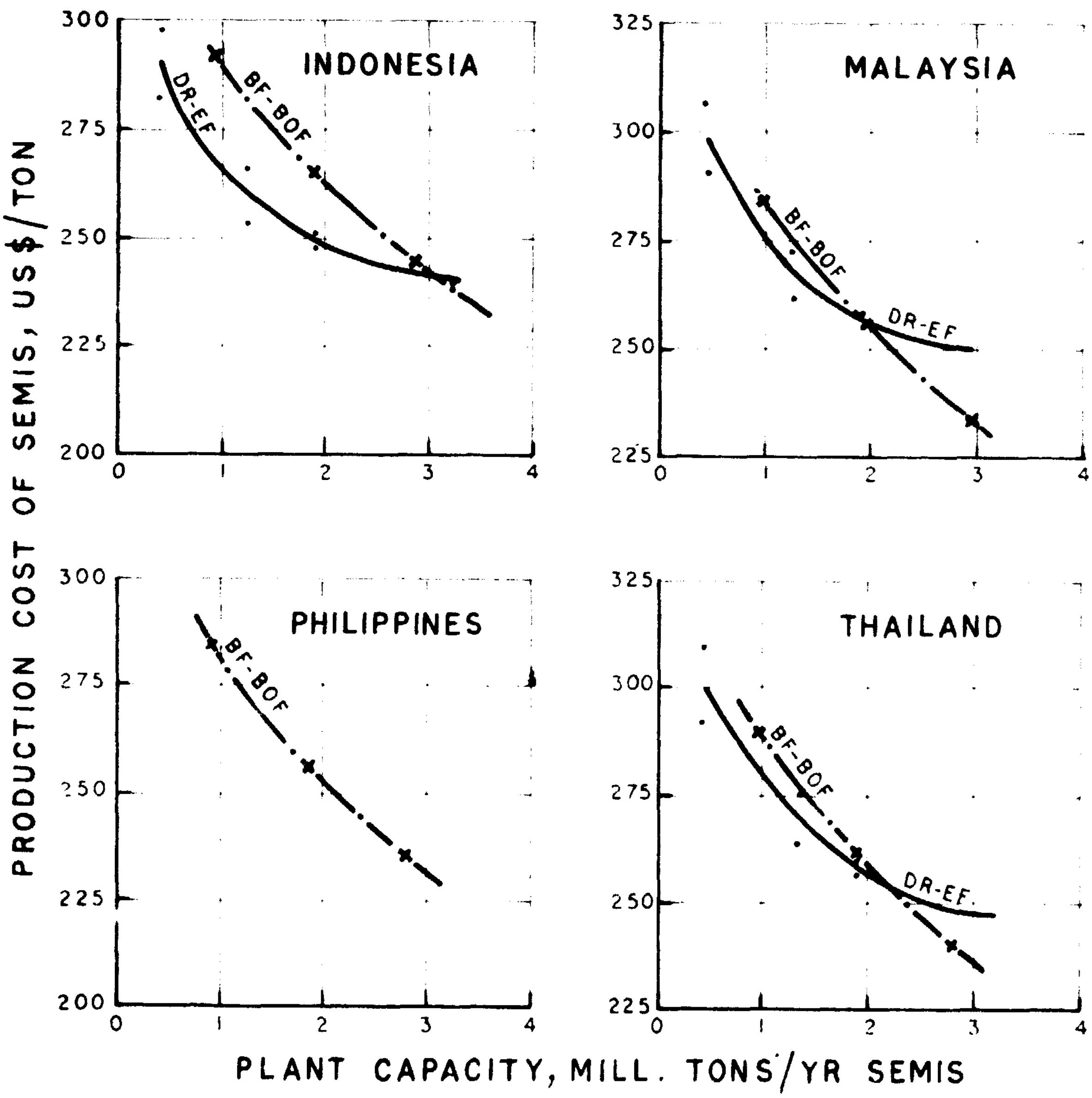


FIG. 6-3 — COMPARISON OF PRODUCTION COST OF SEMIS BY DR-EF AND BF-BOF ROUTES

6 - Integrated plant for semis (cont'd)

Competitiveness with Imported Semis

The prices of imported billets and slabs, including all taxes/levies but excluding import duty, have been estimated for each ASEAN country in Chapter 5 and are as follows:

		Prices, US $/ton	
		Billets	Slabs
Thailand	..	320	260
Malaysia	..	310	255
Singapore	..	300	245
Indonesia	..	300	250
Philippines	..	300	255

From a comparison of the above prices with the average production costs indicated in Table 6-9, the following may be concluded:

a) The production cost of billets would be considerably lower than the imported price in all the countries, even for production levels of around 1 million tons per annum.

b) For locally produced slabs to be competitive with imported slabs, the minimum level of operation for all the countries would be around 2 million tons.

7 - MINIMUM ECONOMIC SIZE PLANT CONCEPT

The major objective of the study is to identify the minimum economic size for the various steel processing units in the ASEAN countries. The two major factors governing the selection of the size of a plant are that the capacity selected should be technically feasible and economically viable. The minimum economic size can also be defined as the lowest capacity plant that would be economical to operate taking into account the specific local and working conditions as well as the selected process technology. The approach adopted in assessing the economic viability of the twelve selected steel processes is discussed in this chapter. Further, the methodology used in computing the internal rate of return (IRR) which is adopted as the basis for determining the economic viability as well as factors influencing the IRR are discussed.

ECONOMIC VIABILITY

For the minimum economic size, the return on investment should at least be equivalent to the cost of capital, which is defined as the weighted average of the desirable return on equity capital and the rate of interest charged on long-term loan.

7 - Minimum economic size plant concept (cont'd)

The prevailing annual interest rates in ASEAN countries are 9 per cent in Malaysia and Philippines, 9.5 per cent in Singapore, 12 per cent in Thailand and 13.5 per cent in Indonesia. Considering a maximum interest rate of 13.5 per cent per annum, and assuming the expected return on equity capital as 15 per cent per annum, the weighted average cost of capital works out to about 14 per cent with a debt to equity ratio of 60:40.

The conventional return on investment, namely the profit before tax on the equity capital (after providing for interest charges on loans) in a normal year of operation is a practicable indicator of profitability. Another method of determining the economic viability of the project would be on the basis of the internal rate of return (IRR) which takes into account the time value of money. This would be a more appropriate approach for detailed project report when all other project parameters including costs have been finalised. However, as suggested by the ASEAN representatives at the Bangkok meeting, the IRR has been worked out for each steel process unit and for all the five countries. It may be noted that while the profit for each steel process unit would vary depending upon interest rate, the IRR however would not be influenced by varying interest rates prevailing in the ASEAN countries.

During discussions, ASEAN representatives desired an IRR of 15 per cent for each process unit for all the countries.

BASIS FOR COST ESTIMATES

The minimum annual capacity and volume of production for each selected process unit has been considered taking into account the technological route. Based on the equipment and facilities required, the capital and production costs have been estimated for each selected process. It will be appreciated that the cost estimates are necessarily of an overall nature at this preliminary stage and are primarily intended for the purpose of determining the minimum economic size of the selected steel processing units. Detailed cost estimates will have to be prepared for the individual projects at the time of Detailed Project Report (DPR) for the specific locations/countries.

Capital Cost

The capital cost estimate would normally include the cost of land and site development, mechanical and electrical equipment comprising production, material handling as well as utility equipment, buildings and foundations, interest on loans during construction and other promotional expenses. However, since no specific locations are considered at this stage for siting the units, the cost of land and site development have not been included in the capital cost estimate.

Most of the plant and equipment will have to be imported and therefore, the prevailing international prices have been used for estimating the cost of the plant and equipment. A provision at 15 per cent of the f.o.b. value of the equipment has been made towards the ocean freight, port charges and inland freight of the imported equipment. However, some of the equipment will be available from domestic sources. For the purpose of this study, it is assumed that the cost of the equipment of domestic manufacture will be of the same order as the landed cost of the imported equipment.

The cost of equipment erection may vary from country to country. However, in the absence of specific data pertaining to individual countries, this cost element has been assumed to be same in all the countries. The cost of buildings and foundations may also somewhat vary from country to country, depending on the terrain, the cost of construction materials and labour. In this connection, questionnaires were issued to the member countries soliciting detailed information as regards the cost of construction materials and labour. Their replies were not received. Hence, for the purpose of this report, the cost of buildings and foundations have been assumed to be the same in all the member countries.

If the project is financed with loans partly or fully, the interest on the loans during the construction period will also be capitalised and will have to be included in the fixed investment. However, for the purpose of computing IRR, the interest on loan during construction need not be considered. Hence, the fixed investment has been estimated excluding the capitalised interest charges.

The cost of infrastructure facilities including water and power supply to the plant boundary, railway siding for the plant, township etc, have been excluded from the capital cost estimate, as these could be estimated for specific locations at the time of DFR.

Production Cost

The production cost covers the expenses of semis/ scrap, other materials, consumables, power, fuel, labour, supervision, administration and sales expenses.

For estimating the production cost for each steel process unit, the unit prices of various input materials as discussed in Chapter 4 have been considered. Local variations in the price of input materials as well as in the wages and salaries have been taken into account based on the information collected during the field visit.

The production cost for each product has been estimated excluding depreciation and interest charges since these are not required for computation of IRR.

COMPUTATION OF IRR

The IRR has been computed considering an operational period of twenty years. The present value of the cash outflows and inflows have been determined considering the beginning of the first year of operation as the zero point. Cash outflows on account of the fixed investment during the construction period have been compounded. The cash inflows (that is the sales receipts minus the production cost) and cash outflows on account of the working capital in the operational period have been discounted. The outflows and inflows are assumed to occur at the beginning of the construction/operation years. While estimating the sales receipts, the selling prices indicated in Chapter 5 and production build-up given in the respective chapters on project profiles have been considered. The IRR is that rate at which the present value of cash outflows and inflows balance each other.

The method adopted for computing the IRR is explained in detail in Table 7-1 for a billet plant in Malaysia. With the basic data presented and the parameters indicated it is seen that the present values of the outflows and inflows are equal at a rate of 14.16 per cent, which is, therefore, the IRR for the plant considered.

7 - Minimum economic size plant concept (cont'd)

TABLE 7-1 - METHOD ADOPTED FOR COMPUTING IRR
(Billet Plant - Malaysia)

Basic Data

Plant capacity, tons per year		..	56,000
Capital cost, US $ mill		..	18.5
Annual production cost at rated capacity, US $ mill		..	13.0
Annual sales receipt at rated production, US $ mill		..	16.8
Working capital requirement, US $ mill			
First year of operation	.. 2.5		
Second year of operation	.. 0.6	..	3.1

Phasing of Capital Expenditure

Construction year		Capital expenditure US $ mill
1	..	6.0
2	..	7.5
3	..	5.0
		18.5

Production Build-up

Operational year		Per cent of rated capacity
1st year	..	80
2nd year and onwards	..	100

Cash Inflow

Operational year		Sales receipt US $ mill (1)	Production cost US $ mill (2)	Cash inflow US $ mill (1)-(2)
1st year	..	13.45	10.70	2.75
2nd year and onwards	..	16.80	13.00	3.80

Cash Outflow

		US $ mill
Capital cost	..	18.5
Working capital	..	3.1
		21.6

7 - Minimum economic size plant concept (cont'd)

Table 7-1 (cont'd)

Computation of IRR

The beginning of the first operating year is considered as the zero point. The present value of all the outflows and inflows accruing during different years are determined as referred to the zero point. The outflows accruing prior to the zero point are compounded and the inflows and outflows accruing after the zero point are discounted. The rate at which the present value of the outflows and inflows are equal is the IRR. For the billet plant discussed above, the present value of the inflows and outflows, when computed with different rates, are equal at a trial rate of 14.16 per cent as given below:

Present value of cash outflows @ 14.16 per cent

Construction period	Outflow US $ mill	Present value @ 14.16% US $ mill
Capital cost		
1st year	6.00	8.93
2nd year	7.50	9.77
3rd year	5.00	5.71
(Zero point)	18.50	24.41
Operating period		
Working capital		
1st year	2.50	2.50
2nd year	0.60	0.53
	3.10	3.03
Total present value of outflows	..	27.44

Present value of cash inflows @ 14.16 per cent

Operating period	Inflow US $ mill	Present value @ 14.16% US $ mill
(Zero point)		
1st year	2.75	2.75
2nd year	3.80	3.33
3rd year	3.80	2.91
4th year	3.80	2.55
5th year	3.80	2.24
6th year	3.80	1.96
7th year	3.80	1.72
8th year	3.80	1.50
9th year	3.80	1.32
10th year	3.80	1.16
11th year	3.80	1.01
12th year	3.80	0.89
13th year	3.80	0.78
14th year	3.80	0.68
15th year	3.80	0.60
16th year	3.80	0.52
17th year	3.80	0.46
18th year	3.80	0.40
19th year	3.80	0.35
20th year	3.80	0.31
	74.95	27.44
Total present value of inflows	..	27.44

Since the present value of cash outflows and inflows are equal at 14.16 per cent as referred to the zero point (beginning of the first operating year), the IRR is 14.16 per cent.

FACTORS INFLUENCING IRR

The IRR is sensitive to those factors which influence the cash outflows and inflows. For a given set of parameters, with increase in outflows or decrease in inflows, the IRR will reduce and with decrease in outflows or increase in inflows the IRR will increase.

Capital Cost

A higher capital cost would mean a higher cash outflow. Further, if the construction period is longer, the initial capital expenditure will get compounded over a longer period resulting in a greater present value of the outflow. As a result, the IRR would be lower. For the billet plant considered as an example, the IRR with the assumptions given in Table 7-1 works out to 14.16 per cent. With all the other parameters remaining the same, if a 10 per cent higher capital cost is considered for this plant, the IRR will decrease to 12.9 per cent as illustrated in Table 7.2 (Case II).

Production Cost

If the production cost increases, the cash inflows would decrease and vice-versa. The decrease in cash inflows as a result of the increase in production cost will mean a lower IRR. For the billet plant considered, with a 10 per cent increase in production cost and other parameters remaining the same, the IRR decreases from 14.16 per cent to 8.50 per cent as worked out in Table 7-2 (Case III).

Selling Price

The cash inflow depends on the sales receipts, being the difference of sales receipts and production cost. With the production cost remaining the same, if a higher sales realisation is attained, the cash inflows will increase. This would result in a higher IRR. It is seen that with an increase of 5 per cent in the sales receipts and with other parameters remaining the same, the IRR improves from 14.16 per cent to 17.35 per cent as given in Table 7-2 (Case I).

IRR Vs PRODUCTIVITY AND PRODUCTION COST

The IRR is also influenced by the actual production attained by the plant vis-a-vis its rated capacity. The IRR for the billet plant discussed as an example in Table 7-1 has been worked out considering the plant attaining a production level of 80 per cent of the rated capacity in the first year of operation and 100 per cent of the rated capacity during the subsequent years of operation. An IRR of 14.16 per cent is obtained on this basis. If this plant is evaluated considering a production level of 80 per cent of the rated capacity in the first year of operation and 90 per cent of the rated capacity during the subsequent years of operation, the IRR decreases to 12.2 per cent as given in Table 7-2 (Case IV). On the other hand, if a higher level of production than the rated capacity is achieved, the IRR would improve.

TABLE 7-2 - FACTORS INFLUENCING IRR

The influence of selling price, capital cost, production cost and level of production on IRR are analysed below. Four cases are considered with variation on the basic data given for the billet plant in Table 7-1 as indicated below.

Case I .. Selling price higher by 5 per cent
Case II .. Capital cost higher by 10 per cent
Case III .. Production cost higher by 10 per cent
Case IV .. Production lower by 10 per cent

Parameters

The parameters for production, capital cost etc will remain the same as given in Table 7-1 except for the following changes:

i) Annual sales receipts for Case I at rated production, mill US $ .. 17.64

ii) Capital cost for Case II, mill US $ .. 20.35

iii) Annual production cost for Case III at rated capacity, mill US $ .. 14.30

iv) Production build-up for Case IV as per cent of rated capacity:
first year .. 80
second year and onwards .. 90

Considering the above, the cash flows will alter as follows for the different cases:

Cash Inflow for Case I

Operational year	Sales receipts US $ mill (1)	Production cost US $ mill (2)	Cash inflow US $ mill (1) - (2)
1st year	14.12	10.70	3.42
2nd year and onwards	17.62	13.00	4.62

7 - Minimum economic size plant concept (cont'd)

Table 7-2 (cont'd)

Phasing of Capital Expenditure for Case II

Construction year		Capital expenditure US $ mill
1	..	6.60
2	..	8.25
3	..	5.50
		20.35

Cash Inflow for Case III

Operational year	Sales receipts US $ mill (1)	Production cost US $ mill (2)	Cash inflow US $ mill (1) - (2)
1st year	13.45	11.70	1.75
2nd year and onwards	16.80	14.30	2.50

Cash Inflow for Case IV

Operational year	Sales receipts US $ mill (1)	Production cost US $ mill (2)	Cash inflow US $ mill (1) - (2)
1st year	13.45	10.70	2.75
2nd year and onwards	15.10	11.83	3.27

Computation of IRR

For the billet plant, the IRR is computed for the four cases using the same method discussed in Table 7-1, but taking into account the variation in parameters for each case discussed above and presented on the next page. The results are summarised below:

		IRR, %
With assumptions given in Table 7-1	..	14.16
Case I with 5 per cent higher selling price	..	17.35
Case II with 10 per cent higher capital cost	..	12.90
Case III with 10 per cent higher production cost	..	8.50
Case IV with 10 per cent lower production	..	12.20

Computation of IRR

	Case-I Outflow/ inflow	Case-I Present value @ 17.35%	Case-II Outflow/ inflow	Case-II Present value @ 12.9%
A. Cash Outflow				
Construction year (Capital cost)				
1st	6.00	9.70	6.60	9.50
2nd	7.50	10.33	8.25	10.52
3rd	5.00	5.87	5.50	6.21
	18.50	25.90	20.35	26.23
Operating year (Working capital)				
1st	2.50	2.50	2.50	2.50
2nd	0.60	0.51	0.60	0.53
	3.10	3.01	3.10	3.03
Present value of outflows ..		28.91		29.26
B. Cash Inflow (Operating year)				
1st	3.42	3.42	2.75	2.75
2nd	4.64	3.95	3.80	3.37
3rd	4.64	3.37	3.80	2.98
4th	4.64	2.87	3.80	2.64
5th	4.64	2.45	3.80	2.34
6th	4.64	2.08	3.80	2.07
7th	4.64	1.78	3.80	1.83
8th	4.64	1.51	3.80	1.63
9th	4.64	1.29	3.80	1.44
10th	4.64	1.10	3.80	1.28
11th	4.64	0.94	3.80	1.13
12th	4.64	0.80	3.80	1.00
13th	4.64	0.68	3.80	0.89
14th	4.64	0.58	3.80	0.79
15th	4.64	0.49	3.80	0.70
16th	4.64	0.42	3.80	0.62
17th	4.64	0.36	3.80	0.55
18th	4.64	0.31	3.80	0.48
19th	4.64	0.26	3.80	0.43
20th	4.64	0.22	3.80	0.38
Present value of inflows ..		28.88		29.30

NOTES

(1) Outflows and inflows considered to occur at the beginning of the period.

(2) Residual value of plant and salvage value of working capital not considered.

SECTION 1

resent value 17.35%	Case-II Outflow/ inflow	Case-II Present value @ 12.9%	Case-III Outflow/ inflow	Case-III Present value @ 8.5%	Case-IV Outflow/ inflow	Case-IV Present value @ 12.2%
9.70	6.60	9.50	6.00	7.66	6.00	8.47
10.33	8.25	10.52	7.50	8.83	7.50	9.44
5.87	5.50	6.21	5.00	5.42	5.00	5.61
[illegible]5.90	20.35	26.23	18.50	21.91	18.50	23.52
2.50	2.50	2.50	2.50	2.50	2.50	2.50
0.51	0.60	0.53	0.60	0.55	0.60	0.53
3.01	3.10	3.03	3.10	3.05	3.10	3.03
28.91		29.26		24.96		26.55
3.42	2.75	2.75	1.70	1.70	2.75	2.75
3.95	3.80	3.37	2.50	2.31	3.27	2.91
3.37	3.80	2.98	2.50	2.12	3.27	2.60
2.87	3.80	2.64	2.50	1.96	3.27	2.32
2.45	3.80	2.34	2.50	1.81	3.27	2.06
2.08	3.80	2.07	2.50	1.66	3.27	1.84
1.78	3.80	1.83	2.50	1.53	3.27	1.64
1.51	3.80	1.63	2.50	1.41	3.27	1.46
1.29	3.80	1.44	2.50	1.30	3.27	1.30
1.10	3.80	1.28	2.50	1.20	3.27	1.16
0.94	3.80	1.13	2.50	1.11	3.27	1.03
0.80	3.80	1.00	2.50	1.02	3.27	0.92
0.68	3.80	0.89	2.50	0.94	3.27	0.82
0.58	3.80	0.79	2.50	0.87	3.27	0.73
0.49	3.80	0.70	2.50	0.80	3.27	0.65
0.42	3.80	0.62	2.50	0.74	3.27	0.58
0.36	3.80	0.55	2.50	0.68	3.27	0.52
0.31	3.80	0.48	2.50	0.63	3.27	0.46
0.26	3.80	0.43	2.50	0.58	3.27	0.41
0.22	3.80	0.38	2.50	0.53	3.27	0.37
28.88		29.30		24.90		26.53

…to occur at the beginning of the period.
…vage value of working capital not considered.

SECTION 2

8 - PROJECT PROFILE - BILLET PLANT

This chapter deals with the production of 100 mm square mild steel billets required by the rerolling mills in the ASEAN countries.

SELECTION OF PRODUCTION PROCESS

Production of 100 mm square mild steel billets can be achieved by directly casting liquid steel into billets in a continuous casting machine, or by rolling blooms in a billet mill. While the first concept is well established and popularly adopted, the second concept will not be techno-economically justified in view of the additional investment and operating cost involved in heating and rolling the blooms into billets. In view of the above, it was decided at the meeting in Bangkok to adopt the arc furnace - continuous billet casting route for the production of 100 mm square billets.

DESIGN BASIS AND MAJOR FACILITIES

Plant Capacity

The plant capacity is based on 330 operating days a year on 3-shifts a day basis. The electric arc furnace is designed to operate with either 100 per cent steel scrap or scrap and sponge iron in suitable proportion, depending on their availabilities and prices. However, this economic analysis is based on use of 100 per cent steel scrap. The continuous casting machines will be designed to cast 100 mm square billets.

Four alternative capacities have been considered in order to study the effect of the scale of production on the operating economics for each country. The smallest capacity is considered as 50,000 - 60,000 tons per annum, while the largest capacity for a billet plant is thought to be about 0.5 million tons per annum. The four alternative plant capacities considered for analysis are as follows:

		Liquid steel tons/yr	Billets tons/yr
Alt. 1	..	60,000	56,000
Alt. 2	..	100,000	94,000
Alt. 3	..	320,000	300,000
Alt. 4	..	540,000	510,000

Major Plant Facilities

A typical list of major plant facilities for an electric arc furnace-continuous casting plant producing billets is given in Appendix 8-1. The major production facilities and their design capacities for the four alternative plant capacities are given in Table 8-1.

TABLE 8-1 - MAJOR PRODUCTION FACILITIES FOR BILLET PLANT

	Alt. 1	Alt. 2	Alt. 3	Alt. 4
Arc furnace				
Number ..	2	2	2	3
Capacity, tons ..	15	25	80	90
Production, '000 tons/yr ..	60	100	320	540
Continuous casting machine				
Number ..	2	2	2	2
Strands per machine ..	2	3	5	6
Size of billets, mm ..	100	100	100	100
Production, '000 tons/yr ..	56	94	300	510

Production ratings of electric arc furnace are based on normal power operation and with cold charge. Use of high power transformers and adoption of oxy-fuel burners have not been considered, although these would lead to higher productivity. For the continuous casters, batch operation has been considered.

8 - Project profile - billet plant (cont'd)

Plant Flowsheet and Layout

A typical plant flowsheet is given in Drawing 5480-8-1. Keeping in view the steelmaking and casting technologies to be adopted and the major plant facilities selected above, a typical plant general layout for the billet plant is shown in Drawing 5480-8-2. The layout is illustrative only, giving the relative disposition of the major facilities and will have to be suitably modified after the location is selected, the plant capacity finalised and the sizes/numbers of the various facilities determined.

CAPITAL COST

The estimated capital cost includes the cost of all equipment and facilities as erected within the plant boundary, including buildings and foundations, expenses towards engineering and administration, cost of spares and other preliminary expenses. Preliminary estimates of the capital cost for the four alternative plant capacities are presented in Table 8-2 on the next page. The estimates are tentative and presented to compare the order-of-magnitude of the investments involved.

8 - Project profile - billet plant (cont'd)

TABLE 8-2 - CAPITAL COST FOR BILLET PLANT
(million US $)

		Alt. 1	Alt. 2	Alt. 3	Alt. 4
I.	Civil and structural work ..	3.0	4.5	10.5	14.5
II.	Mechanical and electrical equipment:				
	a) Arc furnace & auxiliaries ..	2.5	4.0	10.0	16.0
	b) Continuous casters & auxiliaries ..	2.5	3.5	8.0	10.0
	c) Building utilities, cranes etc. ..	1.5	2.5	5.5	7.5
	d) Auxiliary facilities	2.0	3.0	7.0	10.0
	Sub-total ..	8.5	13.0	30.5	43.5
III.	Ocean freight, port charges, internal transport and equipment erection @ 25 per cent of (II) ..	2.5	3.5	7.5	11.0
IV.	Spares ..	0.5	1.0	2.0	2.5
V.	Design, engineering, administration and pre-operation expenses..	2.5	3.5	8.0	11.0
VI.	Contingencies ..	1.5	2.5	5.5	7.5
	TOTAL ..	18.5	28.0	64.0	90.0

8 - Project profile - billet plant (cont'd)

PRODUCTION COST

The production cost per ton of product includes the cost of materials, all conversion costs, administration/sales expenses, and fixed charges including depreciation and interest on loans. The estimates are based on the specific consumption rates of major inputs indicated in Table 8-3 and their unit prices given in Chapter 4.

TABLE 8-3 - SPECIFIC CONSUMPTION RATES FOR BILLET PLANT

	Alt. 1	Alt. 2	Alt. 3	Alt. 4
Imported scrap, kg ..	553	553	553	553
Domestic scrap, kg ..	553	553	553	553
Plant return scrap, kg ..	54	54	54	54
Limestone, kg ..	50	50	50	50
Fe-Mn, kg ..	10	10	10	10
Fe-Si, kg ..	4.5	4.5	4.5	4.5
Fluorspar, kg ..	2	2	2	2
Aluminium, kg ..	0.5	0.5	0.5	0.5
Electric power, kWh ..	750	725	700	700
Graphite electrode, kg ..	7	6.75	6.5	6.5

8 - Project profile - billet plant (cont'd)

The cost of labour and supervision has been calculated on the basis of the following estimated plant manpower requirements:

		Manpower
Alt. 1	..	250
Alt. 2	..	275
Alt. 3	..	300
Alt. 4	..	350

The estimates of production cost, excluding fixed charges, are presented in Appendix 8-2 and summarised in Table 8-4 on the next page.

The production cost of billets, inclusive of fixed charges covering depreciation and interest on loans at 20 per cent of the capital cost, works out as given in Table 8-5.

TABLE 8-5 - PRODUCTION COST OF BILLETS INCLUDING FIXED CHARGES
(US $ per ton)

		Alt. 1	Alt. 2	Alt. 3	Alt. 4
Thailand	..	331	313	282	272
Malaysia	..	298	279	248	238
Singapore	..	343	319	277	265
Indonesia	..	320	305	276	266
Philippines	..	329	302	285	275

8 - Project profile - billet plant (cont'd)

TABLE 8-4 - PRODUCTION COST OF BILLETS EXCLUDING FIXED CHARGES
(US $ per ton)

	Thailand	Malaysia	Singapore	Indonesia	Philippines
Alt. 1					
Cost of materials	159	128	147	155	149
Labour & supervision	12	13	23	10	9
Electric power	38	38	41	30	50
Other manufacturing costs	48	46	58	52	47
Administration & sales expenses	8	7	8	7	8
Production cost:	265	232	277	254	263
Alt. 2					
Cost of materials	159	128	147	155	149
Labour & supervision	8	8	15	6	6
Electric power	36	36	40	29	46
Other manufacturing costs	43	41	49	48	34
Administration & sales expenses	7	6	8	7	7
Production cost:	253	219	259	245	242
Alt. 3					
Cost of materials	159	128	147	155	149
Labour & supervision	3	3	5	2	2
Electric power	35	35	39	28	46
Other manufacturing costs	35	33	36	41	38
Administration & sales expenses	7	6	7	7	7
Production cost:	239	205	234	233	242
Alt. 4					
Cost of materials	159	128	147	155	149
Labour & supervision	2	2	4	2	1
Electric power	35	35	39	28	46
Other manufacturing costs	34	32	33	39	37
Administration & sales expenses	7	6	7	7	7
Production cost:	237	203	230	231	240

VIABILITY

The Internal Rates of Return (IRR) have been computed for all the four alternative capacities. In computing the IRR, the production build-up is taken as 80 per cent in the first year and 100 per cent from the second year onwards. The IRR values are given in Table 8-6 and plotted in Fig 8-1.

TABLE 8-6 - INTERNAL RATE OF RETURN FOR BILLET PLANT

		Alt. 1 %	Alt. 2 %	Alt. 3 %	Alt. 4 %
Thailand	..	5.4	10.1	13.7	22.3
Malaysia	..	14.2	18.7	28.3	33.9
Singapore	..	1.2	8.3	20.2	24.6
Indonesia	..	7.1	11.0	19.1	22.7
Philippines	..	-	1.6	9.3	12.2

Based on the above analysis, the minimum economic plant capacity for which the desired IRR of 15 per cent is likely to be achieved is found to be in the range of 150,000 tons per year in case of Thailand, Singapore and Indonesia, and about 60,000 tons per year in case of Malaysia. However, in the case of Philippines, even for a plant of capacity of about 500,000 tons per year, the IRR is only 12 per cent. This low

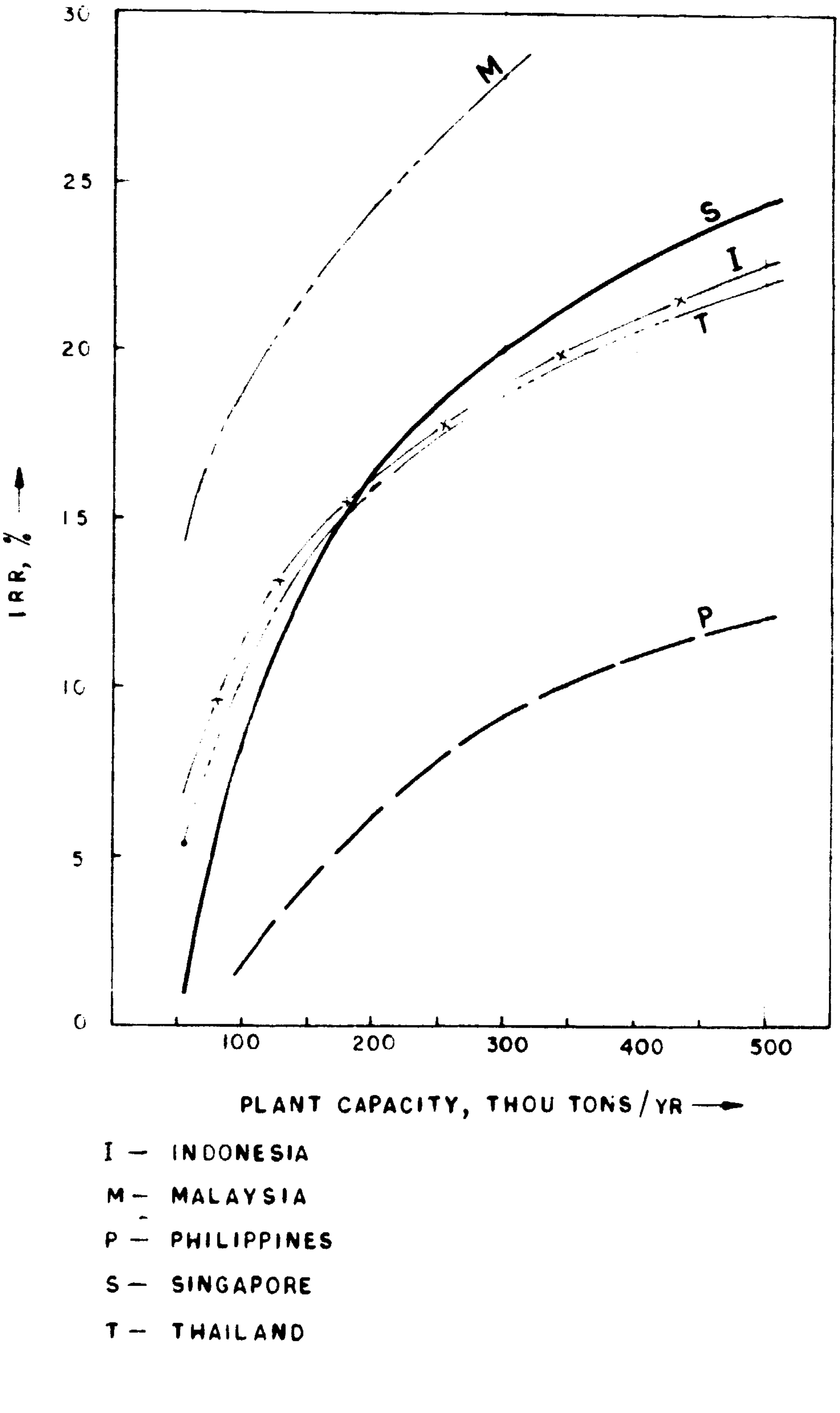


FIG. 8-1 — IRR VS PLANT CAPACITY FOR BILLET PLANT rate of return for Philippines is partly due to the relatively lower selling price of billets, which is US $ 275 per ton compared to US $ 300 per ton adopted for the other countries. If a 10 per cent increase in the selling price of billets is considered for Philippines, then a plant of about 200,000 to 250,000 tons per year capacity is likely to yield the desired IRR of 15 per cent.

9 - PROJECT PROFILE - WIRE ROD MILL

This chapter presents a broad project profile for the production of mild steel wire rods of diameter 5.5 mm to 12 mm, in coils of about 1 ton weight.

SELECTION OF WIRE ROD MILL

Mild steel wire rods are required for building construction and wire drawing applications. Wire rods are manufactured in the form of coils, generally in the size range of 5.5 to 12 mm dia. The coil weight generally varies between 1 ton and 3.5 tons, depending upon the weight of the billet and the mill capacity.

The selection of appropriate rolling mill equipment depends on the desired production and quality requirements. The major types of wire rod mills available are: (i) conventional looping mill, (ii) combination or semi-continuous mill and (iii) continuous mill.

The conventional looping mill with single strand has a capacity of about 75,000 tons per year, based on a finishing speed of about 21 m per sec. A modern version of

9 - Project profile - wire rod mill (cont'd)

the looping mill is the conti-loop mill which has individual drives in the finishing line. The finishing speed is about 35 m per sec and the annual capacity about 100,000 tons.

The semi-continuous mill combines the features of the looping mill and the continuous mill. The arrangement of the various mill stands is governed by the desired production capacity. The maximum finishing speed is about 35 m per sec and the corresponding capacity about 100,000 tons per year.

The continuous wire rod mill was developed with a view to obtaining greater coil weights and higher production capacities. In this mill, the finishing stands are in the form of a single block. The finishing speeds are high, of the order of 50 to 75 m per sec. With a single strand and based on a finishing speed of 55 m per sec, which is generally adopted, a continuous mill can give an annual output of about 150,000 tons.

Of the above mills, the investment on the conventional looping mill is the lowest. The investment on semi-continuous mill is higher than the looping mill.

In the continuous mill, the use of high speed finishing block with small diameter rolls enables greater reduction per pass. Consequently, the number of stands are less than in the other types of mills for the same total reduction in area. Further, due to the smaller diameter rolls, the roll separating force and the rolling torque are lower. The other advantage is that while going in for a large capacity, multi-strand continuous mill with upto 4 strands can be installed. Also, progressive increase in capacity is possible through addition of strands and finishing blocks. As against this, looping and semi-continuous mills are generally limited to two strands. Keeping in view all these factors, the modern continuous wire rod mill is considered for the purpose of evaluation.

DESIGN BASIS AND MAJOR FACILITIES

Plant Capacity

As discussed above, a single strand continuous wire rod mill is capable of an annual production of about 150,000 tons, based on a finishing speed of 55 m per sec. This capacity therefore can be considered as the minimum capacity of a modern wire rod mill. Higher capacity can be

9 - Project profile - wire rod mill (cont'd)

achieved through addition of strands. Keeping this in view, the plant capacities considered for evaluation are:

Alt. 1 - 150,000 tons/year
Alt. 2 - 300,000 tons/year
Alt. 3 - 450,000 tons/year

The facilities are designed for the production of mild steel wire rods of 5.5 mm to 12 mm dia. The plants are designed for 300 days operation on 3-shift basis.

Major Plant Facilities

A typical list of major facilities required for a wire rod mill is given in Appendix 9-1. The major production facilities for the three capacities considered are summarised below in Table 9-1.

TABLE 9-1 - MAJOR PRODUCTION FACILITIES FOR WIRE ROD MILL

	Alt. 1	Alt. 2	Alt. 3
Reheating furnace			
Number ..	1	1	1
Capacity, tons/hr ..	40	80	120
Wire rod mill			
Number ..	1	1	1
Number of strands ..	1	2	3
Finishing speed, m/sec..	55	55	55

Plant Flowsheet and Layout

A typical plant flowsheet for the wire rod mill is given in Drawing 5480-9-1 and a typical layout illustrating the relative disposition of the major plant facilities is presented in Drawing 5480-9-2.

CAPITAL COST

Preliminary estimates of the capital cost, which include the cost of all facilities within the plant boundary as well as the cost of spares and various preliminary expenses work out to US $ 38 million, 67.5 million and 85.5 million respectively for the three alternatives as given in Table 9-2. The cost estimates are tentative and indicate the order-of-magnitude of the investments involved.

PRODUCTION COST

The production cost includes the cost of materials, other manufacturing expenses, administration/sales expenses and fixed charges covering depreciation and interest on loans. In estimating the costs, the following consumption of major inputs per ton of product have been considered:

	Alt. 1	Alt. 2	Alt. 3
Billets, kg	1,060	1,060	1,060
Electric power, kWh	150	150	150
Water, cu m	5	4.5	4.5

9 - Project profile - wire rod mill (cont'd)

TABLE 9-2 - CAPITAL COST FOR WIRE ROD MILL
(million US $)

		Alt. 1	Alt. 2	Alt. 3
I.	Civil and structural work ..	6.5	8.5	10.0
II.	Mechanical and electrical equipment:			
	a) Reheating furnace, complete with charging and discharging mechanisms ..	1.0	1.5	3.0
	b) Wire rod mill complete with electrics and controls ..	14.0	26.5	32.5
	c) Building utilities and auxiliary facilities ..	3.5	7.5	10.0
	Sub-total ..	18.5	35.5	45.5
III.	Ocean freight, port charges, internal transport and equipment erection @ 25 per cent of (II) ..	5.0	9.0	11.5
IV.	Spares ..	1.0	2.0	2.5
V.	Design, engineering, administration and pre-operation expenses ..	3.5	6.5	8.5
VI.	Contingencies ..	3.5	6.0	7.5
	TOTAL ..	38.0	67.5	85.5

The plant manpower requirements have been estimated at 180 for Alt. 1, 200 for Alt. 2 and 220 for Alt. 3.

9 - Project profile - wire rod mill (cont'd)

Based on the input requirements indicated above and the prices given in Chapters 4 and 5, the production cost, excluding fixed charges, are estimated in Appendix 9-2 and summarised in Table 9-3.

TABLE 9-3 - PRODUCTION COST OF WIRE ROD EXCLUDING FIXED CHARGES
(US $ per ton)

	Thailand	Malaysia	Singapore	Indonesia	Philippines
Alt. 1					
Cost of materials	333	325	314	312	313
Labour & supervision	3	3	6	3	2
Other manufacturing costs	24	25	34	20	33
Administration & sales expenses	10	10	10	10	10
Production cost:	370	363	364	345	358
Alt. 2					
Cost of materials	333	325	314	312	313
Labour & supervision	2	2	8	1	1
Other manufacturing costs	23	24	29	20	33
Administration & sales expenses	8	8	8	8	8
Production cost:	366	359	359	341	355
Alt. 3					
Cost of materials	333	325	314	312	313
Labour & supervision	1	1	3	1	1
Other manufacturing costs	22	24	31	19	31
Administration & sales expenses	8	8	8	8	8
Production cost:	364	358	356	340	353

9 - Project profile - wire rod mill (cont'd)

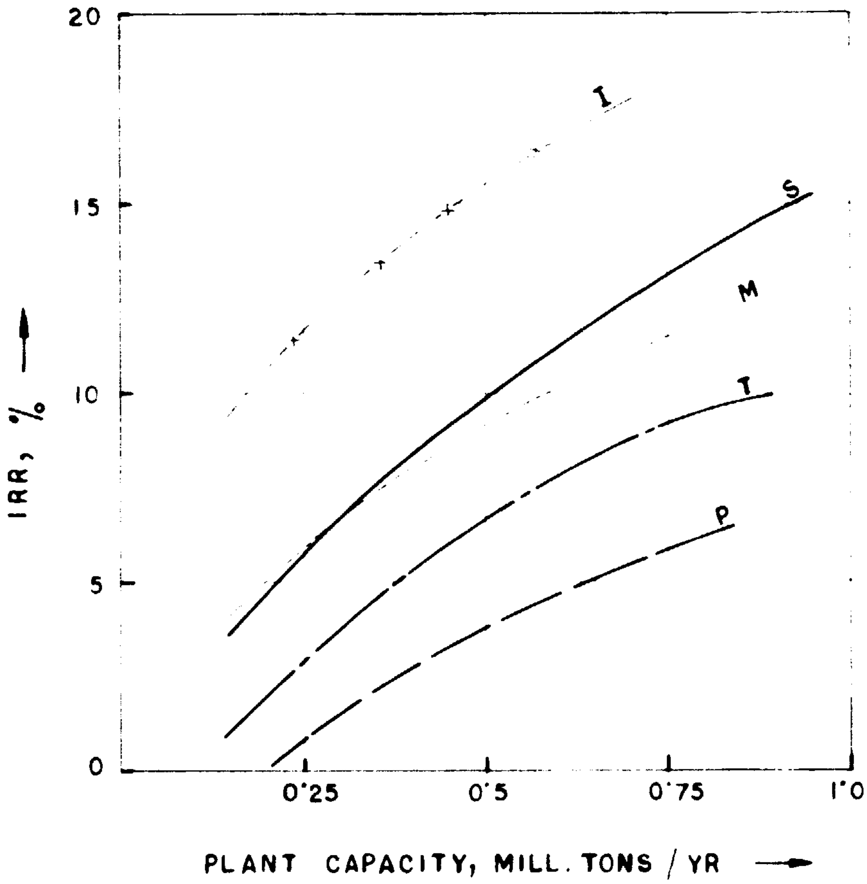
If fixed charges covering depreciation and interest on loans are taken into account at 20 per cent of the capital cost, the production cost works out as presented in Table 9-4.

TABLE 9-4 - PRODUCTION COST OF WIRE ROD INCLUDING FIXED CHARGES
(US $ per ton)

	Alt. 1	Alt. 2	Alt. 3
Thailand ..	421	411	402
Malaysia ..	414	404	396
Singapore ..	415	404	394
Indonesia ..	396	386	378
Philippines ..	409	400	391

VIABILITY

The Internal Rates of Return (IRR) have been computed for the alternative plant capacities. In computing the IRR, the production build-up is taken as 75 per cent in the first year, 90 per cent in the second year and 100 per cent from the third year onwards. The computed IRR values are given in Table 9-5 and plotted in Fig 9-1.



I — INDONESIA
M — MALAYSIA
P — PHILIPPINES
S — SINGAPORE
T — THAILAND

FIG. 9-1 — IRR vs PLANT CAPACITY FOR WIRE ROD MILL

9 - Project profile - wire rod mill (cont'd)

TABLE 9-5 - INTERNAL RATE OF RETURN FOR WIRE ROD MILL

		Alt. 1 %	Alt. 2 %	Alt. 3 %
Thailand	..	1.1	3.8	6.0
Malaysia	..	4.1	6.7	9.6
Singapore	..	3.7	6.7	9.4
Indonesia	..	9.7	12.5	14.9
Philippines	..	-	1.5	3.3

Based on the above analysis, it is seen that even with a wire rod mill capacity of 450,000 tons per year, an IRR of about 15 per cent is obtained only in case of Indonesia.

The IRR has been worked out based on a sales realisation of US $ 375 per ton in case of Philippines and US $ 390 per ton in case of other countries. A sensitivity analysis with respect to the sales realisation indicates that if 5 per cent higher prices are considered, namely, US $ 394 per ton in case of Philippines and US $ 410 per ton in case of other countries, the IRR for a plant capacity of 450,000 tons per year would be as follows:

		IRR %
Thailand	..	13.5
Malaysia	..	15.5
Singapore	..	16.0
Indonesia	..	20.8
Philippines	..	11.2

10 - PROJECT PROFILE - STRUCTURAL SHAPE MILL

This chapter deals with the production of medium structurals, such as angles up to 110 x 110 mm, beams and channels up to 150 x 75 mm, in plain carbon steel grades.

SELECTION OF STRUCTURAL MILL

Production of structurals involves heating of blooms/billets followed by rolling and cooling. Light and medium sections can be rolled in any one of the following types of mills:

i) Open-train/cross country mill
ii) Semi-continuous mill
iii) Continuous mill

The open-train/cross country types have the stands arranged side by side in a single line and are low production units, up to 50,000 tons per year.

Semi-continuous mills for ordinary steels have a continuous roughing train and open type finishing train. Only one pass is taken in each stand. The other version of the semi-continuous mill is one with open train roughing and continuous finishing train. However, this is mainly used for rolling alloy and special steels. Semi-continuous mills are employed where the required production is too high for an open-train/cross country mill, but low for a continuous mill. The annual capacity range of semi-continuous mills is generally between 100,000 and 250,000 tons.

Continuous section mills have capacities ranging from about 300,000 to 700,000 tons per year, depending upon the product size and product-mix. In these mills, the material is rolled in a number of stands at the same time. This enables the use of long billets and the temperature drop during the rolling process is considerably reduced. Automation of these mills enables rolling at high speeds, up to 20 m per second, depending on the size of the finished product.

Keeping in view the above discussion, it is suggested that either a semi-continuous or a continuous mill could be considered, depending on the production requirements.

10 - Project profile - structural shape mill (cont'd)

DESIGN BASIS AND MAJOR FACILITIES

Plant Capacity and Product-mix

Three alternative plant capacities have been considered as indicated below:

Alt. 1 - 100,000 tons/year
Alt. 2 - 400,000 tons/year
Alt. 3 - 600,000 tons/year

The typical production pattern envisaged for the three capacities is given below:

Product	Size range mm	Alt. 1 tons/year	Alt. 2 tons/year	Alt. 3 tons/year
Angles	65x65 to 110x110	40,000	160,000	240,000
Channels	75x40 to 150x75	30,000	120,000	180,000
Beams	100x60 to 150x75	30,000	120,000	180,000
	TOTAL ..	100,000	400,000	600,000

Major Plant Facilities

Keeping in view the tentative product-mix envisaged for the structural mill, a typical list of plant facilities is given in Appendix 10-1. The major production facilities for the three alternatives are briefly described on the next page.

10 - Project profile - structural shape mill (cont'd)

	Alt. 1	Alt. 2	Alt. 3
Reheating furnace			
Number	1	1	1
Capacity, tons/hr	40	110	160
Structural mill			
Type of mill	Semi-continuous	Single strand continuous	Single strand continuous
No. of stands	5	19	19

Plant Flowsheet and Layout

The process flowsheet indicating the flow of materials is given in Drawing 5480-10-1 and a typical general layout showing the relative disposition of the various production and auxiliary facilities for a continuous mill is shown in Drawing 5480-10-2.

CAPITAL COST

The capital cost includes the cost of all the facilities within the plant boundary, the cost of spares and other expenses such as design, engineering and pre-operative expenses. The preliminary estimates of capital cost are presented in Table 10-1.

10 - Project profile - structural shape mill (cont'd)

TABLE 10-1 - CAPITAL COST FOR STRUCTURAL SHAPE MILL
(million US $)

		Alt. 1	Alt. 2	Alt. 3
I.	Civil and structural work ..	8.5	15.0	19.0
II.	Mechanical and electrical equipment:			
	a) Reheating furnace with charging and discharging mechanism ..	1.0	3.0	4.0
	b) Rolling mill with electricals and controls ..	16.5	56.0	71.0
	c) Building utilities and auxiliary facilities ..	3.5	6.0	7.5
	Sub-total ..	21.0	65.0	82.5
III.	Ocean freight, port charges, internal transport and equipment erection @ 25 per cent of (II) ..	5.0	16.5	20.5
IV.	Spares ..	1.3	4.0	5.0
V.	Design, engineering, administration and pre-operation expenses ..	4.2	12.0	14.5
VI.	Contingencies ..	4.0	10.5	13.5
	TOTAL ..	44.0	123.0	155.0

10 - Project profile - structural shape mill (cont'd)

PRODUCTION COST

The production cost includes the cost of materials, other manufacturing expenses, administration and sales expenses and fixed charges covering depreciation and interest on loans. The estimates are based on the specific consumption of major items indicated below, and the unit prices of various input items given in Chapters 4 and 5.

		Consumption per ton product
Bloom/billet	..	1,110 kg
Electric power	..	100 kWh
Fuel	..	0.5×10^6 Kcal

The labour and supervision costs have been estimated on the basis of manpower requirement of 130, 220 and 240 for Alt. 1, Alt. 2 and Alt. 3 respectively.

The production cost excluding fixed charges is estimated in Appendix 10-2 and summarised in Table 10-2.

The production cost of structurals including fixed charges covering depreciation and interest on loans at 20 per cent of the capital cost works out as given in Table 10-3.

10 - Project profile - structural shape mill (cont'd)

TABLE 10-2 - PRODUCTION COST OF STRUCTURALS EXCLUDING FIXED CHARGES
(US $ per ton)

	Thailand	Malaysia	Singapore	Indonesia	Philippines
Alt. 1					
Cost of materials ..	345	338	322	319	321
Labour & supervision ..	5	5	9	4	3
Other manufacturing costs ..	20	22	31	18	30
Administration & sales expenses ..	10	10	10	11	14
Production cost ..	380	375	372	352	368
Alt. 2					
Cost of materials ..	345	338	322	319	321
Labour & supervision ..	2	2	3	1	1
Other manufacturing costs ..	18	19	29	17	28
Administration & sales expenses ..	8	8	8	9	12
Production cost ..	373	367	362	346	362
Alt. 3					
Cost of materials ..	345	338	322	319	321
Labour & supervision ..	1	1	2	1	1
Other manufacturing costs ..	17	18	28	15	26
Administration & sales expenses ..	8	8	8	9	12
Production cost ..	371	365	360	344	360

10 - Project profile - structural shape mill (cont'd)

TABLE 10-3 - PRODUCTION COST OF STRUCTURALS INCLUDING FIXED CHARGES
(US $ per ton)

		Alt. 1	Alt. 2	Alt. 3
Thailand	..	468	435	423
Malaysia	..	463	429	417
Singapore	..	460	424	412
Indonesia	..	440	408	396
Philippines	..	456	424	412

VIABILITY

The Internal Rates of Return (IRR) have been computed for the alternative plant capacities and are presented in Table 10-4. In computing the IRR, the production build-up has been assumed as 75 per cent in the first year, 90 per cent in the second year and 100 per cent from the third year of operation.

TABLE 10-4 - INTERNAL RATE OF RETURN FOR STRUCTURAL MILL

		Alt. 1 %	Alt. 2 %	Alt. 3 %
Thailand	..	-	4.3	6.5
Malaysia	..	0.8	6.2	8.5
Singapore	..	1.7	7.7	10.0
Indonesia	..	6.7	11.9	14.5
Philippines	..	12.2	18.1	21.1

10 - Project profile - structural shape mill (cont'd)

The IRR values are plotted in Fig 10-1 to illustrate the trend in IRR with capacity variations.

Based on the sales realisation considered, namely, US $ 450 per ton for Philippines and US $ 405 per ton for other countries, it is seen that with a plant capacity of 400,000 tons per year, an IRR of 15 per cent minimum is attained only in Philippines. With a higher plant capacity namely, 600,000 tons per year , an IRR of 14.5 per cent is indicated in Indonesia.

A sensitivity analysis indicates that if a higher sales realisation by 5 per cent is considered, that is US $ 425 per ton for Thailand, Malaysia and Singapore, an IRR as given below, is indicated with a plant capacity of 600,000 tons per year.

		IRR %
Thailand	..	12.5
Malaysia	..	14.2
Singapore	..	15.5

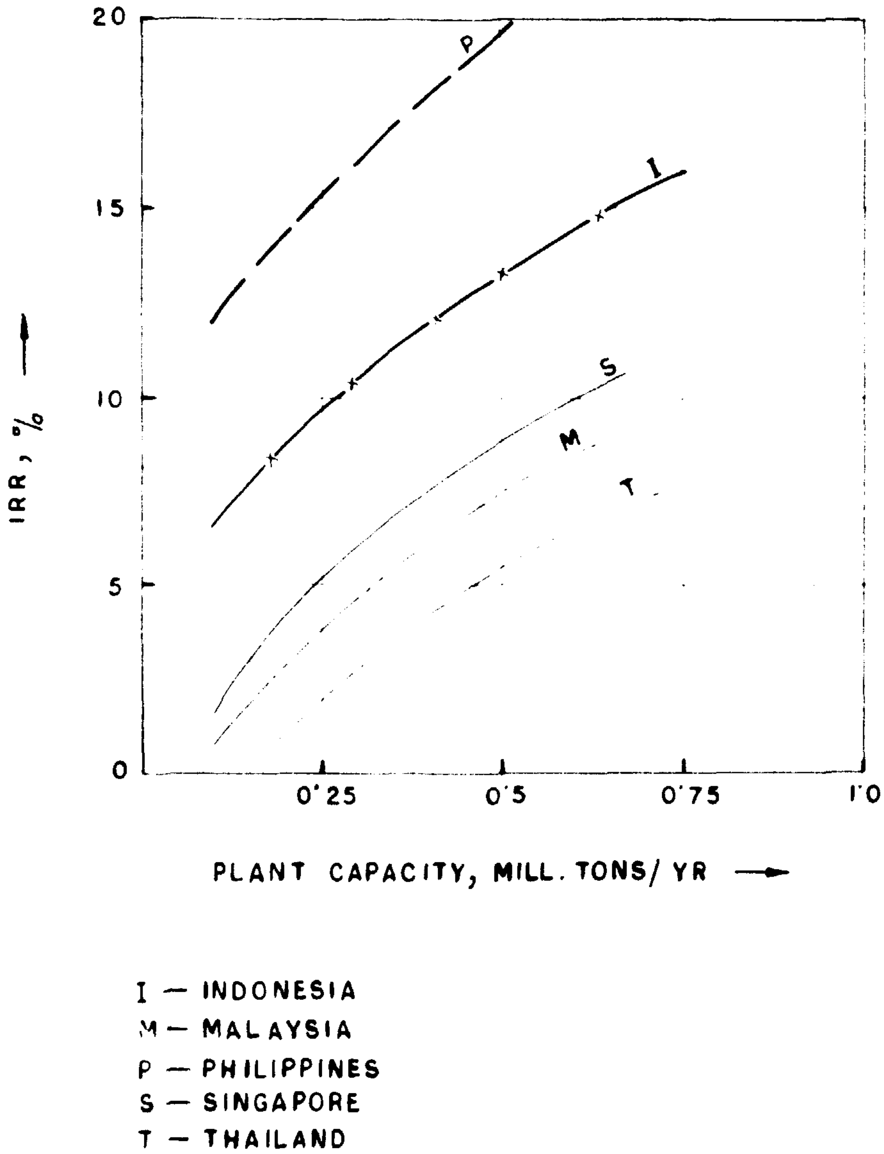


FIG. 10-1 — IRR vs PLANT CAPACITY FOR STRUCTURAL SHAPE MILL

11 - PROJECT PROFILE - BRIGHT BAR PLANT

Bright bars are cold finished bars which have good surface finish, are free of scale and have close dimensional tolerances. Their mechanical properties and machinability are also better compared to ordinary black bars. Bright bars are used in various grades of steels such as carbon, free cutting and alloy steels. Depending on the grade and quality of steel, the applications of bright bars cover the manufacture of nuts, bolts, jigs and fixtures, gears, shafts, axles and other machine components. The major consumer of bright bars is the automobile industry. While bulk of the requirement of bright bars is in the form of rounds, it is also used as squares, hexagons and in small quantities as flats. The demand for bright bars in the ASEAN countries is expected to be mainly for mild steel rounds in the size range of 6-100 mm dia.

SELECTION OF PRODUCTION

The manufacturing processes available for production of bright bars include cold rolling, cold drawing, centreless turning and centreless grinding. Of these, cold drawing is the most popular and widely used process. Cold rolling is essentially for the production of flats. Since the requirement of bright bar flats is limited, cold rolling practice in bright bar plants is seldom employed. Centreless turning and grinding are generally employed for making alloy steel bars and where dimensional tolerances are relatively more stringent. For production of mild steel bright bar rounds, cold drawing process has been considered.

Cold Drawing

In cold drawing a reduction of about 15 to 25 per cent in cross sectional area is generally given. The raw material for cold drawing is hot rolled black bar in straight lengths or wire rod coils. The major production steps involved in the manufacture of bright bars by cold drawing are:

i) Cutting/shearing of black bars
ii) Pickling in a bath of sulphuric acid
iii) Cold drawing
iv) Cutting of drawn bars into desired lengths
v) Straightening and polishing
vi) Inspection and testing
vii) Coating for rust prevention, marking and painting.

11 - Project profile - bright bar plant (cont'd)

For cold drawing of bars in straight lengths, draw benches are used. In the case of coils, automatic drawing lines are generally preferred. In the conventional draw bench, the black bar is fed to a pointing machine to facilitate its entry into the die of the draw bench. Whereas the various production steps before and after drawing are independent of each other in the conventional draw bench process, in an automatic drawing line the straightening of bars prior to and after cold drawing, polishing and cutting are combined with main drawing operation in an integrated unit.

DESIGN BASIS AND MAJOR FACILITIES

Plant Capacity and Facilities

It is proposed to manufacture bright bars in the size range of 6-100 mm. For this purpose, one cold draw bench and one automatic line are considered. The minimum annual production achievable with these facilities is about 20,000 tons per year of mild steel bright bars on two shift working, as given below:

	Diameter mm	Drawing speed m/min	Production capacity tons/yr
Automatic drawing line ..	6-20	60-15	5,000
Cold draw bench ..	20-100	15-2	15,000
			20,000

11 - Project profile - bright bar plant (cont'd)

A typical list of major production equipment, including auxiliary facilities for preparation of black bars as well as finishing facilities for bright bars, is given in Appendix 11-1.

Plant Flowsheet and Layout

A typical flowsheet for a bright bar plant is presented in Drawing 5480-11-1 and a typical plant layout is illustrated in Drawing 5480-11-2. The layout is preliminary and has been developed to illustrate the relative disposition of the major plant facilities.

CAPITAL COST

The capital cost of a bright bar plant with a capacity of 20,000 tons per year is estimated at US $ 5 million as given in Table 11-1.

PRODUCTION COST

The production cost includes the cost of materials, labour and supervision, other manufacturing costs, administration and sales expenses and fixed charges covering depreciation and interest on loans. The consumption of the major inputs are as follows:

		Consumption per ton product
Black bar/wire rod	..	1,050 kg
Electric power	..	80 kWh

11 - Project profile - bright bar plant (cont'd)

TABLE 11-1 - CAPITAL COST FOR BRIGHT BAR PLANT
(million US $)

I.	Civil and structural work	..	0.9
II.	Mechanical and electrical equipment:		
	a) Cold draw bench and accessories	..	0.6
	b) Automatic drawing line	..	0.5
	c) Building, utilities, cranes etc		0.4
	d) Other auxiliary facilities	..	0.8
	Sub-total	..	2.3
III.	Ocean freight, port charges, internal transport and equipment erection @ 25 per cent of (II)	..	0.6
IV.	Spares	..	0.2
V.	Design, engineering, administration and pre-operation expenses	..	0.6
VI.	Contingencies	..	0.4
	TOTAL	..	5.0

The labour and supervision costs have been computed on the estimated manpower requirement of 100. Based on the consumption norms indicated above and the prices discussed in Chapters 4 and 5, the production cost of bright bars excluding fixed charges is computed in Appendix 11-2 and summarised in Table 11-2.

11 - Project profile - bright bar plant (cont'd)

TABLE 11-2 - PRODUCTION COST OF BRIGHT BAR EXCLUDING FIXED CHARGES
(US $ per ton)

	Thailand	Malaysia	Singapore	Indonesia	Philippines
Cost of materials	415	407	390	402	420
Labour & supervision	14	14	26	11	10
Other costs	24	26	30	20	29
Administration & sales expenses	17	17	17	18	19
Production cost:	470	464	463	451	478

The estimated production cost including fixed charges at 20 per cent of the capital cost covering depreciation and interest on loans works out as given in Table 11-3.

TABLE 11-3 - PRODUCTION COST OF BRIGHT BAR INCLUDING FIXED CHARGES
(US $ per ton)

Thailand	..	520
Malaysia	..	514
Singapore	..	513
Indonesia	..	501
Philippines	..	528

11 - Project profile - bright bar plant (cont'd)

VIABILITY

The Internal Rates of Return (IRR) have been computed for each country and are presented in Table 11-3. In computing the IRR, production in the first year of operation is assumed as 80 per cent and 100 per cent from the second year onwards.

TABLE 11-4 - INTERNAL RATE OF RETURN FOR BRIGHT BAR PLANT

		IRR %
Thailand	..	20.3
Malaysia	..	21.6
Singapore	..	21.4
Indonesia	..	25.0
Philippines	..	18.7

It is seen that with a 20,000 tons per year capacity bright bar plant, the IRR is over 15 per cent for all the countries.

12 - PROJECT PROFILE - SEAMLESS TUBE PLANT

This chapter deals with the production of seamless steel tubes up to 200 mm outside diameter as discussed and agreed upon during the follow-up meeting with the ASEAN representatives at Bangkok. The tubes will be made of carbon steel and find application in the following fields:

i) Petroleum industry as casing, tubing, line pipe and refinery tubes.

ii) Engineering and mineral industry as machine parts, core drill, automobile components etc.

iii) Boiler industry as boiler and superheater tubes for medium and high pressure.

iv) Industrial piping for pressure water, gas and steam services in general.

v) Fertiliser and chemical industry as process tubes.

vi) Tube-wells as casing tubes.

Seamless tubes for these applications have to be produced in two categories, namely hot finished and cold drawn. For the cold drawn category, such as for boiler applications, the hot rolled and reduced tubes, mainly in the smaller diameters, will be further processed on a cold draw bench.

12 - Project profile - seamless tube plant (cont'd)

SELECTION OF PRODUCTION PROCESS

The various processes which could be considered for making seamless tubes are :

i) Continuous mandrel mill process
ii) Plug mill process
iii) Pilger mill process
iv) Assel mill process
v) Push bench process
vi) Diescher process
vii) Extrusion process

A brief review of the main characteristics of the above processes, such as their specific applications, production capacities etc is made in Appendix 12-1. From the review, the following will be noted:

i) The continuous mandrel mill and plug mill are high capacity mills, well suited for large production in limited tube size ranges and in long campaigns. These mills also require large inventories of costly rolls and alloy steel mandrels in various sizes. The mandrel mill generally rolls tubes upto 150 mm outside diameter. The tubes rolled in a plug mill, on further reduction in a stretch reducing mill result in higher rejections on account of elongation of inside surface defects.

ii) The hot pilger mill is a very flexible mill that is ideally suited for manufacturing a wide range of tube diameters, wall thicknesses and lengths in small batches.

iii) The Assel mill is generally used for the production of thick wall tubes suitable for ball bearing races, hollow bars for machining etc.

iv) The push bench process generally produces tube up to about 168 mm dia and is generally employed for the production of "mother" tubes. to be further heated and stretch reduced or cold worked. The process yield is lower than in other processes.

v) The Diescher process can only use rolled round blooms. The process can roll only short tube lengths and the surface finish is poor.

vi) The extrusion process is suited for production of costly high alloy steels and stainless steel tubes on account of additional cost of glass lubrication and high tool wear.

Keeping in view the above, the pilger mill process is suggested for the quality and size range of seamless tubes to be produced.

DESIGN BASIS AND MAJOR FACILITIES

Plant Capacity and Product-Mix

The following three annual plant capacities have been considered for evaluations:

Alt. 1	..	25,000 tons
Alt. 2	..	50,000 tons
Alt. 3	..	62,000 tons

The product-mix envisaged for each of the three alternative plant capacities is given in Table 12-1.

12 - Project profile - seamless tube plant (cont'd)

TABLE 12-1 - TENTATIVE PRODUCT-MIX FOR SEAMLESS TUBE PLANT

Tube outside diameter (approx) mm		Production, tons/yr Alt. 1	Alt. 2	Alt. 3
165 to 220	..	5,700	11,400	11,400
120 to 150	..	15,300	30,600	30,600
75 to 100	..	4,000	8,000	10,000
40 to 75	..	-	-	10,000
Total	..	25,000	50,000	62,000

Of the total productions indicated above, cold drawn tubes would account for about 25 per cent, and would be in the size range 75 to 160 mm OD for Alt. 1 and Alt. 2, and 40 to 160 mm OD for Alt. 3.

The tube diameters and wall thicknesses included for manufacture in each alternative are given below:

		Alt. 1	Alt. 2	Alt. 3
Hot finished product:				
i) Approximate tube OD, mm	..	90-220	90-220	50-220
ii) Approximate wall thickness, mm	..	5- 25	5- 25	4- 25
Cold drawn product:				
i) Approximate tube OD, mm	..	75-160	75-160	40-160
ii) Approximate wall thickness, mm	..	4-9.5	4-9.5	3- 10

In Alt. 3, pilger mill will roll tubes up to 140 mm (OD) minimum, and the lower sizes will be produced in stretch reducing mill.

Major Plant Facilities

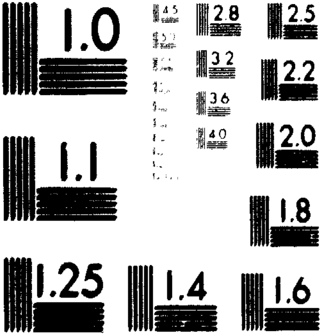
A typical list of major plant facilities required for a seamless tube plant is given in Appendix 12-2. The major production facilities for the three alternatives are summarised in Table 12-2.

TABLE 12-2 - MAJOR PRODUCTION FACILITIES FOR SEAMLESS TUBE PLANT

		Alt. 1	Alt. 2	Alt. 3
Rotary hearth furnace				
Number	..	1	1	1
Capacity, tons/hr	..	12.5	25	25
Piercing press				
Number	..	1	1	1
Force, tons	..	650	650	650
Pilger mill				
Number of stands	..	1	2	2
Stretch reducing mill				
Number of stands	..	-	-	19
Draw bench	..	1	2	2

Plant Flowsheet and Layout

A schematic plant flowsheet is given in Drawing 5480-12-1 and a typical plant general layout for a seamless tube plant is given in Drawing 5480-12-2. The layout indicated is tentative and intended to illustrate the general plant configuration.



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12 - Project profile - seamless tube plant (cont'd)

CAPITAL COST

Preliminary estimates of capital cost for the three alternative capacities are presented in Table 12-3. The capital cost includes the cost of buildings and structures, mechanical and electrical equipment as erected, design and engineering expenses, initial spares and various preliminary expenses. The cost estimates presented in Table 12-3 are preliminary in nature and are primarily intended for providing an idea of the order-of-magnitude of investments involved.

TABLE 12-3 - ESTIMATES OF CAPITAL COST FOR SEAMLESS TUBE PLANT
(million US $)

		Alt. 1	Alt. 2	Alt. 3
I.	Civil and structural work ..	7.5	9.0	10.5
II.	Mechanical and electrical equipment			
	a) Billet preparation equipment, tube mill, cold drawing and finishing equipment ..	24.0	35.5	43.5
	b) Material handling and maintenance shop equipment ..	3.0	4.5	4.5
	c) Utilities and services ..	3.0	4.0	5.0
	Sub-total ..	30.0	44.0	53.0
III.	Ocean freight, port charges, internal transport and equipment erection @ 25 per cent of (II) ..	7.5	11.0	13.0
IV.	Spares ..	3.0	5.0	5.5
V.	Design, engineering, administration and pre-operation expenses ..	6.0	8.5	10.0
VI.	Contingencies ..	5.0	7.0	8.5
	Total ..	59.0	84.5	100.5

12 - Project profile - seamless tube plant (cont'd)

PRODUCTION COST

Production cost comprises the cost of materials, other manufacturing costs, administration and sales expenses and fixed charges covering depreciation and interest on loans. The production cost per ton of seamless tubes excluding fixed charges are computed in Appendix 12-3 for the three alternative capacities. These estimates are based on the prices of the inputs discussed in Chapters 4 and 5 and average consumption of major inputs as given below.

	Consumption/ton tube		
	Alt. 1	Alt. 2	Alt. 3
Bloom, kg ..	1,430	1,430	1,330
Electric power, kWh ..	400	400	500
Fuel oil, kg ..	125	125	125

The estimated production costs of seamless tubes excluding fixed charges are summarised in Table 12- 4.

If fixed charges covering depreciation and interest are taken into account at 20 per cent of the capital cost, the production cost will work out as given in Table 12-5.

12 - Project profile - seamless tube plant (cont'd)

TABLE 12-4 - PRODUCTION COST OF SEAMLESS TUBES
EXCLUDING FIXED CHARGES
(US $ per ton)

	Thailand	Malaysia	Singapore	Indonesia	Philippines
Alt. 1					
Cost of materials ..	430	427	409	400	406
Labour & supervision ..	47	50	89	37	33
Other manufacturing costs ..	94	97	121	77	105
Administration & sales expenses ..	16	16	17	15	15
Production cost ..	587	590	636	529	559
Alt. 2					
Cost of materials ..	430	427	409	400	406
Labour & supervision ..	33	34	61	26	23
Other manufacturing costs ..	80	84	104	64	93
Administration & sales expenses ..	15	15	16	14	14
Production cost ..	558	560	590	504	536
Alt. 3					
Cost of materials ..	403	399	382	375	380
Labour & supervision ..	29	30	53	22	20
Other manufacturing costs ..	83	87	108	67	98
Administration & sales expenses ..	14	14	15	13	14
Production cost ..	529	530	558	477	512

12 - Project profile - seamless tube plant (cont'd)

TABLE 12-5 - PRODUCTION COST INCLUDING FIXED CHARGES
(US $ per ton)

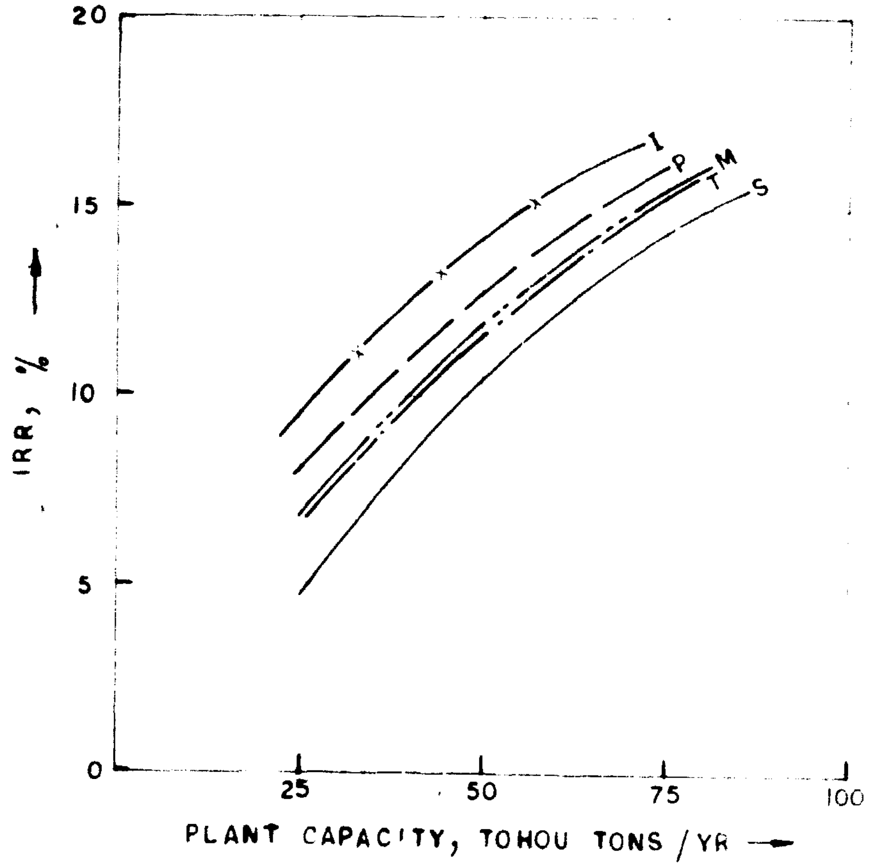
		Alt. 1	Alt. 2	Alt. 3
Thailand	..	1,059	896	853
Malaysia	..	1,062	898	854
Singapore	..	1,108	928	882
Indonesia	..	1,001	842	801
Philippines	..	1,031	874	836

VIABILITY

Based on the production cost estimates presented in Table 12-4 and the net sales revenue per ton of seamless tubes indicated in Chapter 5, the Internal Rate of Return (IRR) has been computed for the three alternatives. In computing the IRR, the production build-up is taken as 80 per cent in the first year, 90 per cent in the second year and 100 per cent from the third year onwards. The IRR are given in Table 12-6 and plotted in Figure 12-1.

TABLE 12-6 - INTERNAL RATE OF RETURN FOR SEAMLESS TUBE PLANT

		Alt. 1 %	Alt. 2 %	Alt. 3 %
Thailand	..	7.0	12.0	13.7
Malaysia	..	6.9	11.9	13.7
Singapore	..	4.9	10.5	12.4
Indonesia	..	9.6	14.2	15.8
Philippines	..	8.1	12.9	14.4



I — INDONESIA

M — MALAYSIA

P — PHILIPPINES

S — SINGAPORE

T — THAILAND

FIG.12-1 — IRR vs PLANT CAPACITY FOR SEAMLESS TUBE PLANT

12 - Project profile - seamless tube plant (cont'd)

It is seen that with a plant capacity of 50,000 tons per year and IRR of about 14 per cent is obtained for Indonesia and with a plant capacity of 62,000 tons per year, the IRR is between 13.7 and 14.4 per cent for the other countries.

13 - PROJECT PROFILE - GI WIRE PLANT

This chapter deals with the production of galvanized mild steel wires used for applications such as fencing, barbed wire, wire meshes and miscellaneous applications. Wires for these uses are required in the size range of 0.55 mm (24 gauge) to 4.88 mm (6 gauge).

PRODUCTION PROCESS

The major steps involved in the production of galvanized steel (GI) wires are:

i) Descaling of wire rod
ii) Wire drawing
iii) Annealing
iv) Galvanising

Descaling

The wire rod is first mechanically descaled in a descaling machine. It is then subjected to chemical descaling, commonly known as pickling, by dipping in an acid (HCl or H_2SO_4) tank for a sufficient length of time followed by rinsing in water to remove the excess acid. The wire rod is then dipped in lime suspension to acquire a lime coating. The lime coating prevents any rusting of the wire and also functions as a lubricant carrier during subsequent drawing operation.

Wire drawing

Mild steel can be given a total reduction of upto 95 per cent in one stage. If further reduction of the wire is required, annealing is required to bring the wire to its original soft condition for further drawing. Every annealing operation is followed by pickling before further drawing. The important types of wire drawing machines available are bull blocks, motor blocks, single and double deck machines and continuous machines. Of these, bull blocks and motor blocks are used for single pass reduction for thicker sizes. Single and double deck machines are employed when the final size is to be obtained in one or two passes from the wire rod. Continuous machines have a number of blocks, upto about 9. Substantial reduction can be obtained in these machines. The reduction in each pass can also be adjusted to obtain various sizes of wire. Wet drawing machines are usually used for drawing wire of sizes below about 1.5 mm. A large number of passes, up to 21, may be obtained in these machines.

13 - Project profile - GI wire plant (cont'd)

Annealing

Intermediate annealing of mild steel wire is carried out at around 700°C. The total cycle time including heating, soaking and cooling is about 15 hrs. Either batch or continuous furnaces may be used. Continuous furnaces are generally preferred for large production capacities. In most of the wire drawing plants, the bell type batch furnace is used.

Galvanising

The available processes for galvanising are hot dip galvanising and electro-galvanising. The investment on the latter is high and is usually justified only for large production capacities. The hot dip galvanising process is usually used for wires. This is a continuous process involving passing of wire through a series of conditioning baths and finally through a bath of molten zinc. Galvanising lines are up to 50 to 60 m in length and may process 30 to 50 strands of wire at a time.

13 - Project profile - GI wire plant (cont'd)

DESIGN BASIS AND MAJOR FACILITIES

Plant Capacity and Product-mix

Keeping in view the major applications, production of mild steel GI wire in the size range 6 gauge to 24 gauge is considered. Three plant capacities have been considered for evaluation, and their annual production programme are indicated in Table 13-1.

TABLE 13-1 - TENTATIVE PRODUCT-MIX FOR GI WIRE PLANT

Size of wire		Production, tons/year		
SWG	mm	Alt. 1	Alt. 2	Alt. 3
6 - 7	4.88 - 4.47	500	1,000	1,500
8 - 11	4.06 - 2.95	4,150	8,300	12,450
12 - 13	2.64 - 2.34	2,300	4,600	6,900
14 - 18	2.03 - 1.22	4,150	8,300	12,450
19 - 24	1.02 - 0.55	400	800	1,200
	TOTAL ..	11,500	23,000	34,500

Major Plant Facilities

The major production equipment required are wire drawing machines, annealing furnaces and galvanising and pickling lines. Besides, auxiliary facilities like pointing machines, welding machines etc are required. The equipment has been selected based on an input wire rod size of 6 mm.

13 - Project profile - GI wire plant (cont'd)

A typical list of the major equipment and facilities is given in Appendix 13-1 and the major production facilities for the three alternatives are summarised in Table 13-2.

TABLE 13-2 - MAJOR PRODUCTION FACILITIES FOR GI WIRE PLANT

	Alt. 1	Alt. 2	Alt. 3
Wire drawing equipment:			
Single block machine	2	4	6
5-block continuous machine	1	2	3
7-block continuous machine	1	2	3
Galvanising line:			
Number	2	2	2
Capacity, tons/day	20	40	60
Annealing furnace:			
Number	1	1	1
Capacity, tons	15	30	45
Pickling line:			
Capacity, tons/day	60	120	180

Plant Flowsheet and Layout

The plant flowsheet is given in Drawing 5480-13-1. A typical plant general layout, showing the disposition of various production and auxiliary facilities, is illustrated in Drawing 5480-13-2.

13 - Project profile - GI wire plant (cont'd)

CAPITAL COST

The capital cost includes the cost of all facilities within the plant boundary, as well as the cost of spares and other preliminary expenses. Preliminary estimates of capital cost for the three capacities are presented in Table 13-3

TABLE 13-3 - CAPITAL COST OF GI WIRE PLANT
(million US $)

		Alt. 1	Alt. 2	Alt. 3
I.	Civil and structural work	0.80	1.20	1.30
II.	Mechanical and electrical equipment:			
	Galvanising facilities	0.70	1.26	2.14
	Wire drawing facilities	0.30	0.60	0.90
	Utilities and auxiliary facilities	0.85	1.10	1.25
		1.85	2.96	4.29
III.	Ocean freight, port charges, internal transport and equipment erection @ 25 per cent of (II)	0.46	0.73	1.07
IV.	Spares	0.19	0.29	0.43
V.	Design, engineering, administration and pre-operative expenses	0.46	0.73	1.00
VI.	Contingencies	0.38	0.59	0.80
	TOTAL ..	4.14	6.50	8.89

13 - Project profile - GI wire plant (cont'd)

PRODUCTION COST

The production cost includes the cost of materials, other manufacturing costs, administration and sales expenses and fixed charges covering depreciation and interest on loans. These estimates are based on the unit prices of various inputs indicated in Chapters 4 and 5 and consumption of major items as given below:

		Consumption per ton wire
Wire rod	..	1,050 kg
Zinc	..	40 kg
Electric power	..	80 kWh

The labour and supervision costs are estimated on the basis of the following manpower requirements.

		Manpower
Alt. 1	..	110
Alt. 2	..	150
Alt. 3	..	190

Details of the computation of production costs, excluding fixed charges are presented in Appendix 13-2 and summarised in Table 13-4.

13 - Project profile - GI wire plant (cont'd)

TABLE 13-4 - PRODUCTION COST OF GI WIRE EXCLUDING FIXED CHARGES
(US $ per ton)

	Thailand	Malaysia	Singapore	Indonesia	Philippines
Alt. 1					
Cost of materials	461	451	434	453	445
Labour & supervision	26	28	49	21	18
Other conversion costs	23	23	34	20	32
Administration & sales expenses	13	13	13	13	13
Production cost ..	523	515	530	507	508
Alt. 2					
Cost of materials	461	451	434	453	445
Labour & supervision	18	19	34	14	13
Other conversion costs	21	22	31	18	30
Administration & sales expenses	13	13	13	13	13
Production cost ..	513	505	512	498	501
Alt. 3					
Cost of materials	461	451	434	453	445
Labour & supervision	15	16	28	12	11
Other conversion costs	20	21	31	18	29
Administration & sales expenses	13	13	13	13	13
Production cost ..	509	501	506	496	498

If fixed charges covering depreciation and interest on loans are included at 20 per cent of the capital cost, the production cost will work out as given in Table 13-5.

13 - Project profile - GI wire plant (cont'd)

TABLE 13-5 - PRODUCTION COST OF GI WIRE INCLUDING FIXED CHARGES
(US $ per ton)

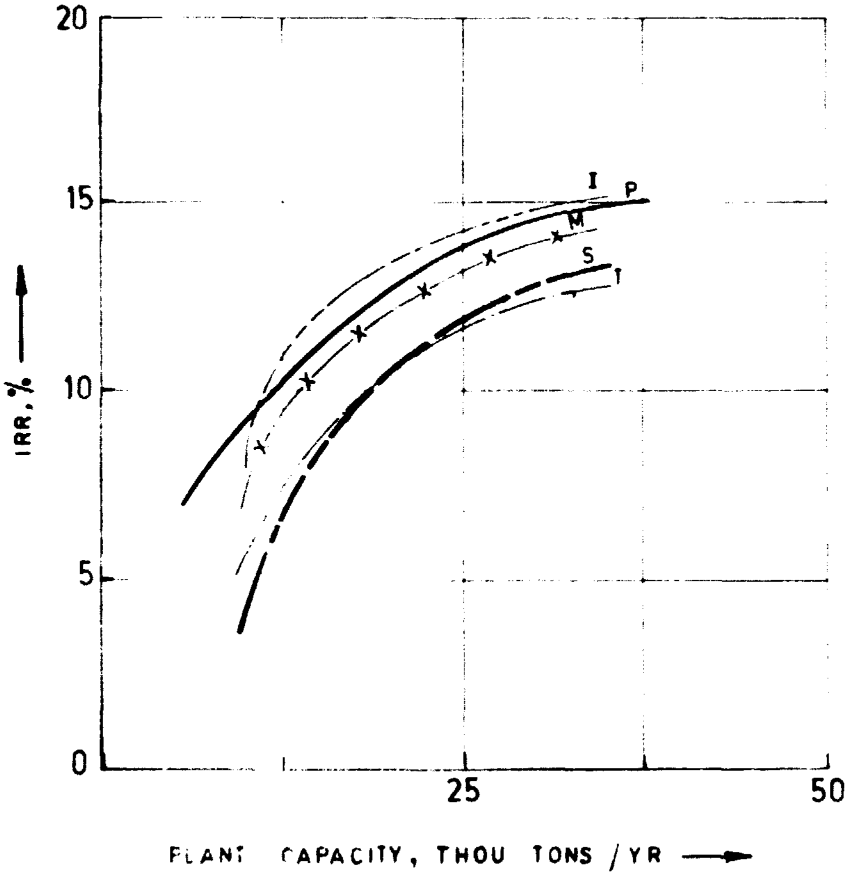
		Alt. 1	Alt. 2	Alt. 3
Thailand	..	595	570	561
Malaysia	..	587	562	553
Singapore	..	602	569	558
Indonesia	..	579	555	548
Philippines	..	580	558	550

VIABILITY

The Internal Rate of Return (IRR) has been computed for the alternative plant capacities. In computing the IRR, the production build-up is taken as 80 per cent in the first year and 100 per cent from the second year and onwards. The computed IRR values are given in Table 13-6 and plotted in Fig 13-1.

TABLE 13-6 - IRR FOR GI WIRE PLANT

		Alt. 1 %	Alt. 2 %	Alt. 3 %
Thailand	..	6.7	10.9	12.6
Malaysia	..	8.3	12.4	14.1
Singapore	..	5.2	10.9	13.0
Indonesia	..	9.9	13.7	15.[illegible]
Philippines	..	9.8	13.2	14.7



I — INDONESIA

M — MALAYSIA

S — SINGAPORE

P — PHILIPPINES

T — THAILAND

FIG. 13-1 — IRR vs PLANT CAPACITY FOR G.I. WIRE

It is seen that with a plant capacity of 34,500 tons per year, the IRR obtained in the different countries varies between 12.6 per cent and 15 per cent.

14 - PROJECT PROFILE - SPECIAL STEELS PLANT

Special steels cover a wide range of steels including carbon steels for special purposes, such as carbon constructional, spring and free cutting steels as well as alloy steels. Alloy steels include those containing alloying elements like chromium, nickel, manganese (above 1 per cent), molybdenum, etc. For an industrially developing country, bulk of the demand for special steels is in four categories, namely carbon constructional steels, alloy constructional steels, spring steels and free cutting steels. The types of products required by these countries are mostly non-flat categories such as bars and rods. The major applications and typical international specifications of the more important and popular grades in the above four categories of steels are given in Appendix 14-1.

SELECTION OF PRODUCTION PROCESS

The major steps involved in the production of special steels are steelmaking, ingot casting and rolling. Besides conditioning involving chipping, grinding etc is done prior to rolling. Depending on the end-use and customer requirements, heat treatment such as normalising and annealing is also sometimes given.

14 - Project profile - special steels plant (cont'd)

Steelmaking

Steelmaking involves melting of the steel scrap charge in electric arc furnace followed by refining. The double slag practice is generally adopted for most of the grades of special steels, except free cutting steels which require a sulphur content of about 0.2 to 0.3 per cent. This practice results in longer heat time on account of extended refining periods.

Casting

The two major routes for casting liquid steel into semis are the conventional ingot casting route and the continuous casting route. The ingot casting route involves rolling of ingots to blooms or billets, whereas the continuous casting route directly produces blooms/billets. In view of this, the yield of bars and rods from liquid steel is higher by about 10 to 12 per cent for continuous casting than that obtained with ingot casting. The production cost is also lower in the continuous casting route, in view of the higher yield and the fact that costly consumables like hot tops, ingot moulds, bottom plates and pit side refractories are not required.

However, continuous casting technology is mainly restricted to ordinary grades of steels. Problems due to segregation, cracking, alumina build-up in nozzle etc are normally encountered. Although considerable progress has been made in recent years in continuous casting of special steels, there are very few plants in the world producing special steels, entirely by continuous casting. Also, continuous casting of free cutting steels using a curved mould is yet to be established. On the other hand, by ingot casting, all types and grades of steels including killed, semi-killed and rimming steel as well as carbon, low alloy, high alloy and stainless steel can be produced. In view of this, conventional ingot casting route is considered for this study.

Rolling

The main criterion for selecting the rolling mill is the starting size of ingot/bloom and the size range of rolled products. For production of quality steels with a metallurgically sound structure, a minimum reduction ratio of 10:1 is required for most grades. For some grades like spring steels, a higher reduction ratio of the order of 20:1 and above is required. For the proposed special steels plant, the suggested rolling mill will comprise one 3-hi roughing stand, two 3-hi intermediate stands and one 2-hi finishing stand.

DESIGN BASIS AND MAJOR FACILITIES

Plant Capacity and Product-mix

Two annual capacities, namely 35,000 tons (Alt. 1) and 70,000 tons (Alt. 2) are considered for evaluating the viability of producing special steels. Keeping in view the applications for special steels in the ASEAN countries the following product-mix has been considered:

		Alt. 1 tons/year	Alt. 2 tons/year
Carbon constructional	..	16,000	32,000
Alloy constructional	..	9,000	18,000
Spring steel	..	5,000	10,000
Free cutting steel	..	5,000	10,000
Total	..	35,000	70,000

The sizes of bars and rods envisaged for production are in the range of 50 - 75 mm.

14 - Project profile - special steels plant (cont'd)

Major Plant Facilities

A typical list of facilities required for a special steels plant, producing the grades of steel indicated above, is given in Appendix 14-2. The major production facilities proposed, for meeting the production requirement of Alt. 1 and Alt. 2 are given in Table 14-1.

TABLE 14-1 - MAJOR PRODUCTION FACILITIES FOR SPECIAL STEELS PLANT

		Alt. 1	Alt. 2
Arc furnace			
Number	..	2	2
Capacity, tons	..	15	30
Liquid steel, tons/yr		45,000	90,000
Ingots, tons/yr	..	41,850	83,700
Reheating furnace			
Number	..	1	1
Capacity, tons/yr	..	10	20
Rolling mill			
No. of stands	..	One 3-hi roughing Two 3-hi intermediate One 2-hi finishing	One 3-hi roughing Two 3-hi intermediate One 2-hi finishing
Production, tons/yr	..	35,000	70,000

14 - Project profile - special steels plant (cont'd)

The production rating of the arc furnace is based on an average of 5 heats per day. The yield from liquid steel to ingot is considered at 93 per cent and from ingot to rolled product at 84 per cent. Annual availability is taken as 300 days.

Plant Flowsheet and Layout

A schematic flowsheet for the special steels plant is given in Drawing 5480-14-1 and a plant general layout is presented in Drawing 5480-14-2. The layout is typical and illustrates the relative disposition of the major plant facilities.

CAPITAL COST

Preliminary estimates of the capital cost, comprising the cost of all facilities within the plant boundary, design and engineering expenses, cost of spares and other preliminary estimates work out to US $ 23.3 million and US $ 34.5 million for Alt. 1 and Alt. 2 respectively, as presented in Table 14-2. The cost estimates are of preliminary nature only and intended for the purpose of illustrating the order-of-magnitude of the investments involved.

14 - Project profile - special steels plant (cont'd)

TABLE 14-2 - CAPITAL COST FOR SPECIAL STEELS PLANT
(Million US $)

			Alt. 1	Alt. 2
I.	Civil and structural work	..	5.20	7.60
II.	Mechanical and electrical equipment:			
	a) Steel melt shop, complete with arc furnace and casting facilities	..	1.70	3.10
	b) Rolling mill, complete with reheating furnace, mills and accessories	..	5.20	5.60
	c) Auxiliary facilities	..	3.40	6.40
	Sub-total	..	10.30	15.10
III.	Ocean freight, port charges, internal transport and equipment erection @ 25 per cent of (II)	..	2.50	3.80
IV.	Spares	..	0.70	1.00
V.	Design, engineering, administration and pre-operation expenses	..	2.60	4.00
VI.	Contingencies	..	2.00	3.00
	TOTAL	..	23.30	34.50

14 - Project profile - special steels plant (cont'd)

PRODUCTION COST

The production cost includes the cost of materials, other manufacturing costs, administration/sales expenses and fixed charges covering depreciation and interest on loans. The average consumption of major inputs is given in Table 14-3 and the prices of various inputs indicated in Chapters 4 and 5. The labour and supervision costs are estimated on the basis of a total manpower requirement of 300 for Alt. 1 and 320 for Alt. 2.

TABLE 14-3 - CONSUMPTION OF MAJOR INPUTS FOR SPECIAL STEELS PLANT

		Specific consumption
Steel scrap	..	1,168 kg
Ferro-silicon	..	7.5 kg
Ferro-manganese	..	14.7 kg
Ferro-chrome	..	10.5 kg
Ferro-molybdenum	..	1.5 kg
Ferro-vanadium	..	0.3 kg
Nickel	..	3.5 kg
Limestone	..	135 kg
Graphite electrodes	..	7.5 kg
Ingot moulds	..	20 kg
Refractories	..	160 kg
Electric power	..	1,080 kWh
Fuel	..	0.6×10^6 Kcal

The production cost estimates excluding fixed charges are detailed in Appendix 14-3 and summarised in Table 14-4.

14 - Project profile - special steels plant (cont'd)

TABLE 14-4 - PRODUCTION COST OF SPECIAL STEELS EXCLUDING FIXED CHARGES
(US $ per ton)

	Thailand	Malaysia	Singapore	Indonesia	Philippines
Alt. 1					
Cost of materials	265	229	246	255	257
Labour & supervision	24	25	44	19	16
Other manufacturing costs	172	170	190	165	207
Administration & sales expenses	16	16	16	16	16
Production cost:	477	440	496	455	496
Alt. 2					
Cost of materials	265	229	246	255	257
Labour & supervision	13	13	24	10	9
Other manufacturing costs	168	167	185	162	203
Administration & sales expenses	16	16	16	16	16
Production cost:	462	425	471	443	485

If the incidence of fixed charges covering depreciation and interest on loans is taken into account at 20 per cent of the capital cost, the production cost will work out as presented in Table 14-5.

14 - Project profile - special steels plant (cont'd)

TABLE 14-5 - PRODUCTION COST INCLUDING FIXED CHARGES
(US $ per ton)

		Alt. 1	Alt. 2
Thailand	..	610	561
Malaysia	..	573	524
Singapore	..	629	570
Indonesia	..	588	542
Philippines	..	629	584

VIABILITY

IRR have been computed for the alternative plant capacities considering a production of 60 per cent in the first year, 80 per cent in the second year, 90 per cent in the third year and 100 per cent from the fourth year onwards and a net sales realisation of US $ 620 per ton. The computed IRR values are given in Table 14-6.

TABLE 14-6 - INTERNAL RATE OF RETURN FOR SPECIAL STEELS PLANT

		Alt. 1 %	Alt. 2 %
Thailand	..	12.7	17.9
Malaysia	..	15.9	21.5
Singapore	..	10.6	16.9
Indonesia	..	14.8	19.9
Philippines	..	10.9	15.6

14 - Project profile - special steels plant (cont'd)

It is seen that with a plant of capacity 35,000 tons per year, an IRR of about 15 per cent can be obtained in Indonesia and Malaysia, whereas a plant capacity of about 70,000 tons per year is indicated in case of the other countries to realise an IRR of minimum 15 per cent.

15 - PROJECT PROFILE - STAINLESS STEEL PLANT

This chapter deals with the production of cold rolled stainless steel strip of maximum width 600 mm and 0.3 to 1 mm thickness, based on integrated operation commencing with steelmaking. The cold rolled strip will be mainly of austenitic grade and is expected to be primarily consumed for the manufacture of domestic utensils and kitchenware. The available production technologies are reviewed and the appropriate process route selected in order to evolve the major project parameters.

SELECTION OF PRODUCTION PROCESS

Keeping in view the quality and size of the finished cold rolled product envisaged for production, the major process alternatives available for steelmaking and casting, hot strip rolling and cold strip rolling are briefly reviewed in Appendix 15-1. From the review, the following may be concluded:

i) The arc furnace is the most suitable melting unit.

ii) Three secondary refining processes are available namely, Creusot Loire-Uddeholm (CLU), argon-oxygen decarburisation (AOD) and vacuum oxygen decarburisation (VOD). Of these, the CLU process is relatively new. The AOD process is more suitable for high production applications and also requires large supply of cheap argon. VOD process would be an appropriate choice for the levels of production envisaged.

iii) The continuous casting of stainless steel slabs is well proven in industrial operation.

iv) For hot strip rolling, the planetary mill is the appropriate choice for the scale of production envisaged.

v) For cold strip rolling the Sendzimir mill is a suitable choice.

DESIGN BASIS AND MAJOR FACILITIES

Plant Capacity

For the production of 600 mm wide strip, with thickness varying from 0.3 to 1.0 mm, the optimum capacity of a Sendzimir mill is around 10,000 to 15,000 tons per year. Higher production from a Sendzimir mill can be achieved by increasing the width of the cold rolled strip. On the other hand, if the strip width is restricted to 600 mm, increased production is possible only through repetition of similar rolling and processing facilities. Although there are a number of stainless steel plants with two Sendzimir mills, instances of more than two mills operating in one plant are rare. Keeping this in view, two plant capacities of 20,000 tons per year and 30,000 tons per year of CR strips have been considered for evaluation.

15 - Project profile - stainless steel plant (cont'd)

Major Facilities

A typical list of facilities for a stainless steel plant with integrated arc furnace steelmaking, hot rolling and cold rolling facilities is given in Appendix 15-2. For the two alternative capacities considered, the major production facilities and their annual capacities are briefly described in Table 15-1.

TABLE 15-1 - MAJOR PRODUCTION FACILITIES FOR STAINLESS STEEL PLANT

		Alt. 1	Alt. 2
Electric arc furnace			
Number	..	1	1
Capacity, tons	..	20	30
Number of heats per day	..	6	6
Liquid steel production, tons/yr	..	31,200	46,800
Vacuum refining unit			
Number	..	1	1
Capacity, tons	..	20	30
Continuous slab caster			
Number	..	1x1-strand	1x2-strand
Slab production, tons/yr	..	29,400	44,100
Hot rolling facilities			
Reheating furnace	..	1	1
Planetary mill	..	1	1
Annual production of HR coils, tons/yr	..	26,800	40,200
Cold rolling and finishing facilities			
Annealing and pickling line	..	2	3
Sendzimir mill	..	2	2
Skin pass mill	..	1	1
Annual production of CR sheet/strip, tons/yr	..	20,000	30,000

In determining the capacities and numbers of the various major facilities, 300 days plant operation and normal productivity levels achievable have been assumed. It may be noted that the planetary hot strip mill has a capacity of about 100,000 tons per annum. The surplus capacity of this mill could be utilised for supplying hot rolled coils to other cold rolling mills that may be installed elsewhere in the ASEAN region.

Plant Flowsheet and Layout

A schematic flowsheet of the proposed stainless steel plant is given in Drawing 5480-15-1 and a typical plant layout is illustrated in Drawing 5480-15-2. The layout is illustrative, only giving the relative disposition of the major facilities and will have to be modified to suit the location selected.

CAPITAL COST

Estimates of capital cost of all facilities within the plant boundary, as well as cost of spares and preliminary expenses works out to US $ 165 million and US $ 203.5 million for the first and second alternatives respectively, as given in Table 15-2 on the next page.

15 - Project profile - stainless steel plant (cont'd)

TABLE 15-2 - CAPITAL COST FOR STAINLESS STEEL PLANT
(million US $)

			Alt. 1	Alt. 2
I.	Civil and structural work	..	25.0	30.0
II.	Mechanical and electrical equipment			
	a) Arc furnace and auxiliaries, vacuum refining unit and continuous casting machine	..	10.5	15.0
	b) Hot rolling facilities	..	10.0	10.0
	c) Cold rolling and finishing facilities	..	36.0	46.0
	d) Building utilities, yard facilities and auxiliary facilities	..	24.0	29.0
	Sub-total	..	80.5	100.0
III.	Ocean freight, port charges, internal freight and equipment erection @ 25 per cent of (II)	..	20.0	25.0
IV.	Spares	..	9.0	11.5
V.	Design, engineering, administration and pre-operation expenses	..	16.5	20.0
VI.	Contingencies	..	14.0	17.0
	Total	..	165.0	203.5

PRODUCTION COST

Production cost includes the cost of materials, other manufacturing expenses, administration/sales expenses and fixed charges covering depreciation and interest on loans.

15 - Project profile - stainless steel plant (cont'd)

The consumption of major materials and utilities are given in Table 15-3.

TABLE 15-3 - CONSUMPTION OF MAJOR MATERIALS AND UTILITIES FOR STAINLESS STEEL PLANT

	Unit	Consumption per ton CR sheet/strip Alt. 1	Alt. 2
Scrap ..	kg	1,100	1,100
High C Fe-Cr ..	kg	195	195
Low C Fe-Cr ..	kg	78	78
Silicon chrome ..	kg	8.5	8.5
Low C Fe-Mn ..	kg	8.5	8.5
Ferro-silicon ..	kg	11	11
Nickel ..	kg	80	80
Flux ..	kg	125	125
Electric power ..	kWh	1,900	1,840
Graphite electrode	kg	11.5	11 0
Fuel ..	G cal	1.58	1.58
Oxygen ..	cu m	14.5	14.5

The requirement of manpower is estimated at 950 for Alternative 1 and at 1,000 for Alternative 2.

Based on the consumption norms indicated in Table 15-3 and the unit prices estimated in Chapters 4 and 5, the production costs of CR stainless steel sheet/strip excluding fixed charges are computed in Appendix 15-3 and summarised in Table 15-4 on next page.

15 - Project profile - stainless steel plant (cont'd)

TABLE 15-4 - PRODUCTION COST OF STAINLESS STEEL CR SHEET/STRIP EXCLUDING FIXED CHARGES
(US $ per ton)

	Thailand	Malaysia	Singapore	Indonesia	Philippines
Alt. 1					
Cost of materials ..	1,057	1,007	979	992	1,072
Labour & supervision	131	137	245	103	91
Other manufacturing costs ..	446	448	543	417	488
Administration & sales expenses ..	30	30	35	30	30
Production cost:	1,664	1,622	1,802	1,542	1,681
Alt. 2					
Cost of materials ..	1,057	1,007	979	992	1,072
Labour & supervision	92	96	172	72	64
Other manufacturing costs ..	379	382	456	356	426
Administration & sales expenses ..	25	25	25	25	25
Production cost:	1,553	1,510	1,632	1,445	1,587

Estimated production cost including fixed charges covering depreciation and interest charges at 20 per cent of the capital cost are given in Table 15-5.

TABLE 15-5 - PRODUCTION COST OF STAINLESS STEEL CR SHEET/STRIP INCLUDING FIXED CHARGES
(US $ per ton)

		Alt. 1	Alt. 2
Thailand	..	3,314	2,910
Malaysia	..	3,272	2,867
Singapore	..	3,452	2,989
Indonesia	..	3,192	2,802
Philippines	..	3,331	2,944

VIABILITY

In order to ascertain the project viability and determine the minimum economic size, the internal rates of return (IRR) have been computed for the three alternative capacities, in the five ASEAN countries. The IRR calculation is based on the net sales revenue per ton of finished product, given in Chapter 5, the estimated production cost and a production of 60 per cent in the first year, 80 per cent in the second year, 90 per cent in the third year and 100 per cent in the fourth year and onwards, of the rated capacity.

The IRR values are presented in Table 15-6 and graphically represented in Fig 15-1.

TABLE 15-6 - INTERNAL RATE OF RETURN FOR STAINLESS STEEL PLANT

		Alt. 1 %	Alt. 2 %
Thailand	..	-	3.0
Malaysia	..	0.2	3.7
Singapore	..	-	1.5
Indonesia	..	4.7	7.8
Philippines	..	-	2.4

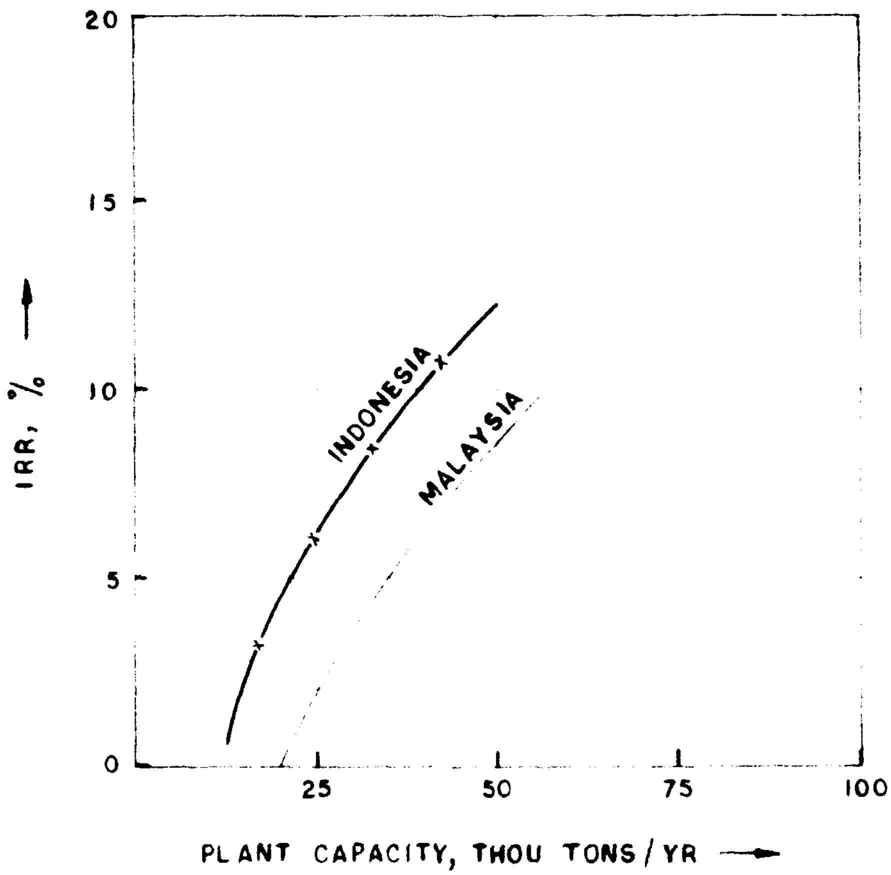


FIG. 15-1 — IRR VS PLANT CAPACITY FOR STAINLESS STEEL PLANT

15 - Project profile - stainless steel plant (cont'd)

It is noted that, with a sales realisation of US $ 2,315 per ton considered for Indonesia and US $ 2,090 per ton for the other countries, an IRR of 15 per cent is not obtained even with a plant capacity of 30,000 tons per year.

A sensitivity analysis indicates that, if 15 per cent higher sales realisation is considered, i.e. US $ 2,660 per ton for Indonesia and US $ 2,400 per ton for the other countries, the IRR for the plant capacity of 30,000 tons per year would improve as follows:

		%
Thailand	..	7.5
Malaysia	..	8.0
Singapore	..	6.4
Indonesia	..	11.6
Philippines	..	7.0

The IRR for the proposed plant would further improve if the capacity of the hot planetary mill is fully utilised and the hot rolled coils/sheets sold in the region.

16 - PROJECT PROFILE - HOT STRIP MILL

This chapter reviews the production of ordinary grade, plain carbon hot rolled strip to be used for (a) further cold rolling for applications such as electrolytic tin plates and galvanised sheets, (b) for production of welded tubes, and (c) for fabrication purposes such as those for automobile industry and miscellaneous consumer industries. A maximum strip width of 1500 mm has been considered, keeping in view the applications.

SELECTION OF HOT STRIP MILL

Hot rolling of slab into strip can be done on any one of the following types of mills:

i) Continuous mill
ii) Semi-continuous mill
iii) Planetary mill
iv) Steckel mill

A brief review of the above mills with respect to various factors such as the nominal capacity of each type of mill, investment requirement, product quality and operative skills required, which govern the selection of any one type of mill in preference to the others, is made in Appendix 16-1 and summarised below.

Continuous Mill

A continuous mill can give a very large output of acceptable quality strip; for example, a 1420 mm (56") continuous mill will have an output of 2 to 3 million tons per year of tonnage steels. This type of mill today is the accepted choice for installation in multi-million ton steelworks.

Semi-continuous Mill

A semi-continuous mill can roll acceptable quality strip of width equal to a continuous mill, but will have a comparatively lower output. A 1420 mm (56") semi-continuous mill will have an output of about 1 to 1.5 million tons per year.

Planetary Mill

The planetary mill, though fairly well established for the production of narrow strip, has not gained acceptance for the production of wide strip. Of the existing installations numbering about 15, only three are designed for rolling of strip wider than 1200 mm. The main problems with this type of mill are the excessive maintenance and high degree of operational skill required, which become difficult to cope with as the mill width increases.

Steckel Mill

The steckel mill has a capacity lower than that of a semi-continuous mill of comparable width. The product quality is inferior to that of a semi-continuous mill product in respect of surface finish and gauge uniformity restricting the use of the hot rolled strip produced. For example, hot rolled strip from steckel mill is generally not of acceptable quality after further cold rolling for applications such as electrolytic tinning. Further, the yield is lower by about 2 per cent compared to other types of mills, the rate of roll wear is high and frequent roll adjustment is required.

Choice of Mill

For the ASEAN countries, the objective is to produce strip of maximum width 1500 mm for applications including tinning lines. Keeping in view the quality requirements and width, only a semi-continuous or continuous mill is considered suitable. Of the two, a semi-continuous mill is selected for analysis, since the capacity is lower than that of a continuous mill. The economic viability of a 1680 mm/1730 mm hot strip mill capable of producing hot rolled strip up to 1500 mm width is examined.

DESIGN BASIS AND MAJOR FACILITIES

Plant Capacity

The hot strip mill selected will have capacity of 1.5 million tons per year on three-shift basis, while producing 1500 mm wide strips of minimum 1.6 mm thickness.

The specifications of the input material and finished product are given below:

Input		
Material	..	Slabs of plain carbon steel
Dimensions, mm		
length	..	10,000 max.
width	..	1,500 max.
thickness	..	200 max.
Finished product		
Material	..	HR strip/sheet in equal proportions
Dimensions		
width, mm	..	1,500 max.
thickness, mm	..	1.6 min.
coil weight, ton	..	25 max.

16 - Project profile - hot strip mill (cont'd)

Major Plant Facilities

A typical list of major plant facilities for hot strip mill complex is given in Appendix 16-2 and the major production facilities are summarised in Table 16-1.

TABLE 16-1 - MAJOR PRODUCTION FACILITIES FOR HOT STRIP MILL

Pusher type slab reheating furnace		
Number	..	3
Capacity of furnace, tons/hr	..	150
Hot strip mill, including scale breaker, single stand four-high reversing rougher, six stand finishing mills, coilers and auxiliary equipment		
Number	..	1
Finishing speed, m/sec.	..	18
Capacity, tons/hr	..	325
Shearing line	..	2

Plant Flowsheet and Layout

A schematic flowsheet of the proposed hot strip mill is given in Drawing 5480-16-1 and a typical plant layout is given in Drawing 5480-16-2 to illustrate the relative disposition of the major plant facilities.

16 - Project profile - hot strip mill (cont'd)

CAPITAL COST

The capital cost of a 1.5 million tons per year HR strip plant is estimated at US $ 307 million including the cost of all equipment, buildings and foundations, design and engineering expenses etc as given in Table 16-2.

TABLE 16-2 - CAPITAL COST FOR HOT STRIP MILL
(million US $)

I.	Civil and structural steel work	37.0
II.	Mechanical and electrical equipment:	
	a) Slab reheating furnace, semi-continuous hot strip mill complete with electrical equipment etc.	132.0
	b) Ancillary equipment including roll shop, cranes, handling equipment etc.	14.0
	c) Utilities and services	14.5
		160.5
III.	Ocean freight, port charges, internal transport and equipment erection at 25 per cent of (II)	40.0
IV.	Spares	15.0
V.	Design, engineering, administration and pre-operation expenses	28.5
VI.	Contingencies	26.0
	TOTAL	307.0

PRODUCTION COST

Production cost comprises the cost of materials, other manufacturing costs, administration and sales expenses and fixed charges covering depreciation and interest on loan. The consumption of major materials and utilities are given below:

		Unit	Consumption per ton HR strip
Slab	..	kg	1,050
Electric power	..	kWh	125
Fuel oil	..	kg	40
Rolls	..	kg	1

The requirement of manpower for the plant is estimated at 700. Based on the consumption norms indicated above and the unit prices estimated in Chapters 4 and 5, the production cost of HR coil/sheet excluding fixed charges are computed in Appendix 16-3 and summarised in Table 16-3.

16 - Project profile - hot strip mill (cont'd)

TABLE 16-3 - PRODUCTION COST OF HR COIL/SHEET EXCLUDING FIXED CHARGES
(US $ per ton)

		Thailand	Malaysia	Singapore	Indonesia	Philippines
Cost of materials	..	267	264	253	257	263
Other items	..	22	23	29	17	26
Administration & sales expenses	..	9	9	9	8	8
Production cost	..	298	296	291	282	297

If fixed charges covering depreciation and interest on loan are taken into account at 20 per cent of the capital cost, the production cost will work out as given in Table 16-4.

TABLE 16-4 - PRODUCTION COST INCLUDING FIXED CHARGES
(US $ per ton)

Thailand	..	339
Malaysia	..	337
Singapore	..	332
Indonesia	..	323
Philippines	..	338

VIABILITY

In order to ascertain the project viability, the internal rate of return (IRR) has been computed for the five countries. The IRR is based on the net sales realisation per

16 - Project profile - hot strip mill (cont'd)

ton of finished product given in Chapter 5, the estimated production cost and a production of 60 per cent in the first year, 80 per cent in the second year, 90 per cent in the third year and 100 per cent in the fourth year and onwards of the rated capacity. The IRR values are presented in Table 16-5.

TABLE 16-5 - INTERNAL RATE OF RETURN FOR HOT STRIP MILL

		IRR %
Thailand	..	14.0
Malaysia	..	14.5
Singapore	..	15.8
Indonesia	..	18.7
Philippines	..	15.9

It is seen that with the plant capacity considered, the IRR varies between 14 and 18.7 per cent for the five countries.

17 - PROJECT PROFILE - COLD STRIP MILL

This chapter deals with the production of ordinary grade plain carbon cold rolled strip and sheets.

The cold rolled strip/sheets will be used for production of electrolytic tin plates and galvanised sheets, welded tubes and cold formed sections, and for fabrication purpose in miscellaneous consumer industries. Keeping in view these applications, a maximum strip width of 1,000 mm has been considered. The selection of production technology, major plant facilities, layout, estimates of capital and production costs and the project viability are discussed herein.

SELECTION OF PRODUCTION PROCESS

Cold rolling and finishing of hot rolled strip generally comprises the following main operations:

i) Pickling
ii) Cold rolling
iii) Surface cleaning of the cold rolled strip
iv) Annealing
v) Skin passing
vi) Finishing operations including shearing or slitting
vii) Inspection, packing and despatch

17 - Project profile - cold strip mill (cont'd)

The various alternative processes/equipment which can be employed for each of the above operations are briefly reviewed in Appendix 17-1.

From the detailed review, it will be noted that for the pickling process, generally a continuous pickling line with hydrochloric acid as the pickling medium is employed. For cold reduction, either a four-high reversing mill or a four to six stand tandem mill can be used. Reversing four-high mills are suitable when relatively lower throughput of material is involved and tandem mills are suitable for higher production levels. From considerations of the quality of finished cold rolled strip, the material rolled in a four-high reversing mill with automatic gauge control system is comparable with that rolled from a tandem mill. For annealing of cold rolled strip, a combination of box annealing furnaces and continuous annealing line is generally employed for large outputs. For skin passing operation, either a single stand or a two-stand four-high mill is employed, the latter type being generally preferred when the capacity of the cold rolling mill plant is about 1-million ton.

Keeping in view the above considerations, it is recommended that either a four-high reversing mill or a five stand tandem mill complete with associated processing facilities including a continuous pickling line with hydrochloric acid as the pickling medium, annealing facilities, single stand or a twin stand four-high skin pass mill, shearing slitting lines can be considered for the present study.

DESIGN BASIS AND MAJOR FACILITIES

Plant Capacity

Two plant capacities have been considered as indicated below:

		tons/yr
Alt. 1	..	300,000
Alt. 2	..	1,000,000

The 300,000 tons per year plant is based on a single-stand four-high reversing mill with associated processing and finishing facilities. For Alt.2, a five-stand tandem mill with associated processing and finishing facilities has been considered. The input material and finished product specifications are given in Table 17-1 for the two plant capacities.

17 - Project profile - cold strip mill (cont'd)

TABLE 17-1 - INPUT MATERIAL AND FINISHED PRODUCT SPECIFICATIONS FOR COLD STRIP MILL

	Alt. 1	Alt. 2
Input material ..	H.R. coils of plain carbon steel	H.R. coils of plain carbon steel
HR coil dimensions, mm		
Width ..	650 - 1050	650 - 1050
Thickness ..	1.6 - 5.0	1.6 - 5.0
H.R. coil weight, tons..	15	15
Pickled coil weight, tons	30	30
Finished product ..	C.R. coil/sheet in equal proportions	C.R. coil/sheet in equal proportions
Dimensions of CR coil, mm		
Width ..	600 - 1000	600 - 1000
Thickness ..	0.2 - 2.5	0.15 - 2.5
C.R. coil weight, tons..	1 - 30	1 - 30
Dimensions of CR sheet, mm		
Width ..	600 - 1000	600 - 1000
Length ..	1000 - 4000	1000 - 4000

Major Plant Facilities

A typical list of the major plant facilities for a cold strip mill complex is given in Appendix 17-2 and the major facilities for the two capacities are summarised in Table 17-2.

17 - Project profile - cold strip mill (cont'd)

TABLE 17-2 - MAJOR PLANT FACILITIES FOR COLD STRIP MILL

		Alt. 1	Alt. 2
Continuous pickling line			
Number	..	1	1
Processing speed, m/min max			
entry section	..	500	600
pickling section	..	200	250
exit section	..	300	350
Cold rolling mill			
Type	..	Single stand 4-high reversing mill	5-stand tandem mill
Rolling speed, m/min max	..	700	1800 (at No. 5 stand)
Skin pass mill			
Type	..	Single stand 4-high	Two-stand 4-high
Rolling speed, m/min max	..	1500	1800
Continuous annealing line			
Number	..	-	-
Line speed, m/min	..	-	30-500
Bell annealing furnace	..	12 furnaces with 12 hoods, 36 bases, 36 inner covers	16 furnaces with 16 hoods, 48 bases, 48 inner covers
Shearing line	..	1	3
Slitting line	..	1	1

17 - Project profile - cold strip mill (cont'd)

Plant Flowsheet and Layout

A schematic flowsheet of the proposed cold strip mill is given in Drawing 5480-17-1 and a typical plant layout is given in Drawing 5480-17-2 to illustrate the relative disposition of the major plant facilities.

CAPITAL COST

With the facilities envisaged, it is estimated that the capital cost of a 300,000 and 1,000,000 tons per year cold rolling plant will be about US $ 177.5 million and US $ 326.5 million respectively, as given in Table 17-3. The capital cost includes all the equipment, buildings and foundations, utilities, design and engineering and other pre-operation expenses.

PRODUCTION COST

Production cost comprises the cost of materials, all other manufacturing costs, administration and sales expenses and fixed charges covering depreciation and interest on loans. The consumption of major materials and utilities are given below for the two alternatives.

		Unit	Consumption/ ton CR strip
HR strip	..	kg	1,068
Power	..	kWh	200
Fuel oil	..	kg	5
Rolls	..	kg	1

17 - Project profile - cold strip mill (cont'd)

TABLE 17-3 - CAPITAL COST FOR COLD ROLLING PLANT
(million US $)

			Alt. 1	Alt. 2
I.	Civil and structural steelwork	..	20.0	39.0
II.	Mechanical and electrical equipment			
	a) Pickling line, cold rolling mill, skin pass mill, annealing furnaces, shearing and slitting lines	..	70.0	135.0
	b) Material handling equipment including cranes, roll shop equipment etc	..	15.0	20.0
	c) Utilities and services	..	8.0	15.0
	Sub-total	..	93.0	170.0
III.	Ocean freight, port charges, internal transport and equipment erection at 25 per cent of (II)	..	23.0	42.5
IV.	Spares	..	10.0	18.0
V.	Design, engineering, administration and other pre-operation expenses	..	16.5	30.0
VI.	Contingencies	..	15.0	27.0
	Total	..	177.5	326.5

The requirement of manpower is estimated at 525 for Alt. 1 and at 700 for Alt. 2.

17 - Project profile - cold strip mill (cont'd)

Based on the consumption norms indicated above and the prices of materials discussed in Chapters 4 and 5, the production costs of CR coil/sheet excluding fixed charges are computed in Appendix 17-3 and summarised in Table 17-4.

TABLE 17-4 - PRODUCTION COST FOR COIL/SHEET EXCLUDING FIXED CHARGES (US $ per ton)

	Thailand	Malaysia	Singapore	Indonesia	Philippines
Alt. 1					
Cost of materials	379	370	359	368	374
Labour and supervision	5	5	9	4	3
Other conversion costs	31	31	34	27	34
Administration and sales expenses	12	12	12	12	12
Production cost:	427	418	414	411	423
Alt. 2					
Cost of materials	379	370	359	368	374
Labour and supervision	2	2	4	2	1
Other conversion costs	23	23	24	19	27
Administration and sales expenses	12	12	12	12	12
Production cost:	416	407	399	401	414

17 - Project profile - cold strip mill (cont'd)

If the incidence of the fixed charges covering depreciation and interest on loans is taken into account at 20 per cent of the capital cost, the production cost will work out as given in Table 17-5.

TABLE 17-5 - PRODUCTION COST INCLUDING FIXED CHARGES
(US $ per ton)

		Alt. 1	Alt. 2
Thailand	..	545	481
Malaysia	..	536	472
Singapore	..	532	464
Indonesia	..	529	466
Philippines	..	541	479

VIABILITY

In order to ascertain the project viability and determine the minimum economic size, the internal rate of return has been computed for the two alternative capacities. The IRR calculation is based on the net sales realisation per ton of finished product as given in Chapter 5, the estimated production cost and a production of 60 per cent in the first year, 80 per cent in the second year, 90 per cent in the third year and 100 per cent from the fourth year and onwards of the rated capacity. The IRR values are presented in Table 17-6.

17 - Project profile - cold strip mill (cont'd)

TABLE 17-6 - INTERNAL RATE OF RETURN FOR COLD STRIP MILL

		Alt. 1 %	Alt. 2 %
Thailand	..	-	-
Malaysia	..	-	-
Singapore	..	-	0.4
Indonesia	..	-	-
Philippines	..	3.0	10.4

The internal rate of return has been computed in the above analysis considering an average sales realisation of US $ 423 per ton for Thailand, Malaysia and Singapore; US $ 420 per ton for Indonesia; and US $ 475 per ton for Philippines. A sensitivity analysis indicates that with a plant capacity of 1 million ton per year, IRR as given below is projected if sales realisation higher by 10 per cent (case i) and 15 per cent (case ii) are considered.

		Sales realisation, US $ per ton			IRR, %	
		Base	Case (i)	Case (ii)	Case(i)	Case(ii)
Thailand	..	423	465	486	7.8	12.1
Malaysia	..	423	465	486	9.6	13.7
Singapore	..	423	465	486	11.2	15.0
Indonesia	..	420	464	483	10.3	14.2
Philippines	..	475	523	546	18.4	21.7

18 - PROJECT PROFILE - PLATE MILL

This chapter reviews the production of plain carbon plates for diverse heavy engineering and consumer applications including those for ship building, boilers, chemical and fertiliser industry and miscellaneous fabrication. A maximum plate width of 2500 mm has been considered as decided with the representatives of the ASEAN countries in the review meeting at Bangkok.

SELECTION OF PRODUCTION PROCESS

Hot rolling of plates from slabs may be done on any one of the following types of mills:

i) Single stand two-high pull over type mill
ii) Single stand two-high reversing mill
iii) Single stand three-high mill
iv) Single stand four-high reversing mill
v) Two stand tandem mill

Single stand two-high pull over mills are of non-reversible type, hence after each pass material is to be lifted on tilting type table on the exit side and brought to the entry side. These mills are obsolete nowadays, as their production capacity is limited to about 20,000 to 25,000 tons per year and product quality is not generally up to internationally acceptable standards. Two-high reversing plate mills have a relatively higher capacity compared to pull over mills but these mills have the limitation of excessive roll wear and high roll deflection due to which product quality is relatively inferior.

Three-high mills overcome the above problems to a considerable extent, as the middle roll having less diameter than the top and bottom rolls is always backed up by either the top or the bottom roll. However, one of the limitations of the three-high mill is the reduction in the total roll separating force for a given reduction compared to two-high reversing mills, as the middle roll which is always in contact with the rolling stock is of smaller diameter. Three-high mills can be considered for production requirements up to 200,000 tons per year.

Four-high reversing mills overcome the above limitations of two-high and three-high mills. Roll deflection and

18 - Project profile - plate mill (cont'd)

consequently gauge variation is minimised due to the back up rolls provided on top and bottom. Modern installations generally go in for four-high reversing mills. Four-high mills have capacities of 400,000 to 600,000 tons per year for rolling plates in the width range of 1500 to 2500 mm.

Tandem plate mills have two stands which reduce the rolling time, as the reduction to be provided to the rolling stock is divided in two stands and thus increase the production rates. Moreover, satisfactory roll shape is maintained for relatively longer periods between roll changes. Tandem mills can have various possible combinations by using two/three/four-high roughing stand followed by three/four-high finishing stand. Tandem plate mills are generally installed for productive capacity range of about 1 to 2 million tons per year.

DESIGN BASIS AND MAJOR FACILITIES

Plant Capacity

Two plant capacities as indicated below have been evaluated.

Alt. 1	..	200,000 tons/yr
Alt. 2	..	600,000 tons/yr

18 - Project profile - plate mill (cont'd)

Based on the review of the various types of plate mills given above, the production requirement of Alt. 1 and Alt. 2 can be met by a three-high type mill and a four-high reversing type plate mill respectively. The input material and finished product specifications are given in Table 18-1 for the two plant capacities.

TABLE 18-1 - MATERIAL SPECIFICATION AND PRODUCT-MIX FOR PLATE MILL

	Alt. 1	Alt. 2
Input material	Slabs of plain carbon steel	Slabs of plain carbon steel
Slab length, mm	4,000 max	6,000 max
Slab thickness, mm	200 max	200 max
Slab weight, tons	10 max	15 max
Finished product	Plates	Plates
Length, mm	1,000-5,000	1,000-5,000
Width, mm	1,000-2,500	1,000-2,500
Thickness, mm	6-25	6-25
Production, tons/year		
6-10 mm thick	50,000	125,000
11-16 mm thick	80,000	250,000
17-25 mm thick	70,000	225,000
Total ..	200,000	600,000

18 - Project profile - plate mill (cont'd)

Major Plant Facilities

A typical list of major plant facilities required for a plate mill is given in Appendix 18-1 and the major facilities for the two capacities are summarised in Table 18-2.

TABLE 18-2 - MAJOR PLANT FACILITIES FOR PLATE MILL

	Alt. 1	Alt. 2
Pusher type reheating furnace		
Number	1	1
Capacity, tons/hr	100	150
Plate mill		
Type of mill	Three-high	Four-high reversing
Capacity, tons/hr	60-90	100-140
Major in-line facilities with the mill		
Hydraulic descaler	1	1
Edger stand	1	1
Leveller	1	1
Shears	2	2
Side trimmer/slitter	1	1
Cooling bed	1	1
Inspection bed	1	1
Transfer conveyors	2	2

18 - Project profile - plate mill (cont'd)

Plant Flowsheet and Layout

A schematic flowsheet for plate rolling is given in Drawing 5480-18-1 and a typical plant layout in Drawing 5480-18-2. The layout is preliminary and has been developed to illustrate the relative disposition of the major plant facilities.

CAPITAL COST

Preliminary estimate of capital cost of all the facilities within the plant boundary, as well as the cost of spares, design and engineering etc works out to US $ 76 million and US $ 117 million for Alt. 1 and 2 respectively as presented in Table 18-3.

PRODUCTION COST

Production cost comprises the cost of materials, other manufacturing costs, administration and sales expenses and fixed charges covering depreciation and interest on loans. The specific consumption rates of major materials and utilities are given below.

		Unit	Consumption per ton plate	
			Alt. 1	Alt. 2
Slab	..	kg	1,250	1,250
Electric power	..	kWh	100	115
Fuel oil	..	kg	45	45

18 - Project profile - plate mill (cont'd)

The requirement of manpower is estimated at 275 and 425 for Alt. 1 and Alt. 2 respectively.

TABLE 18-3 - CAPITAL COST FOR PLATE MILL
(million US $)

			Alt. 1	Alt. 2
I.	Civil and structural work	..	9.0	15.0
II.	Mechanical and electrical equipment:			
	a) Slab reheating furnace, plate mill with in-line finishing equipment	..	27.0	43.0
	b) Material handling equipment, roll shop equipment and misc. equipment	..	8.5	11.0
	c) Utilities and services	..	3.5	5.5
	Sub-total	..	39.0	59.5
III.	Ocean freight, port charges, internal transport and equipment erection @ 25 per cent of (II)	..	10.0	15.0
IV.	Spares	..	4.0	6.0
V.	Design, engineering, administration and pre-operation expenses	..	8.0	11.5
VI.	Contingencies	..	6.0	10.0
	TOTAL	..	76.0	117.0

Based on the consumption norms indicated and the prices of materials discussed in Chapters 4 and 5, the production costs

18 - Project profile - plate mill (cont'd)

of plates excluding fixed charges are computed in Appendix 18-2 and summarised in Table 18-4.

TABLE 18-4 - PRODUCTION COST OF PLATES EXCLUDING FIXED CHARGES
(US $ per ton)

	Thailand	Malaysia	Singapore	Indonesia	Philippines
Alt. 1					
Cost of materials ..	304	306	291	291	302
Labour & supervision ..	4	4	7	3	3
Other conversion costs ..	25	26	32	19	28
Admin. & sales expenses ..	10	10	10	10	10
Production cost ..	343	346	340	323	343
Alt. 2					
Cost of materials ..	304	306	291	291	302
Labour & supervision ..	2	2	4	2	1
Other conversion costs ..	22	23	28	16	26
Admin. & sales expenses ..	10	10	10	9	10
Production cost ..	338	341	333	318	339

The estimated production cost including fixed charges covering depreciation and interest on loans at 20 per cent of the capital cost is given in Table 18-5.

18 - Project profile - plate mill (cont'd)

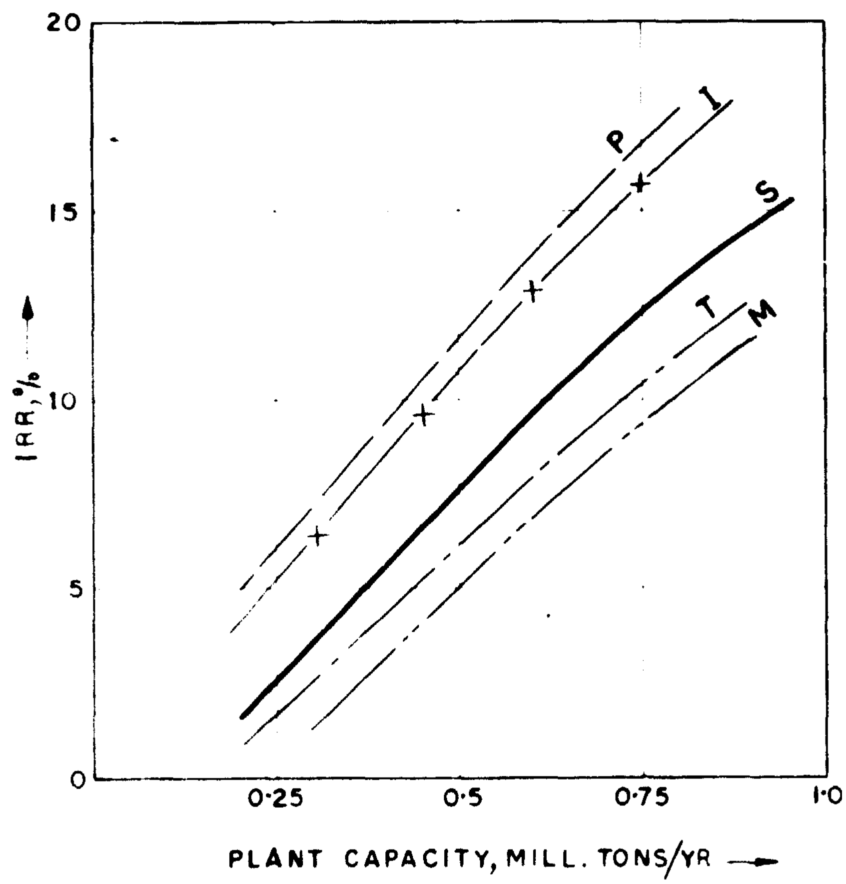
TABLE 18-5 - PRODUCTION COST INCLUDING FIXED CHARGES
(US $ per ton)

		Alt. 1	Alt. 2
Thailand	..	419	377
Malaysia	..	422	380
Singapore	..	416	372
Indonesia	..	399	357
Philippines	..	419	378

VIABILITY

In order to ascertain the project viability the IRR has been computed for the two alternative capacities. The IRR calculation is based on the net sales realisation per ton of finished product discussed in Chapter 5, the estimated production cost and a production of 60 per cent in the first year, 80 per cent in the second year, 90 per cent in the third year and 100 per cent from the fourth year and onwards.

The IRR values are presented in Table 18-6 and graphically represented in Fig. 18-1.



I — INDONESIA
M — MALAYSIA
P — PHILIPPINES
S — SINGAPORE
T — THAILAND

FIG. 18-1—IRR vs PLANT CAPACITY FOR PLATE MILL

18 - Project profile - plate mill (cont'd)

TABLE 18-6 - INTERNAL RATE OF RETURN FOR PLATE MILL

		Alt. 1 %	Alt. 2 %
Thailand	..	0.9	8.0
Malaysia	..	-	6.8
Singapore	..	1.8	9.8
Indonesia	..	4.2	12.9
Philippines	..	6.3	13.9

The IRR presented in Table 18-6 are based on a net sales realisation of US $ 370 per ton for Malaysia, Singapore and Thailand, US $ 365 per ton for Indonesia and US $ 390 per ton for Philippines. A sensitivity analysis with respect to net sales realisation price indicates that if a 5 per cent higher sales realisation is considered, namely US $ 389 per ton for Malaysia, Singapore and Thailand, US $ 384 per ton for Indonesia and US $ 410 per ton for Philippines, the IRR with a plant capacity of 600,000 tons per year will be as follows.

		IRR %
Thailand	..	13.8
Malaysia	..	12.9
Singapore	..	15.2
Indonesia	..	17.7
Philippines	..	18.8

19 - PROJECT PROFILE - ELECTROLYTIC TINNING LINE

This chapter presents the project profile for production of tinplates by electrolytic coating of cold rolled strip. Protective coating of tin on steel strip imparts to its surface corrosion resistance from atmosphere, water and organic acids, thereby making the coated strip suitable for use in industries such as canning, oil paints, medicines and others. A maximum width of 1000 mm of coated sheets has been considered, as decided with the representatives of the ASEAN countries in the review meeting at Bangkok.

SELECTION OF PRODUCTION PROCESS

Tin coating can be applied on cold rolled strip, either by hot dipping in tinning bath or by electrolytic coating. Electrolytic tinning is preferred because by this process better quality of product, lower operational cost, high production rates and better control in obtaining differentially coated products is achieved.

19 - Project profile - electrolytic tinning line (cont'd)

A brief review of available technologies for electrolytic tinning is made in Appendix 19-1. Keeping in view the relative advantages and disadvantages of the various processes as described in the above appendix, it is recommended that an electrolytic tinning line with acid electrolytic medium be considered.

DESIGN BASIS AND MAJOR FACILITIES

Plant Capacity and Product-mix

A tinning line of capacity 150,000 tons per year has been selected for examining the viability. The input material and finished product specifications, together with the proposed product-mix are given in Table 19-1.

TABLE 19-1 - MATERIAL SPECIFICATION FOR ELECTROLYTIC TINNING LINE

Input Material

Cold rolled, annealed, skin passed low carbon steel strip

Finished Product

Strip width, mm	..	500-1000
Coil weight, tons	..	15
Strip thickness, mm	..	0.20-0.35
Production, tons/year		
0.2 - 0.25 mm	..	60,000
0.25 - 0.3 mm	..	40,000
0.3 - 0.35 mm	..	50,000
Total	..	150,000

19 - Project profile - electrolytic tinning line (cont'd)

Major Plant Facilities

A typical list of major plant facilities required for an electrolytic tinning plant is given in Appendix 19-2 and the major facilities are summarised in Table 19-2.

TABLE 19-2 - MAJOR PLANT FACILITIES FOR ELECTROLYTIC TINNING LINE

Coil preparation line		
Number	..	1
Line speed, m/min	..	30 - 750
Capacity, tons/hr	..	20 - 40
Electrolytic tinning line		
Number	..	1
Line speed, m/min	..	450/350/450
Capacity, tons/hr	..	20 - 40
Shearing line		
Number	..	2
Capacity, tons/hr	..	15 - 25
Reassorting line	..	1

Plant Flowsheet and Layout

A schematic flowsheet of the proposed electrolytic tinning plant is given in Drawing 5430-19-1 and a typical plant layout is illustrated in Drawing 5480-19-2. The layout is preliminary and has been developed to illustrate the relative disposition of the major plant facilities.

CAPITAL COST

It is estimated that the capital cost of an electrolytic tinning line with a capacity of 150,000 tons per year will be about US $ 88.5 million as given in Table 19-3.

TABLE 19-3 - CAPITAL COST FOR ELECTROLYTIC TINNING LINE (million US $)

I.	Civil and structural work	9.0
II.	Mechanical and electrical equipment:	
	a) Coil preparation line, electrolytic tinning line, shearing lines, reassorting line and packing equipment	38.0
	b) Miscellaneous equipment including anode cast house, laboratory facilities, cranes and other material handling equipment	5.0
	c) Utilities and services	4.0
	Sub-total	47.0
III.	Ocean freight, port charges, internal transport and equipment erection @ 25 per cent of (II)	11.5
IV.	Spares	5.0
V.	Design, engineering, administration and pre-operation expenses	9.0
VI.	Contingencies	7.0
	TOTAL	88.5

19 - Project profile - electrolytic tinning line (cont'd)

PRODUCTION COST

Production cost comprises the cost of materials, other manufacturing costs, administration and sales expenses and fixed charges covering depreciation and interest on loans. The average consumption rates of major materials and utilities are given below:

	Unit	Consumption per ton tinplate
CR coil ..	kg	1,110
Tin ..	kg	3.5
Electric power	kWh	125
Fuel oil ..	kg	1

The requirement of manpower has been estimated at 325. Based on the consumption norms indicated above and the unit prices estimated in Chapters 4 and 5, the production costs of electrolytic tinplate excluding fixed charges are computed in Appendix 19-3 and summarised in Table 19-4.

TABLE 19-4 - PRODUCTION COST OF TINPLATES EXCLUDING FIXED CHARGES
(US $/ton)

	Thailand	Malaysia	Singapore	Indonesia	Philippines
Cost of materials	484	472	454	462	547
Labour & supervision	6	6	11	5	4
Other conversion costs	93	93	96	91	95
Administration & sales expenses	17	17	17	17	19
Production cost:	600	588	578	575	665

If fixed charges covering depreciation and interest on loans are considered at 20 per cent of the capital cost, the production cost will be as given in Table 19-5.

TABLE 19-5 - PRODUCTION COST INCLUDING FIXED CHARGES
(US $ per ton)

Thailand	..	718
Malaysia	..	706
Singapore	..	696
Indonesia	..	693
Philippines	..	783

VIABILITY

In order to ascertain the project viability and to determine the minimum economic size, the internal rate of return (IRR) has been computed for the five ASEAN countries. The IRR calculation is based on net sales revenue per ton of finished product, as given in Chapter 5, the estimated production cost and a production of 60 per cent in the first year, 80 per cent in the second year, 90 per cent in the third year and 100 per cent in the fourth year and onwards.

19 - Project profile - electrolytic tinning line (cont'd)

The IRR values are presented in Table 19-6.

TABLE 19-6 - INTERNAL RATE OF RETURN FOR ELECTROLYTIC TINNING LINE

Thailand	..	13.5
Malaysia	..	14.9
Singapore	..	16.0
Indonesia	..	16.4
Philippines	..	2.8

The IRR is low in Philippines due to the relatively high price of US $ 500 per ton for CR coils compared to US $ 415-445 considered for other countries.

20 - REGIONAL STEEL PLANTS

This chapter presents a preliminary assessment of the economics of establishing large processing units, where prima facie such possibilities exist and compares with the corresponding minimum economic size units suggested earlier in the report. Preliminary estimates of capital and production costs for hypothetical large integrated steel plants which could serve the ASEAN market as a whole, are also indicated.

REGIONAL STEEL PROCESS PLANTS

Regional steel processing plants could be conceived within the overall framework of cooperation amongst the member ASEAN countries. Such large plants could be installed at appropriate locations. For each of the 12 steel processes considered, the minimum economic capacities with certain basic assumptions have been determined in Chapters 8 to 19. It will be observed that, for most of the processes, the minimum economic capacities are fairly large. However, in the case of billet plant, hot strip mill and plate mill, plants of

20 - Regional steel plants (cont'd)

larger capacity with resultant savings in capital and operating costs are possible on account of the economies of scale. The economics of these plants has been examined keeping in view the following assumptions:

i) The product-mix for the large processing plant would be similar to that considered for the minimum economic size units.

ii) The semis required by the large processing plants would also be imported.

iii) The estimates of production cost are based on average prices/rates obtaining in the region.

iv) No specific locations have been considered.

Billet Plant

The economics of billet production by electric arc furnace-continuous casting of plants up to capacities as high as 0.5 million tons per annum, has been discussed in Chapter 8. Further, Chapter 6 examines the viability of semis production in large plants with integrated iron and steelmaking facilities, for annual capacities ranging from about 0.5 million tons to about 3 million tons. The results of these analyses indicate that the cost of billets produced in large plants is competitive with the price of imported billets, as shown on the next page.

20 - Regional steel plants (cont'd)

		US $/ton
Selling price of imported billets	..	275-300
Production cost for billet plant:		
i) 0.5 million tons/year semi-integrated plant	..	238-275
ii) 1 million tons/year integrated DR-EF plant	..	265-280
iii) 3 million tons/year integrated BF-BOF plant	..	230-235

Hot Strip Mill

A fully continuous 1,420 mm (56") wide hot strip mill with a capacity of 3 million tons per year could be considered for evaluation. The economics of the large size processing plant compares with the minimum economic size processing plant discussed in Chapter 16, as given below:

		3 million ton plant	1.5 million ton plant
Investment, US $ million	..	400	307
Production cost (1), US $/ton		320	334 (2)
Selling price, US $/ton	..	350-360	350-360

NOTES

(1) Inclusive of fixed charges (depreciation and interest on loans) at 20 per cent of fixed investment.

(2) Average for the region.

Thus, a saving in production cost is possible with a large capacity processing plant.

Plate Mill

A 2-stand, 4-hi tandem plate mill of 1 million tons per year capacity could be considered for evaluation. The economics of the large size processing plant compares with the minimum economic size plant discussed in Chapter 18, as given below:

	1 million ton plant	0.6 million ton plant
Investment, US $ million ..	175	117
Production cost[1], US $/ton	365	373[2]
Selling price, US $/ton ..	365-390	365-390

NOTES
(1) Inclusive of fixed charges (depreciation and interest on loans) at 20 per cent of fixed investment
(2) Average for the region.

As compared to an average production cost of US $ 373 per ton for the region with 0.6 million tons per year capacity plant, the production cost with 1 million tons per year capacity plant is found to be lower by US $ 8 per ton.

INTEGRATED STEEL PLANTS

The economics of integrated steel plants for finished steel products is compared with the minimum economic size units as well as with prices of imported steel. In this connection, two alternative plant capacities with different process routes, product-mix, etc are discussed below.

Plant Capacity and Major Facilities

The economics of semis production in integrated plants has been studied in Chapter 6. It is found that the cost of semis from such integrated plants based on either DR-EF or BF-BOF routes would be lower than the price of imported semis. Hence, it is expected that the cost of rolled products from an integrated steel plant would also be lower than the price of imported products. This section, therefore, attempts to analyse the economics of finished steel production in integrated steel plants. Two alternative plant concepts indicating product-mix, major facilities etc have been considered for analysis as given in Table 20-1.

20 - Regional steel plant (cont'd)

TABLE 20-1 - ALTERNATIVE CONCEPTS OF INTEGRATED STEEL PLANT

		Alt. 1	Alt. 2
Finished Products	..	Plates, HR strip/sheets, CR strip/sheets	Wire rods, medium structurals
Process Route	..	BF-BOF	DR-EF
Annual Capacities, '000 tons			
Liquid steel	..	3,000	1,500
Continuous cast semis	..	2,850	1,410
Rolled products for sale	..	Plates 600 HR strip/sheet 930 CR strip/sheet 1000	Wire rods 600 Structurals 600
Semis for sale	..	-	100
Major Production Facilities			
Ironmaking	..	Two 3,000 cu m blast furnaces	Two 600,000 tons/yr direct reduction modules
Steelmaking	..	Three 180-ton converters Three 2-strand continuous slab casters	Six 95-ton arc furnaces Six 6-strand continuous billet casters
Rolling	..	One single stand 4-hi reversing plate mill (0.6 m tpy) One 1,470 mm continuous hot strip mill (2 m tpy) One five strand tandem cold strip mill (1 m tpy)	One 4-strand wire rod mill with finishing blocks (0.6 m tpy) One single strand continuous structural mill (0.6 m tpy)

20 - Regional steel plants (cont'd)

Capital Cost Estimates

The approximate capital costs for the two plants, considering hypothetical locations in the ASEAN region, are estimated in Table 20-2.

TABLE 20-2 - PRELIMINARY ESTIMATES OF CAPITAL COST FOR INTEGRATED STEEL PLANTS
(million US $)

	Alt. 1	Alt. 2
Coke ovens ..	190	-
Ironmaking ..	195	175
Steelmaking ..	225	120
Rolling mills ..	600	175
Auxiliary and yard facilities	350	115
Sub-total ..	1,560	585
Design, engineering and administration expenses ..	155	60
Contingencies ..	170	65
TOTAL ..	1,885	710

The corresponding capital costs for integrated semis plants, as estimated in Chapter 6 are US $ 450 million approximately for DR-EF plant producing 1.4 million tons per year of billets, and about US $ 1,045 million for a BF-BOF plant producing 2.85 million tons of slabs annually.

20 - Regional steel plants (cont'd)

It is to be noted that the capital cost estimates presented in Table 20-2 are tentative and indicative in nature. The costs would vary depending upon the actual plant location, site conditions, plant capacity and product-mix, plant facilities selected and various other factors that are governed by prevailing local conditions.

Production Cost Estimates

The estimated production costs for flat products and non-flat products are given in Tables 20-3 and 20-4 respectively. These production costs are summarised below and compared with the selling prices of corresponding imported products:

	Production cost US $/ton	Selling price range US $/ton
Flat Products		
Plates ..	353	365-370
HR sheets/strips ..	310	350-355
CR sheets/strips ..	428	425-475
Non-flat products		
Wire rods ..	334	375-390
Structurals ..	361	405-450

These estimates are indicative in nature and are based on average unit prices/rates prevailing in the ASEAN region. The actual production costs could vary somewhat depending upon the actual plant location.

20 - Regional steel plants (cont'd)

TABLE 20-3 - ESTIMATED PRODUCTION COST OF FLAT PRODUCTS

		Cost US $/ton
Cost of Slab (including fixed charges)	..	239 (1)
Cost of Plates		
Cost of 1.25 tons slab	..	299
Credit for scrap	..	(-)18
		281
Other operating expenses (2)	..	33
Fixed charges (3)	..	39
Total	..	353
Cost of HR Strip/Sheets		
Cost of 1.05 tons slab	..	251
Credit for scrap	..	(-) 4
		247
Other operating expenses (2)	..	29
Fixed charges (3)	..	34
Total	..	310
Cost of CR Strip/Sheets		
Cost of 1.068 tons HR coil	..	331
Credit for scrap	..	(-) 5
		326
Other operating expenses (2)	..	37
Fixed charges (3)	..	65
Total	..	428

NOTES

(1) Average of estimates presented in Table 6-8 for Alt. 3.
(2) Average estimates for all the five countries.
(3) At 20 per cent of capital cost.

20 - Regional steel plants (cont'd)

TABLE 20-4 - ESTIMATED PRODUCTION COST OF NON-FLAT PRODUCTS

		Cost US $/ton
Cost of Billet (including fixed charges)	..	260 (1)
Cost of Wire Rods		
Cost of 1.06 tons billets	..	276
Credit for scrap	..	(-)5
		271
Other operating expenses (2)	..	30
Fixed charges (3)	..	33
Total	..	334
Cost of Structurals		
Cost of 1.11 tons billets	..	289
Credit for scrap	..	(-)9
		280
Other operating expenses (2)	..	29
Fixed charges (3)	..	52
Total	..	361

NOTES

(1) Average of estimates presented in Table 6-9 for 1.5 million tons/year capacity.
(2) Average estimates for all the five countries.
(3) At 20 per cent of capital cost.

20 - Regional steel plants (cont'd)

From the estimates of production cost, it will be observed that integrated operation in large regional plants would enable production of finished steel at competitive prices as compared to imported products.

A comparison of the production costs for integrated steel plants and minimum economic size units is presented below and illustrates the advantages of large scale production in integrated steel plants over minimum economic size plants:

	Integrated steel plant		Minimum economic size plant	
	Annual production '000 tons	Production cost US $/ton	Annual production '000 tons	Production cost[1] US $/ton
Plates ..	600	353	600	373
HR strip/sheets	2,000	310	1,500	334
CR strip/sheets	1,000	428	1,000	472
Wire rods ..	600	334	450	392
Structurals ..	600	361	400	424

NOTE
(1) Average production cost for the five countries.

21 - ACTION ORIENTED PROGRAMME

Preliminary projections indicate that the demand for steel in the ASEAN region in terms of crude steel will be about 12.3 million tons by 1985, 16.7 million tons by 1990 and 28 million tons by 2000. As against this, the present steelmaking capacity in integrated and semi-integrated plants is only about 3.2 million tons per year at present in terms of crude steel or 2.6 million tons per year of finished products. Therefore, there is an urgent need for increasing the steelmaking capacity in the region. An action oriented programme covering short-term and long-term measures is, therefore presented in this chapter to enable the ASEAN countries to initiate appropriate actions.

POINTS FOR CONSIDERATION

For an action oriented follow-up programme, the following points need consideration:

1. While there is an installed capacity of about 2.6 million tons per year of finished steel with integrated and semi-integrated plants, the production has been

21 - Action oriented programme (cont'd)

only about 1.4 million tons per year. The poor utilisation of installed capacity appears to be mainly due to the availability of imported steel at prices more competitive vis-a-vis local production and the limited availability of domestic scrap. Thus, measures to make available scrap or sponge iron at prices competitive to the imported scrap require attention.

2. There is a substantial capacity in the region for rerolling of bars, rods and light sections based on imported billets. The utilisation of the rerolling mills and consequently the availability of bars and rods can be substantially improved, provided adequate availability of billets at a competitive price is assured.

3. Experience with flat rolling mills established in Philippines based on imported semis indicates that due to the vagaries in the supply and price of imported semis, the utilisation of these mills has been low. It is not considered prodent to establish large steel processing units based on imported semis.

4. A study on production of semis by integrated plants indicates that production of semis would be competitive vis-a-vis imported semis. Therefore, even if steel processing units for

production of hot rolled and cold rolled sheets, plates, heavy structurals etc are established in different ASEAN countries, these should ultimately be linked to integrated steel plants producing semis.

5. An analysis indicates that production of various categories of steel in integrated steelworks in the region would be competitive, even though major raw materials have to be imported.

6. The study on minimum economic size plants indicates that for most of the steel process units, large minimum economic size plants are necessary due to the following reasons:

   a) Selling prices for finished products have been considered at par with imported prices.

   b) Investment on new projects, reflected in the cost of production, is very high due to frequent oil price hikes and the consequent steep inflation.

As a result, some ASEAN countries are already protecting the local production by levying duty on imports varying between 2 and 50 per cent. Hence, the ASEAN countries may have to consider protection of new industries for an initial period.

21 - Action oriented programme (cont'd)

SHORT-TERM MEASURES

In order to increase the steel production and to take up implementation of various steel processing units expeditiously, the following short-term measures are suggested.

1. Merchant sponge iron plants should be set up in Indonesia, Malaysia and Thailand where natural gas is available. These plants will supply sponge iron to the existing and new arc furnace semi-integrated steel plants. Later on, these merchant sponge iron plants can be expanded to integrated steel plants for production of semis and finished products.

2. In order that the sponge iron price is competitive with the international price of scrap, natural gas which is one of the major inputs for sponge iron plant, should be reasonably priced. It was gathered during field investigations that the price of gas is: US $ 2.6 per Gcal in Indonesia, US $ 5.6 per Gcal in Thailand and US $ 8.0 per Gcal in Malaysia. It is expected that the price of gas will be fixed reasonably by the respective countries to ensure that the steel produced using sponge iron, is competitive with imported steel.

21 - Action oriented programme (cont'd)

3. With adequate availability of steel from electric arc furnaces, production of billets, wire rods, wire products, cold finished bars, GI wires etc can be taken up as national plants in the ASEAN countries. However, detailed feasibility studies will be necessary for determining the minimum economic size for these units.

4. The product for medium structural mill and seamless pipe plant can also be considered in the short-term programme. However, adequate data on demand are not available to establish the product-mix and the capacity for these units. These projects can be taken up either as national projects or as regional projects after establishing the demand of each country based on proper market survey.

5. No information is available in regard to the demand for special steel and stainless steel products. However, these projects may be taken up in the short-term programme after establishing the demand of each country based on proper market survey. As the demand for special steel and stainless steel products may not be large enough for each country, these plants could be set up as regional plants.

21 - Action oriented programme (cont'd)

LONG-TERM MEASURES

The long-term measures involve setting up of large integrated steel plants for semis and finished products involving development of infrastructure, transport and communication facilities etc as discussed below.

1. Considering the demand of about 16.7 million tons per year by 1990 and 28.0 million tons per year by 2000, all the four ASEAN countries except Singapore will ultimately have one or two large integrated steel projects. Singapore will, however, be better placed for production of stainless steel, special steel etc.

2. At present, the production of steel in the ASEAN countries is mainly confined to bars and rods. Hence, bulk of the flat products in the form of hot rolled coils, cold rolled coils, plates, tin plates are being imported. It is, therefore, essential that the steel plants for manufacture of flat products should be established on a priority basis.

21 - Action oriented programme (cont'd)

3. As discussed earlier, Philippines has hot and cold rolling mills but their utilisation is extremely poor because of the uncertain availability of semis and their fluctuating price in the international market. Therefore, it would be **prudent** to tie up units for hot strip mill, cold strip mill, plate mill and tinning line with integrated steel projects as far as possible. Even if facilities for such products are established as steel processing units based on imported semis, their backward integration with iron and steelmaking facilities should be taken up immediately.

4. As the large integrated steel plant will have to depend upon imported raw materials for iron and steelmaking, and as the products of these plants will have to be distributed to the various ASEAN countries, it is essential that these plants should have port based locations.

5. The product-mix of the various integrated steel plants to be set up in the ASEAN countries should be complementary to each other so that the fast growing demand for various categories of steel can be largely met from these plants.

21 - Action oriented programme (cont'd)

6. For efficient distribution of steel products to the various ASEAN countries from the steel plants, suitable shipping facilities will have to be established.

7. ASEAN countries should give preference to steel products from steel plants in the region so that fairly large capacity plants can be set up.

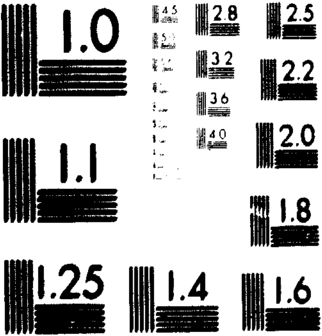
The success of the various short-term and long-term measures indicated above will, however, depend upon the seriousness of the ASEAN countries to work together and come to a proper understanding specially in regard to marketing, financing, pricing policy, shipping and product distribution, development of infrastructure, sharing of benefits and responsibilities etc.

22 - PRELIMINARY FINDINGS

This chapter highlights the main findings of the study including the steel situation in the ASEAN countries, capacity and product-mix for each steel process unit, prices of inputs and finished products, financial aspects, expected level of profitability etc. The salient aspects of minimum economic size units for 12 selected steel processes, comparison with large integrated steel plant for semis and finished products, and the appropriate strategy for steel development and action-oriented programme for the region, have also been discussed.

STEEL SITUATION

ASEAN countries' present production of crude steel, mainly from scrap based arc furnaces and the two integrated steel plants, Malaywata in Malaysia and Krakatau in Indonesia, is about 1.4 million tons per year; whereas the total installed capacity is about 2.6 million tons per year of finished products or 3.2 million tons per year of crude steel. As against the above, the total requirement of crude



MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS-1963-A

22 - Preliminary findings (cont'd)

steel of the ASEAN countries is about 7.8 million tons per year. Consequently, these countries currently import about 6.4 million tons per year of steel, comprising about 1 million ton of semis and the balance as finished products.

The production capacity existing in the region for the major steel products is summarised below:

		Production capacity tons/yr
Bars, rods and sections	..	4,024,000
Hot and cold rolled sheets	..	1,102,000
Galvanised sheets	..	1,095,000
Welded pipes	..	1,003,000
Tin plates	..	180,000

Based on preliminary projections, the likely shortfall for major categories of steel is estimated at about 8.9 million tons per year and 12.7 million tons per year respectively by 1985 and 1990 for the entire region as given in Table 22-1 and summarised on the next page.

22 - Preliminary findings (cont'd)

		National '000 tons	Regional mill tons
Shortfall by 1985			
Bars, rods and wire rods	..	100 to 365	0.765
Sections	..	120 to 230	0.940
Plates	..	20 to 315	0.835
HR sheet/strip	..	565 to 1280	3.735
CR sheet/strip	..	245 to 590	2.020
Tin plates	..	100 to 160	0.600
			8.895
Shortfall by 1990			
Bars, rods and wire rods	..	115 to 650	1.300
Sections	..	175 to 290	1.195
Plates	..	30 to 390	1.205
HR sheet/strip	..	695 to 1960	5.285
CR sheet/strip	..	310 to 940	2.885
Tin plates	..	100 to 225	0.820
			12.690

Keeping in view the substantial demand, ASEAN countries have been planning for the last several years to set up integrated steel plants. Indonesia has already commissioned some of the facilities of the Krakatau integrated steel plant. These include one module of 400,000 tons capacity DR plant, two 85-ton arc furnaces, two 4-strand billet casters and a wire rod mill. Malaysia, Thailand and Philippines have also done considerable preparatory work and are seriously contemplating implementation of steel projects.

TABLE 22-1 - LIKELY FUTURE SHORTFALLS FOR SELECTED STEEL PRODUCTS
('000 tons)

		Thailand		Malaysia		Singapore		Indonesia		Philippines	
	—	1985	1990	1985	1990	1985	1990	1985	1990	1985	1990
Bars and rods inclusive wire rods	..	315	485	100	130	(+)15	(+)80	365	650	-	115
Sections	..	200	290	170	185	230	260	220	285	120	175
Plates	..	20	30	160	220	315	385	245	390	95	180
HR sheets/strip	..	1,280	1,960	615	825	565	695	615	870	660	935
CR sheets/strip	..	590	940	340	465	275	310	570	840	245	330
Tin plates	..	110	200	125	165	100	100	160	225	105	130

22 - Preliminary findings (cont'd)

Because of the large resources involved in multi-million ton steelworks, member countries are interested in exploring the possibilities of having initially economic size units for each of the following steel processes under consideration with possibilities of backward integration in future.

i) Billet plant
ii) Wire rod mill
iii) Structural shape mill
iv) Bright bar plant
v) Seamless pipe plant
vi) GI wire plant
vii) Special steel plant
viii) Stainless steel plant
ix) Hot strip mill
x) Cold strip mill
xi) Plate mill
xii) Electrolytic tinning line

MINIMUM ECONOMIC SIZE

For minimum economic size, the return on investment should at least be equal to the cost of capital, which is defined as the weighted average of the desirable return on equity capital and the rate of interest charged on long term loan. The prevailing annual interest rates in ASEAN countries are : 9 per cent in Malaysia and Philippines, 9.5 per cent in Singapore, 12 per cent in Thailand and

13.5 per cent in Indonesia. Considering the maximum interest rate of 13.5 per cent per annum and assuming an expected return on equity capital of 15 per cent per annum, the weighted average cost of capital works out to about 14 per cent, with a debt equity ratio of 60 : 40.

For assessing the economic viability, the conventional approach is generally the expected net return on the equity capital after providing for depreciation, interest charges and taxes. Another approach is the internal rate of return (IRR) which takes into account the time value of money. The second approach has been adopted as suggested by the ASEAN representatives. For minimum economic size the IRR expected by the ASEAN countries is 15 per cent.

While considering the prices of input materials and finished products for assessing the viability, the incidence of duty on imported steel, though applicable in some countries, has not been considered. Similarly tax on profit, which may be exempted for new industries for the initial period, has not been considered.

The capital cost has been considered to be same for all the countries. In estimating the production cost for each steel product, local variations in the prices of input materials as well as in the wages and salaries have been taken into account.

The IRR has been calculated for an operational period of twenty years and considering the beginning of the first year of operation as the zero point. Outflows on account of the fixed investment during construction have been compounded. The cash inflows and outflows accruing during the operational period have been discounted. The IRR has been computed as the rate at which the outflows and inflows balance each other.

The IRR is sensitive to those factors which influence the cash inflows and outflows. With increase in cash outflows or decrease in inflows the IRR will reduce and with decrease in cash outflows or increase in inflows the IRR will increase.

A higher capital cost would mean a higher cash outflow and thus a reduced IRR. A higher sales receipt or a reduced production cost would mean a higher cash inflow and thus an increased IRR. A higher production cost would correspond to a lower cash inflow and the IRR will consequently decrease. Further, a lower level of production would result in a lower cash inflow and a reduced IRR. A sensitivity analysis with reference to the selling prices considered is given in Table 22-2 at the end of the chapter.

Billet Plant

The billet plant has been visualised with electric arc furnaces and continuous casting machines for production of 100 mm sq mild steel billets. Four plant capacities have been analysed. The plant capacities considered and the estimated capital cost for the different alternatives are as follows:

		Plant capacity tons/yr	Capital cost mill US $
Alt. 1	..	56,000	18.5
Alt. 2	..	94,000	28.0
Alt. 3	..	300,000	64.0
Alt 4	..	510,000	90.0

22 - Preliminary findings (cont'd)

A 50 : 50 mix of domestic and imported scrap has been considered as the charge. The prices of domestic and imported scrap considered for the different countries are as follows:

		Scrap price, US $/ton	
		Domestic	Imported
Thailand	..	115	150
Malaysia	..	70	140
Singapore	..	85	160
Indonesia	..	120	140
Philippines	..	95	151

On the above basis, and the selling prices of billets varying from US $ 275 to 300 per ton, the IRR has been worked out for the different plant capacities, as given below:

		Selling price US $/ton	IRR, %			
			Alt 1	Alt 2	Alt 3	Alt 4
Thailand	..	300	5.4	10.1	18.7	22.3
Malaysia	..	300	14.2	18.7	28.3	32.9
Singapore	..	300	1.2	8.3	20.2	24.6
Indonesia	..	295	7.1	11.0	19.1	22.7
Philippines	..	275	-	1.6	9.3	12.2

For realising an IRR of 15 per cent, a plant capacity of 150,000 to 200,000 tons per year is indicated for Thailand, Singapore, and Indonesia and a capacity of 60,000 tons per year for Malaysia. For Philippines, the IRR works out to about 12 per cent only even with a large capacity of 500,000 tons per year. This is mainly because of the lower selling prices of US $ 275 per ton of billets considered for Philippines.

For production of billets, steel scrap can be replaced by sponge iron depending upon its availability and price. At present, sponge iron is being sold by Indonesia at US $ 105 per ton. Sponge iron is also likely to be produced in the near future by Thailand and Malaysia. Hence, the viability of billet project would alter depending upon the ultimate price of sponge iron vis-a-vis the availability and price of scrap.

Wire Rod Mill

Wire rod mill of three different capacities namely 150,000 tons per year, 300,000 tons per year and 450,000 tons per year have been evaluated for production of 5.5 to 12 mm wire rods. The capital cost for these three plant capacities

22 - Preliminary findings (cont'd)

is estimated at US $ 38 million, US $ 67.5 million and US $ 85.5 million respectively. Considering a billet price of US $ 300 to 320 per ton and a selling price of US $ 375 to 390 for wire rod, the IRR for the three alternatives works out as follows:

	Purchase price of billet US $/ton	Selling price of wire rod US $/ton	IRR, %		
			Alt 1	Alt 2	Alt 3
Thailand ..	320	390	1.1	3.8	6.0
Malaysia ..	310	390	4.1	6.7	8.6
Singapore ..	300	390	3.7	6.7	9.4
Indonesia ..	300	390	9.7	12.5	14.9
Philippines ..	300	375	-	1.5	3.3

With the input and selling prices considered, an IRR of about 15 per cent is obtained for Indonesia only at the largest of the capacities considered for evaluation namely 450,000 tons per year. A sensitivity analysis indicates that if 10 per cent higher selling prices are considered, the IRR varying between 12 and 20 per cent are obtained for the five

22 - Preliminary findings (cont'd)

countries with a plant capacity of 150,000 tons per year as given below:

		Selling price of wire rod US $/ton	IRR %
Thailand	..	429	13.9
Malaysia	..	429	15.8
Singapore	..	429	15.5
Indonesia	..	429	19.7
Philippines	..	413	12.3

Structural Shape Mill

The product-mix comprises medium structurals such as angles of up to 110 x 110 mm and beams and channels of up to 150 x 75 mm in plain carbon steel grades. The plant capacities considered for evaluation and the corresponding estimated capital costs are as follows:

		Plant capacity tons/yr	Capital cost mill US $
Alt - 1	..	100,000	44
Alt - 2	..	400,000	123
Alt - 3	..	600,000	155

22 - Preliminary findings (cont'd)

Based on a bloom/billet price of US $ 300 to 320 per ton and a selling price of US $ 405 to 450 per ton for structurals, the IRR obtained with different plant capacities are as follows:

		Purchase price of Bloom/ billet US $/ton	Selling price of structurals US $/ton	IRR, %		
				Alt-1	Alt-2	Alt-3
Thailand	..	320	405	-	4.3	6.5
Malaysia	..	310	405	0.8	6.2	8.5
Singapore	..	300	405	1.7	7.7	10.0
Indonesia	..	300	405	6.7	11.9	14.5
Philippines	..	300	450	12.2	18.1	21.1

A sensitivity analysis indicates the IRR varies between 12.7 and 22 per cent with a plant capacity of 100,000 tons per year considering 15 per cent higher selling prices, and between 14.8 and 26 per cent with a plant capacity of 400,000 tons per year considering 10 per cent higher selling prices as given on the next page.

22 - Preliminary findings (cont'd)

		Plant capacity 100,000 tons/yr		Plant capacity 400,000 tons/yr	
		Selling price US $/ton	IRR %	Selling price US $/ton	IRR %
Thailand	..	466	12.7	446	14.8
Malaysia	..	466	13.6	446	16.1
Singapore	..	466	14.0	446	17.2
Indonesia	..	466	17.3	446	20.4
Philippines	..	518	22.1	495	26.2

Bright Bar Plant

A capacity of 20,000 tons per year has been visualised for production of bright bars (cold finished bars) in the size range of 6 to 100 mm dia. The estimated capital cost for a plant of this capacity is US $ 5 million. Considering the average price of bars and wire rods of US $ 375 to 404 per ton and the selling prices of US $ 560 to 565 per ton for bright bars, the IRR obtained is as follows:

		Average price of bars and wire rod US $/ton	Price of bright bars US $/ton	IRR %
Thailand	..	400	560	20.3
Malaysia	..	390	560	21.6
Singapore	..	375	560	21.4
Indonesia	..	387.5	565	25.0
Philippines	..	404	560	18.7

22 - Preliminary findings (cont'd)

Seamless Tube Plant

Three different capacities have been considered for production of carbon steel seamless tubes up to 220 mm OD as follows:

		Capacity tons/yr
Alt. 1	..	25,000
Alt. 2	..	50,000
Alt. 3	..	62,000

The capital cost for the plant capacities considered is US $ 59 millions, US $ 84.5 millions and US $ 100.5 millions respectively. Based on an input bloom price of US $ 300 to 320 per ton and a selling price of US $ 860 per ton for tubes, the IRR obtained with the different plant capacities are given below:

		Price of bloom US $/ton	Price of tubes US $/ton	IRR, %		
				Alt 1	Alt 2	Alt 3
Thailand	..	320	860	7.0	12.0	13.7
Malaysia	..	310	860	6.9	11.9	13.7
Singapore	..	300	860	4.9	10.5	12.4
Indonesia	..	300	860	9.6	14.2	15.8
Philippines	..	300	860	8.1	12.9	14.4

22 - Preliminary findings (cont'd)

It is seen that the IRR varies between 12.4 and 15.8 per cent with a plant capacity of 62,000 tons per year. With a plant capacity of 50,000 tons per year, if selling prices higher by 5 per cent and 10 per cent are considered, the IRR would improve to 12.3 to 15.8 and 14.0 to 17.4 per cent respectively as given below:

	Selling price US $/ton	IRR %	Selling price US $/ton	IRR %
Thailand ..	903	13.7	946	15.4
Malaysia ..	903	13.6	946	15.3
Singapore ..	903	12.3	946	14.0
Indonesia ..	903	15.8	946	17.4
Philippines ..	903	14.6	946	16.2

GI Wire Plant

Three different plant capacities have been evaluated for production of galvanised mild steel wire (6 to 24 gauge) as follows:

	Capacity tons/yr
Alt. 1 ..	11,500
Alt. 2 ..	23,000
Alt. 3 ..	34,500

22 - Preliminary findings (cont'd)

The capital cost for the three plant capacities considered are US $ 4.14 million, US $ 6.5 million and 8.89 million respectively. Based on a wire rod price of US $ 390 to US $ 415 per ton and a selling price of US $ 575 per ton, the IRR obtained are as follows:

		Price of wire rod US $/ton	Price of GI wire US $/ton	IRR % Alt 1	Alt 2	Alt 3
Thailand	..	415	575	6.7	10.9	12.6
Malaysia	..	405	575	8.3	12.4	14.1
Singapore	..	390	575	5.2	10.9	13.0
Indonesia	..	410	575	9.9	13.7	15.0
Philippines	..	400	575	9.8	13.2	14.7

Special Steels Plant

Two plant capacities of 35,000 tons per year and 75,000 tons per year have been evaluated. Production of bars and rods in the size range of 50 to 75 mm of carbon, low alloy and spring steel grades has been considered. The capital costs for the two plant capacities are estimated at US $ 23.3 million and US $ 34.5 million respectively. Based on the prices of domestic and imported scrap indicated earlier for the different countries and an average selling price of US $ 620 per ton for all the countries, the IRR for the two plant capacities discussed works out as follows:

		IRR, %	
		Alt 1	Alt 2
Thailand	..	12.7	17.9
Malaysia	..	15.9	21.5
Singapore	..	10.6	16.2
Indonesia	..	14.8	19.9
Philippines	..	10.9	15.6

It is seen that an IRR of about 15 per cent is obtained for a plant capacity of 35,000 tons per year for Malaysia and Indonesia. With a plant capacity of 70,000 tons per year, an IRR of minimum 15 per cent is obtained for all the countries.

Stainless Steel Plant

Capacities of 20,000 tons and 30,000 tons per year have been evaluated for production of 600 mm wide cold rolled stainless steel strips. While the steelmaking and cold rolling facilities have been provided to match the required production, the capacity of 600 mm wide hot planetary mill has necessarily to be about 100,000 tons per year. The capital cost for the two alternatives considered is

US $ 165 million and US $ 203.5 million respectively. Based on a selling price of US $ 2,315 per ton for Indonesia and US $ 2,090 per ton for other countries, the maximum IRR obtained at a plant capacity of 30,000 tons per year is 7.8 per cent which is for Indonesia. A sensitivity analysis indicates that if the selling price is increased by 15 per cent, the IRR with a plant capacity of 30,000 tons per year is 7.5 per cent for Thailand, 8.0 per cent for Malaysia, 6.4 per cent for Singapore, 11.6 per cent for Indonesia and 7 per cent for Philippines.

The IRR will further improve if the capacity of hot planetary mill is fully utilised and the hot rolled coils/ sheets are sold to future cold rolling mills in the region.

Hot Strip Mill

A semi-continuous hot strip mill with a capacity of about 1.5 million tons per year has been visualised for production of 1,500 mm wide hot rolled coils and sheets. The estimated capital cost of the mill is US $ 307 million. Based on a slab price of US $ 245 to 260 per ton and an average selling price of US $ 350 to 357 per ton for hot

22 - Preliminary findings (cont'd)

rolled products, the IRR varies between 14 per cent and 18.7 per cent as given below:

		Price of slabs US $/ton	Price of HR product US$/ton	IRR %
Thailand	..	260	350	14.0
Malaysia	..	255	350	14.5
Singapore	..	245	350	15.8
Indonesia	..	250	352	18.7
Philippines	..	255	357	15.9

Cold Strip Mill

Two plant capacities, one of 300,000 tons per year with a single stand 4-hi and another of one million tons per year with a 5-stand tandem mill have been considered for production of 1,000 mm wide cold rolled coils. The capital cost estimated for the two plant capacities is US $ 177.5 million and US $ 326.5 million respectively. Based on hot rolled coil price of US $ 340 to 360 per ton and a selling price of US $ 420 to US $ 475 per ton for the cold rolled products, the maximum IRR obtained is only 10 per cent even with the larger of the two plant capacities considered as given on the next page.

22 - Preliminary findings (cont'd)

		Price of HR coil US $/ton	Price of CR product US $/ton	IRR %
Thailand	..	360	423	-
Malaysia	..	350	423	-
Singapore	..	340	423	0.4
Indonesia	..	350	420	-
Philippines	..	355	475	10.4

If selling price higher by 15 per cent is considered, the IRR obtained with a plant capacity of 1 million tons per year varies between 12 to 21.7 per cent as follows:

		IRR %
Thailand	..	12.1
Malaysia	..	13.7
Singapore	..	15.0
Indonesia	..	14.2
Philippines	..	21.7

Plate Mill

Two plant capacities, one of 200,000 tons per year with a 3-hi mill and another of 600,000 tons with a 4-high reversing mill, have been considered for production of 2,500 mm wide plates. The capital cost for the two

22 - Preliminary findings (cont'd)

alternatives evaluated are US $ 76 millions and US $ 117 millions respectively. Based on a slab price of US $ 245 to US $ 260 per ton and the selling price of plates at US $ 365 to US $ 390 per ton, the maximum IRR obtained is 6.3 per cent with a capacity of 200,000 tons per year and 13.9 per cent with a capacity of 600,000 tons per year as given below:

		Price of slabs US $/ton	Price of plates US $/ton	IRR, % Alt. 1	Alt. 2
Thailand	..	260	370	0.9	8.0
Malaysia	..	255	370	-	6.8
Singapore	..	245	370	1.8	9.8
Indonesia	..	250	365	4.2	12.9
Philippines	..	255	390	6.3	13.9

A sensitivity analysis indicates that if selling prices higher by 5 and 15 per cent are considered, the IRR will be as follows:

		Case (i)	Case (ii)
Plant capacity, tons/yr	..	200,000	600,000
Increase in selling price, %	..	15	5
IRR, %			
Thailand	..	12.9	13.8
Malaysia	..	12.3	12.9
Singapore	..	13.3	15.2
Indonesia	..	14.0	17.7
Philippines	..	16.3	18.8

22 - Preliminary findings (cont'd)

Electrolytic Tinning Line

A capacity of 150,000 tons per year for production of 1,000 mm wide tinplates has been considered. Based on the price of cold rolled coils at US $ 445 per ton for Thailand, US $ 430 per ton for Malaysia, US $ 415 per ton for Singapore, US $ 425 per ton for Indonesia and US $ 500 per ton for Philippines, and a selling price of tinplates of US $ 700 per ton for all the countries, the IRR works out to 13.5 per cent for Thailand, 14.9 per cent for Malaysia, 16 per cent for Singapore, 16.4 per cent for Indonesia and 2.8 per cent for Philippines. The low IRR for Philippines is on account of the higher cold rolled coil price of US $ 500 per ton. A sensitivity analysis indicates that with a 10 per cent higher selling price, the IRR will be about 14.3 per cent for Philippines.

INTEGRATED STEEL PLANT FOR SEMIS

The viability of production of plates, hot rolled coils, cold rolled coils, structurals, wire rods etc has been examined based on imported semis. However, experience shows that assured supply of semis on a regular basis poses problems. This in turn results in poor utilisation of plant capacity thus affecting its economics.

22 - Preliminary findings (cont'd)

The runway inflation caused by the frequent oil price hikes has pushed up the equipment prices and other costs during the last few years resulting in substantial increase in capital costs of the new projects. As a result, the minimum economic size for the different steel processing units are comparatively large.

It is likely that the local production of semis may improve the viability of the various steel process units under consideration. Therefore, with a view to assessing the cost of semis vis-a-vis their imported prices and to serve as a basis for examination of steel production in the region, the production of semis, namely billets/slabs in integrated steelworks has been evaluated.

Due to availability of natural gas, DR-EF route has been considered for Indonesia, Malaysia and Thailand and BF-BOF route for all the countries excepting Singapore. Based on the prevailing prices of equipment and materials, the capital cost for steelworks for different capacities has been estimated as follows:

DR-EF route		BF-BOF route	
Capacity mill tons	Capital Cost US $ mill	Capacity mill tons	Capital cost US $ mill
0.425	195 (billets) 230 (slabs)	0.95	525 (billets) 545 (slabs)
1.275	440 (billets) 520 (slabs)	1.90	830 (billets) 865 (slabs)
1.900	635 (billets) 690 (slabs)	2.85	1,035 (billets) 1,045 (slabs)

22 - Preliminary findings (cont'd)

Based on the prevailing prices of input materials, energy etc, the production cost of semis for different capacities has been estimated as follows:

DR-EF route (1)		BF-BOF route (1)	
Capacity mill tons	Production cost US $/ton	Capacity mill tons	Production cost US $/ton
0.425	281-292 (billets) 299-310 (slabs)	0.95	281-290 (billets) 285-294 (slabs)
1.275	253-263 (billets) 267-277 (slabs)	1.90	254-264 (billets) 257-267 (slabs)
1.900	247-256 (billets) 252-262 (slabs)	2.85	235-245 (billets) 235-244 (slabs)

NOTE
(1) Including 20 per cent interest and depreciation charges.

It is noted that the production cost of billets by integrated steelworks will be lower in the region than the present imported price **for all the capacities considered.** For slabs to be competitive with imports, the minimum level of production is around 2 million tons per year.

REGIONAL STEEL PLANTS

The economics of establishing large processing units and integrated steelworks for serving the ASEAN market as a whole is as follows.

22 - Preliminary findings (cont'd)

Regional Process Plants

For most of the steel processes, the minimum economic size plant capacity as emerging from the analysis presented in Chapters 8 to 19 are fairly large. However, in case of billet plant, hot strip mill and plate mill plants of larger capacities may be considered.

In case of billet plant, the production cost of billets with different plant capacities is as follows:

		Production cost US $/ton
0.5 million tons per year semi-integrated plant	..	238-275
1 million tons per year integrated DR-EF plant	..	265-280
3 million tons per year integrated BF-BOF plant	..	230-235

As compared to the above, the imported billets cost US $ 275-300 per ton.

A hot strip mill of 3 million tons per year capacity will involve an investment of US $ 400 million and the production cost of HR sheets/strip from such a mill is

22 - Preliminary findings (cont'd)

estimated, as an average for the region, at US $ 320 per ton. As against this, the production cost for minimum economic size unit of 1.5 million tons per year capacity, as an average for the region, is US $ 334 per ton.

For a plate mill of 1 million tons per year capacity, the investment will be about US $ 175 million and the production cost of plates, as an average for the region, is estimated at US $ 365 per ton. As compared to this, the production cost for the minimum economic size unit of 0.6 million tons per year, as an average for the region, is US $ 373 per ton.

Integrated Steel Plants

For comparing the economics of integrated steel plants for finished steel products with minimum economic size units discussed earlier, the following two alternatives have been studied.

		Alt. 1	Alt. 2
Liquid steel capacity, mill tons/yr	..	3.0	1.5
Process route	..	BF-BOF	DR-EF
Finished products, tons/yr			
Plates	..	600,000	-
HR strip/sheet	..	930,000	-
CR strip/sheet	..	1,000,000	-
Wire rods	..	-	600,000
Structurals	..	-	600,000
Semis for sale	..	-	100,000

22 - Preliminary findings (cont'd)

The approximate capital cost for the two alternative plant capacities considered at hypothetical locations in the ASEAN region is as follows:

		US $ mill
Alt. 1	..	1,885
Alt. 2	..	710

A comparison of the production cost of various steel products from the integrated steel plants, as discussed above, with that from the minimum economic size processing units, as well as the selling prices considered for steel products is given below:

	Integrated steel plant		Minimum economic size unit		Selling price range
	Production '000 t/yr	Production cost US $/ton	Production '000 t/yr	Production cost US $/ton	US $/ton
Plates ..	600	353	600	373	365-370
HR strip/ sheets ..	2,000	310	1,500	334	350-355
CR strip/ sheets ..	1,000	423	1,000	472	425-475
Wire rods ..	600	334	450	450	375-390
Structurals..	600	361	400	424	405-450

22 - Preliminary findings (cont'd)

ACTION ORIENTED PROGRAMME

To meet the growing demand for steel in the region, an action oriented follow-up programme involving short-term and long-term measures is suggested below. The success of the various measures indicated will depend upon the seriousness of the ASEAN countries to work together and come to an understanding vis-a-vis marketing, financing, development of infrastructure facilities etc. Considering the magnitude of the task, such regional cooperation is considered essential.

Short-term Measures

Setting up of merchant sponge iron plants in Indonesia, Malaysia and Thailand will provide the impetus for the development of the steel industry by making available adequate supply of sponge iron for existing and new arc furnace steel plants. With adequate supply of steel from arc furnace plants, production of billets, wire rods, wire products, cold finished bars etc can be taken up as national plants. Depending upon the demand, production of medium structurals, seamless tubes, special steels and stainless steel strips can also be considered as national or regional plants in the short-term programme.

Long-term Measures

Considering the substantial demand for steel, one or two large steel projects could be established in all the countries, except Singapore where facilities for production of stainless steel sheet, special steels and similar products could be considered. The steel plants could be planned with their product-mix complementary to each other so that economic size units can be selected for each plant. Plants for production of flat products in the region should be taken up on a priority basis.

As the steel plants in the region will have to depend upon imported raw materials, port based locations are suggested for the steel plants.

SECTION 1

TABLE 22-2 - SENSITIVITY ANALYSIS WITH RESPECT TO SELLING PRICE

(SP: Selling price : US $ per ton;
IRR : Internal Rate of Return : per cent)

		Thailand	Malaysia	Singapore	Indonesia	Philippines
WIRE ROD MILL						
Plant Capacity, 150,000 tons/year						
SP (base)/IRR	..	390/1.1	390/4.1	390/3.7	390/9.7	375/-
SP (+ 5%)/IRR	..	410/8.4	410/10.6	410/10.3	410/15.0	394/6.6
SP (+10%)/IRR	..	429/13.9	429/15.8	429/15.5	429/19.7	413/12.3
Plant Capacity, 300,000 tons/year						
SP (base)/IRR	..	390/3.8	390/6.7	390/6.7	390/12.5	375/1.5
SP (+ 5%)/IRR	..	410/10.9	410/13.2	410/13.1	410/18.0	394/9.1
SP (+10%)/IRR	..	429/16.6	429/18.5	429/18.5	429/22.8	413/14.9
Plant Capacity, 450,000 tons/year						
SP (base)/IRR	..	390/6.0	390/8.6	390/9.4	390/14.9	375/3.3
SP (+ 5%)/IRR	..	410/13.5	410/15.5	410/16.1	410/20.8	394/11.2
STRUCTURAL SHAPE MILL						
Plant Capacity, 100,000 tons/year						
SP (base)/IRR	..	405/-	405/0.8	405/1.7	405/6.7	450/12.2
SP (+ 5%)/IRR	..	425/4.8	425/6.0	425/6.7	425/10.7	473/15.8
SP (+10%)/IRR	..	446/9.1	446/10.1	446/10.6	446/14.2	495/19.1
Plant Capacity, 400,000 tons/year						
SP (base)/IRR	..	405/4.3	405/6.2	405/7.7	405/11.9	450/18.1
SP (+ 5%)/IRR	..	425/10.1	425/11.6	425/12.8	425/16.4	473/22.3
SP (+10%)/IRR	..	446/14.8	446/16.1	446/17.2	446/20.4	495/26.2
SEAMLESS TUBE PLANT						
Plant Capacity, 50,000 tons/year						
SP (base)/IRR	..	860/12.0	860/11.9	860/10.5	860/14.2	860/12.9
SP (+ 5%)/IRR	..	903/15.7	903/13.6	903/12.3	903/15.8	903/14.6
SP (+10%)/IRR	..	946/16.4	946/15.3	946/14.0	946/17.4	946/16.2
Plant Capacity, 62,000 tons/year						
SP (base)/IRR	..	860/13.7	860/13.7	860/12.4	860/15.8	860/14.4
SP (+ 5%)/IRR	..	903/15.4	903/15.4	903/14.2	903/17.4	903/16.1

Plant Capacity, 100,000 tons/year

SP (base)/IRR	..	405/-
SP (+ 5%)/IRR	..	425/4.8
SP (+10%)/IRR	..	446/9.1

Plant Capacity, 400,000 tons/year

SP (base)/IRR	..	405/4.3
SP (+ 5%)/IRR	..	425/10.1
SP (+10%)/IRR	..	446/14.8

SEAMLESS TUBE PLANT

Plant Capacity, 50,000 tons/year

SP (base)/IRR	..	860/12.0
SP (+ 5%)/IRR	..	903/15.7
SP (+10%)/IRR	..	946/16.4

Plant Capacity, 62,000 tons/year

SP (base)/IRR	..	860/13.7
SP (+ 5%)/IRR	..	903/15.4

SECTION 2

PLATE MILL

Plant Capacity, 200,000 tons/year

SP (base)/IRR	..	370/0.9
SP (+15%)/IRR	..	426/12.9

Plant Capacity, 600,000 tons/year

SP (base)/IRR	..	370/8.0
SP (+ 5%)/IRR	..	389/13.8

405/0.8	405/1.7	405/6.7	450/12.2
425/6.0	425/6.7	425/10.7	473/15.8
446/10.1	446/10.6	446/14.2	495/19.1

405/6.2	405/7.7	405/11.9	450/18.1
425/11.6	425/12.8	425/16.4	473/22.3
446/16.1	446/17.2	446/20.4	495/26.2

860/11.9	860/10.5	860/14.2	860/12.9
903/13.6	903/12.3	903/15.8	903/14.6
946/15.3	946/14.0	946/17.4	946/16.2

860/13.7	860/12.4	860/15.8	860/14.4
903/15.4	903/14.2	903/17.4	903/16.1

370/-	370/1.8	365/4.2	390/6.3
426/12.3	426/13.3	420/14.0	449/16.3

370/6.8	370/9.8	365/12.9	390/13.9
389/12.9	389/15.2	383/17.7	410/18.8

10180 (B)

FINAL REPORT

TO

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ON

STUDY ON MINIMUM ECONOMIC SIZE PLANTS FOR STEEL PROCESSES IN ASEAN COUNTRIES

DP/RAS/78/047

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APPENDICES

APPENDIX 2-1

SEMI-INTEGRATED STEEL PLANTS IN THAILAND

Plant	Products	Steelmaking capacity tons/yr	Rolling capacity tons/yr
1. The Bangkok Iron & Steel Works Co Ltd, Phrapradaeng Dt.	Bars and small sections	173,000 (1)	150,000
2. Bangkok Steel Industry Co Ltd Samutprakaran ..	Round bars	92,000 (1)	80,000
3. G.S. Steel Co Ltd, Samutprakaran ..	Bars	158,000	150,000
4. The Siam Iron & Steel Co Ltd, Taluang ..	Bars & wire rods	154,000	165,000
5. Thai India Steel Co Ltd, Samutprakaran ..	Reinforcing bars, flats	45,000	60,000
	Total ..	622,000	605,000

NOTE
(1) Estimated.

Source: SEAISI Directory 1979.

APPENDIX 2-2

SEMI-INTEGRATED STEEL PLANTS IN INDONESIA

Plant	Products	Steelmaking capacity tons/yr	Rolling capacity tons/yr
1. P.T. Baja Indonesia Utama, Jakarta	Billets	200,000	-
2. P.T. Budidharma Jakarta, Jakarta	Bars	90,000	120,000
3. P.T. Djatim Utama Steel Mfg Co Ltd, Djawa Timur	Bars, wire rails	20,000	20,000
4. P.T. Gunung Bahara, Medan	Bars	16,000 (1)	14,000
5. P.T. Inti General Yaja Steel, Semarang	Bars	17,000 (1)	15,000
6. P.T. Irosteel Works, Jakarta	Bars	70,000	60,000 (1)
7. P.T. Ispat Indo, Surabaya	Wire rods	150,000	130,000
8. P.T. Djakarta Iron Products, Jakarta		5,000	4,300
9. P.T. Maxiferro (Steel) Industry Co Ltd, Tangerang, W. Java	Bars, wire rods	30,000	60,000
10. P.T. Pulogadung Steel Mfg Co Ltd, Jakarta	Bars	30,000	45,000
11. P.T. Toyogiri Iron & Steel, Jawa Barat	Rolled products	70,000 (1)	60,000
	Total ..	698,000	528,000

NOTE:
(1) Estimated

Source: SEAISI Directory - 1979

APPENDIX 2-3

SEMI-INTEGRATED STEEL PLANTS IN THE PHILIPPINES

Plant	Products	Steelmaking capacity tons/yr	Rolling capacity tons/yr
1. Philippines Blooming Mills, Rizal	Bars, sections	235,000	135,000
2. Allenco Steel Corporation, Rizal	Bars, wire rods	50,000 (1)	43,000
3. Apollo Steel Mills, Mandaluyong	Bars	60,000	52,000
4. Armco Marsteel Alloy Corporation, Metro Manila	Merchant products	70,000 (1)	60,000
5. Armstrong Industries Inc, Bulacan	Steel products	35,000 (1)	30,000
6. Marcelo Steel Corporation Manila	Bars, wire rods	54,000	21,000
7. Marsteel Corporation, Novaliches	Bars, structurals, hoop	30,000	32,000
8. National Steel Corporation, Iligan City	Plates, sheets, bars	60,000 (1)	962,000
Pasig, Manila	CR coil/sheets	-	140,000
9. Globe Steel Corporation, Rizal	Bars	...	50,000
	Total	..	1,525,000

NOTE:
(1) Estimated

Source: SEAISI Directory - 1979

APPENDIX 2-4

INSTALLED CAPACITY IN THE ASEAN COUNTRIES FOR VARIOUS STEEL PRODUCTS

		Thailand tons/year	Malaysia tons/year	Singapore tons/year	Indo tons
Bars & rods and sections					
Integrated plants	..	-	157,000	-	480,
Semi-integrated plants	..	605,000	107,000	365,000	528,
Re-rolling mills	..	200,000	128,000	12,000	297,
		805,000	392,000	377,000	1,305,
Hot and cold rolled sheets	..	-	-	-	-
Galvanised sheets	..	226,000	135,000	-	267,
Welded pipes	..	154,000	105,000	45,000	39[illegible]
Tin plates	..	60,000	-	-	
Wire and wire products	..	...	61,000	60,000	27[illegible]

NOTE
(1) Excludes Thailand and Philippines for which data is not available

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SECTION 1

APPENDIX 2-4

INSTALLED CAPACITY IN THE ASEAN COUNTRIES FOR VARIOUS STEEL PRODUCTS

Malaysia tons/year	Singapore tons/year	Indonesia tons/year	Philippines tons/year	Total tons/year
157,000	-	480,000	-	637,000
107,000	365,000	528,000	423,000	2,028,000
128,000	12,000	297,000	722,000	1,359,000
392,000	377,000	1,305,000	1,145,000	4,024,000
-	-	-	1,102,000	1,102,000
135,000	-	267,000	467,000	1,095,000
105,000	45,000	394,000	305,000	1,003,000
-	-	-	120,000	180,000
61,000	60,000	274,000	...	395,000(1)

hilippines for which data is not available

SECTION 2

APPENDIX 2-5

PRODUCTION AND IMPORT OF STEEL IN 1977 A…
(tons)

		Thailand		Malaysia[1]		Singapore	
		1977	1978	1977	1978	1977	1…
Production (equivalent crude steel)		308,532	385,000	212,000	195,000	215,000	28…
Imports							
Semis	..	226,070	385,376	24,326[2]	22,968[2]	24,700	55…
Sections	..	167,482	193,868	63,999	70,682	192,500	10…
Plates	..	477,965[4]	18,337	63,737	88,199	206,605	222…
Sheets	..		447,629	380,989	270,623	153,642	231…
Tin plates	..	50,434	43,766	66,266	68,287	71,728	56…
Wire rods	..	45,645	47,466	65,437	115,219	64,504	37…
Wires	..	50,867	20,967	-	-	11,184	…
Tubes & fittings	..	14,668	-	61,314	77,854	248,748	
Hoops & strips	..	24,890	14,228	7,968	14,746	28,772	2…
Wheels & tyres	..	662	5,513	-	-	-	6…
TOTAL	..	1,058,683	1,177,150	734,036	728,578	1,002,383	75…

NOTES

(1) Based on information on imports made available by Malay…
(2) Billets only
(3) Includes 40,005 tons of merchant bars.
(4) Includes sheets.

Source: Steel Statistics for Member Countries, SEAISI.

SECTION 1

M.N. DASTUR & COMPANY (P) LTD
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APPENDIX 2-5

UCTION AND IMPORT OF STEEL IN 1977 AND 1978
(tons)

	Malaysia (1) 1978	Singapore 1977	Singapore 1978	Indonesia 1977	Indonesia 1978	Philippines 1977	Philippines 1978
	195,000	215,000	281,000	250,000	225,000	357,000	276,000
(2)	22,948 (2)	24,700	55,520	167,800	180,147	651,700	338,529 (2)
	70,682	192,500	107,358	154,297	78,779	58,753	21,138
	88,199	206,605	222,972	98,958	131,932	153,973 (4)	90,750
	27[illegible],623	153,642	231,193	409,445	437,509		344,678
	68,287	71,728	56,409	72,999	89,698	54,074	92,817
	115,219	64,504	37,318	119,137	128,908	13,456	73,937 (3)
	-	11,184	9,506	5,970	5,745	12,713	-
	77,854	248,748	-	77,703	158,648	26,587	24,675
	14,746	28,772	28,028	43,954	37,668	29,696	-
	-	-	6,766	1,969	17,610	-	-
	728,578	1,002,383	755,070	1,152,232	1,266,644	1,000,952	986,524

-ion on imports made available by Malaysian Industrial Development Agency.

ons of merchant bars.

for Member Countries, SEAISI.

SECTION 2

APPENDIX 3-1

WORLD IRON ORE/PELLET SITUATION

A brief review of the world situation on iron ore/pellet is given below with a view to identify the possible sources of supply to the ASEAN countries.

IRON ORE

Reserves

A survey of the iron ore resources of the world by the United Nations has shown that the world resources of iron ore are estimated at 782,500 million tons, as indicated below:

WORLD IRON ORE RESOURCES
(million tons)

	Reserves	Potential	Total resources
Developing region	58,900	137,200	196,100
Developed region	192,400	394,000	586,400
Total ..	251,300	531,200	782,500

Source: Survey of World Iron Ore Resources, United Nations, New York, 1970.

It may be added that Asia and the Far-East have reserves of 16,900 million tons and potential of 52,500 million tons, making a total of 69,400 million tons, equivalent to 9 per cent of the total world iron ore sources.

Appendix 3-1 (cont'd)

Production

World iron ore production has been growing to keep pace with the steel production. The world iron ore production has increased from 624 million tons in 1965, to 774 million tons in 1970, and 880 million tons in 1975. The major producing countries are U.S.S.R, Australia, U.S.A., Brazil, Canada, India, France, South Africa, Sweden, Liberia and others.

Trade

In the international market, iron ore is the second largest single tonnage item traded, next only to oil. The rapid expansion in world iron ore trade has resulted from factors such as the growth of the steel industry, use of richer ores, the emergence of Japan as the leading importer and the introduction of large bulk carriers, leading to substantial reduction in ocean freights. The sea-borne trade in iron ore has witnessed rapid growth, as can be seen from the following figures:

Year	Million tons
1965	150
1970	247
1974	320
1978	342

It is expected that this trend would continue and it has been forecast that approximately 420 million tons of ore would be traded in 1980 and 535 million tons in 1985. The country-wise production and export of iron ore for 1978 are as follows:

Appendix 3-1 (cont'd)

WORLD IRON ORE PRODUCTION AND EXPORTS - 1978
(million tons)

Country		Production	Export
U.S.S.R.	..	244.2	41.0
Australia	..	83.2	75.0
U.S.A.	..	82.1	4.3
Brazil	..	80.0	66.4
Canada	..	42.9	31.6
India	..	37.0	20.4
France	..	33.5	11.4
S.Africa	..	23.6	14.0
Sweden	..	21.5	20.5
Liberia	..	18.5	20.0
Others	..	208.5	37.4
World Total	..	875.0	342.0

Source: Panel Discussion Speeches, IISI 13, Sydney, October 1979.

PELLET

Pellet, as a source of iron, has gained commercial acceptance during the last two decades. The world annual pelletising capacity has grown from 20 million tons in 1960, to 70 million tons in 1965, 120 million tons in 1970 and to 188 million tons in 1975. The world capacity is currently estimated at 230 million tons per year and it is expected that by 1981 another 40 million tons per year would be produced. Latin American countries have at present about 19.5 million tons per year of pellet capacity in operation in Brazil and

Appendix 3-1 (cont'd)

Peru and have another 29 million tons per year of capacity under construction and planning in Argentina, Brazil, Chile and Venezuela. Consequently, these countries have emerged as significant sources of pellet supply. Sweden has a pelletising capacity of about 9 million tons per year of which a considerable portion is for DR pellet and by 1981 Sweden will have an additional pellet capacity of about 2 million tons per year. Australia has a pelletising capacity of over 12 million tons per year.

The analysis of iron ore/pellet available from different sources such as Australia, Sweden, India and Brazil is given on the next page.

POSSIBLE SOURCES OF SUPPLY

Taking into account the above review, on the availability and quality of ore/pellet, the potential sources of supply for iron ore lumps/pellets for the ASEAN countries could be Australia, Sweden, Brazil and India. However, considering the nearness to the ASEAN countries, Australia and India would have an edge over Sweden and Brazil in terms of ocean freight.

Appendix 3-1(cont'd)

ANALYSIS OF IRON ORE/PELLET FROM MAJOR SOURCES

Source	Material	Size mm	Chemical Composition, % Fe	SiO_2	Al_2O_3	P	S
Australia							
Hammersley Iron Pty Ltd - Tom Price	Lump	8-30	65.6	2.52	1.44	0.053	0.015
Mt. Newman Joint Ventures - Mt. Whaleback (1)	Lump	6-30	67.7	1.24	0.71	0.021	0.007
Mt. Goldsworthy Mining Ltd - Mama Mamba (1)	Lump	6-30	62.3	2.50	1.30	0.064	0.025
Texas Gulf - Hanvright Marandoo (1)	Lump	6-30	63.4	2.60	1.50	0.043	NA
Hammersley	Pellet		63.3	5.16	3.10	0.067	0.004
Broken Hill Pty Co.Ltd, Whyalla	Pellet		66.7	2.20	1.50	0.020	0.003
Savage River Mines, Savage River	Pellet		66.9	1.72	1.82	0.008	0.002
Cliffs Robe River, Pannamarnica	Pellet		63.3	6.30	3.15	0.004	0.007
India							
NMDC - Bailadila	Lump	9.5-150	66.0	10.0(SiO_2+Al_2O_3)		0.10	0.05
- Donimalai	Lump	10-30	65.5	4.2	4.2	0.10	0.05
- Bailadila (1)	Pellet	-	+ 66.0	-	-	-	-
- Goa	Lump	-	59.0	-	4.5	0.10	0.10
	Pellet		66.0	2.10	1.75	0.06	0.03
Brazil							
SAMARCO - Utah International	Pellet	-	66.0	3.10	0.60	0.040	0.002
CVRD	Pellet	-	68.1	0.9	0.84	0.026	0.005
MBR	Lump	12-50	64.66	1.0	1.75	0.070	0.010
Sweden							
LKAB	Pellet	-	68.6	0.59	0.35	0.013	0.010

Note: (1) Under development

APPENDIX 3-2

WORLD COAL SITUATION

In view of the need to import coking coal for the ASEAN countries, a brief review of the world coal situation is given below.

RESERVES

The total coal reserves of the world have been placed at about 10,782 billion tons, including measured reserves of all ranks at about 1,298 billion tons and economically recoverable hard coal at about 476 billion tons. U.S.S.R., U.S.A. and China P.R. account for about 90 per cent of the world's total coal resources; these countries also possess about 82 per cent of the world's economically recoverable hard coal. West Germany, Australia, India and South Africa account for another 14 per cent of recoverable hard coal, while other African countries and South America have very little coal resources. It has been estimated that the world's coking coal reserves amount to some 120 billion tons or about 25 per cent of economically recoverable hard coal.

EXPORTING COUNTRIES

The world production of hard coal in 1977 was about 2,465 million tons and some of the leading producers were U.S.A., U.S.S.R., China P.R., Poland, Australia and Canada. The international coal trade is limited to the higher quality hard coals, in view of the relatively high shipping rates

Appendix 3-2 (cont'd)

involved. In 1977, about 199 million tons of coal entered the world trade and the leading exporting countries included U.S.A., Poland, Australia, U.S.S.R. and Canada.

Australia is the world's third large exporter of hard coal and the second largest exporter of coking coal. In 1978, Australia exported 38 million tons of hard coal of which 33 million tons were coking coal. The country possesses 20 billion tons of economically mineable hard coal, of which about 50 per cent is believed to be coking coal. Australia's large bituminous coal deposits occur mainly in Queensland, from where coals with good coking properties can be obtained.

In U.S.A., the Appalachian coal belt is one of the world's largest and best known hard coal reserves. According to the U.S. Bureau of Mines, the reserve base of premium grade coking coals may amount to 40-50 billion tons, of which about 50 per cent are identified. U.S.A. is the world's largest hard coal producer and also exporter. Canada possesses adequate coal reserves and is a leading producer and exporter of hard coal.

QUALITY

Coking coals must meet certain physical and chemical requirements to be used in the manufacture of metallurgical coke. The proximate analysis of typical coking coals of Australia, Canada and U.S.A. is shown on the next page.

PROXIMATE ANALYSIS OF COKING COALS

Sources	Location	Inherent moisture %	V.M. %	F.C. %	Ash %	S %	Free swelling index
Australia							
Queensland - Low volatile	Bluff	1.4	15.6	74.1	8.9	1.0	6
- Med. volatile	Black water	2.0	23.0	67.0	8.0	6.4	6-7
- High volatile	Black water	2.1	27.0	63.0	8.5	0.5	5.5
- High volatile	Kianga	2.8	32.5	57.9	6.8	0.68	4
Canada							
Kaiser Resources Ltd	Balmer	1.5	19-22 (1)	-	9.5 (1) max	0.40 max	6-8
U.S.A.							
Pennsylvania - High volatile	Pittsburgh	1.1-3.7	32.3-36.4	-	4.8-10.8	0.7-3.2	
West Virginia - Blendable	Iaeger	6.0	26.0-27.5	-	7.0- 7.5	0.85	
Low volatile	Sewell	-	22.0	-	4.0	0.9	
Virginia - Classical met. coal	Pocahontas	1.9-5.3	15.5-21.8	-	2.3-6.0	0.3-0.8	
Kentucky - High volatile	Fireclay	3.6-7.3	33.8-40.0	-	5.0-11.0	0.6-2.4	

NOTE
(1) Air dried.

Appendix 3-2 (cont'd)

POSSIBLE SOURCES

Based on a review of the world coal situation, in respect of meeting the coking coal requirements of the ASEAN countries, Australia could be considered as a potential source, in view of the country's nearness and its export performance. However, traditional exporting countries like U.S.A. and Canada could also be considered as possible sources.

APPENDIX 4-1

BASIS FOR DETERMINING UNIT PRICES OF MAJOR MATERIALS AND ENERGY INPUTS

1. For locally available materials, the prices are based on data collected during the field study and information made available by some ASEAN countries.

2. For imported materials, prices are ex-port and no import duties have been considered.

3. Port charges have been assumed as US $ 5 per ton for all countries and business/sales tax have been taken as shown below:

		Business/sales tax (% on C & F value)
Thailand	..	7.7
Malaysia	..	4.0
Singapore	..	Nil
Indonesia	..	2.5
Philippines	..	10.0

4. Iron ore price (f.o.b.) calculated as follows:

   BF grade (63% Fe) at US $ 0.30 per Fe unit

   DR grade (65% Fe) at US $ 0.50 per Fe unit

5. Pellet price assumed at US $ 0.50 per Fe unit for f.o.b. supply. Fe content of pellet assumed as 66 per cent.

6. Price of zinc assumed at US $ 780 per ton f.o.b.

7. Metallurgical coal price assumed at US $ 48 per ton f.o.b.

8. Ocean freight for all countries assumed as follows:

Iron ore/pellet	..	US $ 10 per ton
Coal	..	US $ 13 per ton
Others	..	US $ 30 per ton

APPENDIX 5-1

PREVAILING DUTY RATES ON IMPORTED STEEL PRODUCTS

Item	Thailand %	Philippines %	Indonesia %
Rebars	20	50	30
Wire rod	2	30	20/25
HR sheet	2	10	5
CR sheet	2	30	5
Plates	2	10	5
GI sheet	75 (US $/t)	50	20/40
Tinplate	-	50	Nil
Pipes, black	-	50	10(above 100 mm dia) 40(below 100 mm dia)
Beams	2	30	5
Stainless steel sheet	15 (US $/t)	10	5
Bright bar (above 25 mm dia)	2	10	10

APPENDIX 5-2

PRICES OF SEMI-FINISHED PRODUCTS COLLECTED DURING FIELD INVESTIGATIONS
(US $ per ton C&F)

Product	Thailand	Malaysia	Singapore	Indonesia	Philippines
Billet	270	300	295	300	295
HR coil	320	322	310-350	-	341
CR coil	462	385	410	-	-

Source:

1. For billet prices:

Thailand	-	Thai India Steel Co Ltd, Bangkok
Malaysia	-	Amalgamated Steel Mills, Kuala Lumpur
Singapore	-	National Iron and Steel Mill Ltd, Singapore
Indonesia	-	P.T. Ispat Indo, Surabaya
Philippines	-	Philippine Blooming Mill, Rizal

2. For HR coil prices:

Thailand	-	Thai Asia Steel Pipe Co, Bangkok
Malaysia	-	Maruichi Malaysia Steel Tube, Kuala Lumpur
Singapore	-	Leong Huat Industries Ltd and The Malaysian Steel Pipes Co Ltd
Philippines	-	Pasig Steel Corporation, Manila

3. For CR coil prices:

Thailand	-	Sangkasi Thai Co Ltd, Bangkok
Malaysia	-	Federal Iron Works Bhd, Kuala Lumpur
Singapore	-	Leong Huat Industries Ltd

APPENDIX 5-3

ESTIMATED PRICES OF SEMI-FINISHED INPUT MATER

(US $ per ton)

Product		Thailand			Malaysia			Singapore	
		CIF price	Port charges & sales tax	Total	CIF price	Port charges & sales tax	Total	CIF price	Port charges & sales tax
Billet/bloom	..	295	25	320	295	15	310	295	5
Slab	..	240	20	260	240	15	255	240	5
HR coil	..	335	25	360	335	15	350	335	5
CR coil	..	410	35	445	410	20	430	410	5
Wire rod	..	385	30	415	385	20	405	385	5
Bars	..	365	30	395	365	20	385	365	5

NOTE

(1) Based on selling price of US $ 520 per ton as indicated by Metals Industry Research & Development Center, Manila which includes 30% customs duty. Input price calculated as US $ 400 (i.e. US $ 520/1.3).

SECTION 1

APPENDIX 5-3

... PRICES OF SEMI-FINISHED INPUT MATERIALS
(US $ per ton)

...laysia		Singapore			Indonesia			Philippines		
... charges ...les tax	Total	CIF price	Port charges & sales tax	Total	CIF price	Port charges & sales tax	Total	CIF price	Port charges & sales tax	Total
15	310	295	5	300	290	10	300	270	30	300
15	255	240	5	245	240	10	250	230	25	255
15	350	335	5	340	336	14	350	320	35	355
20	430	410	5	415	413	12	425	450	50	500
20	405	385	5	390	385	25	410			400 (1)
20	385	365	5	370	365	40	405	365	40	405

...ton as indicated by Metals Industry
...which includes 30% customs duty.
...i.e. US $ 520/1.3).

SECTION 2

APPENDIX 5-4

SELLING PRICES OF FINISHED PRODUCTS COLLECTED DURING FIELD INVESTIGATIONS
(US $ per ton)

Product	Thailand	Malaysia	Singapore	Indonesia	Philippines
Rebars	401	317	325	402	450-500
Wire rod	475	425	-	430-450	-
Bright bars	-	665	-	-	-
Structurals	-	-	-	426	-
HR coil/sheet	-	-	-	-	420-505
CR coil	-	-	-	-	572
Tinplate	700	-	-	-	-

Sources:

1. For rebars:

   Thailand - G.S. Steel Co Ltd, Bangkok
   Malaysia - Malayawata Steel Bhd. Penang
   Singapore - National Iron and Steel Co
   Indonesia - P.T. Krakatau Steel, Cilegon
   Philippines- National Steel Corporation, Iligan city

2. For wire rod:

   Thailand - Siam Iron and Steel Co Ltd, Saraburi
   Malaysia - Malayawata Steel Bhd, Penang
   Indonesia - P.T. Ispat Indo, Surabaya and P.T. Krakatau Steel, Cilegon

3. For bright bars:

   Malaysia - Bright Steel Pvt Ltd, Kuala Lumpur

4. For structurals:

   Indonesia - P.T. Krakatau Steel, Cilegon

5. For HR coil/sheet:

   Philippines- National Steel Corporation, Iligan city

6. For CR coil/sheet:

   Philippines- National Steel Corporation, Iligan city

7. For tinplate:

   Thailand - Thai Tinplate Mfg Co, Bangkok

APPENDIX 5-5

ESTIMATED SELLING PRICES OF FINISHED PRODUCTS
(US $ per ton)

Product	Thailand			Malaysia			Singapore		
	CIF price	Port charges	Total	CIF price	Port charges	Total	CIF price	Port charges	To[illegible]
Billet/bloom ..	295	5	300	295	5	300	295	5	3[illegible]
Slab ..	240	5	245	240	5	245	240	5	2[illegible]
Wire rod ..	385	5	390	385	5	390	385	5	3[illegible]
Bright bar ...	555	5	560	555	5	560	555	5	5[illegible]
GI wire ..	570	5	575	570	5	575	570	5	5[illegible]
Structurals ..	400	5	405	400	5	405	400	5	4[illegible]
HR sheet ..	355	5	360	355	5	360	355	5	3[illegible]
HR coil ..	335	5	340	335	5	340	335	5	3[illegible]
CR sheet ..	425	5	430	425	5	430	425	5	4[illegible]
CR coil ..	410	5	415	410	5	415	410	5	41[illegible]
Plates ..	365	5	370	365	5	370	365	5	37[illegible]
Tinplate ..				700 (1)		700 (1)			70[illegible]
Stainless steel sheet/ strip ..	2,085	5	2,090	2,085	5	2,090	2,085	5	2,09[illegible]
Seamless tubes ..	855	5	860	855	5	860	855	5	86[illegible]
Special steel bars/rods ..			620 (1)			620 (1)			6[illegible]

NOTES
(1) Assumed price.
(2) Selling price indicated by Departemen Perindustrian RI, Jakarta, less sales tax and impor
(3) Selling price indicated by Metals Industry Research & Development Centre, Manila, less sales tax and import duty.

SECTION 1

APPENDIX 5-5

ATED SELLING PRICES OF FINISHED PRODUCTS
(US $ per ton)

Malaysia		Singapore			Indonesia			Philippines		
Port charges	Total	CIF price	Port charges	Total	CIF price	Port charges	Total	CIF price	Port charges	Total
5	300	295	5	300	290	5	295	270	5	275
5	245	240	5	245	240	5	245	230	5	235
5	390	385	5	390	385	5	390			375(3)
5	560	555	5	560			565(2)	555	5	560
5	575	570	5	575	570	5	575	570	5	575
5	405	400	5	405			405(2)			450(3)
5	360	355	5	360			365(2)			390(3)
5	340	335	5	340	335	5	340	320	5	325
5	430	425	5	430			425(2)			495(3)
5	415	410	5	415	410	5	415	450	5	455
5	370	365	5	370			365(2)			390(3)
	700(1)			700(1)			700(1)			700(1)
5	2,090	2,085	5	2,090			2,315(2)	2,085	5	2,090
5	860	855	5	860	855	5	860	855	5	860
	620(1)			620(1)			620(1)			620(1)

ian RI, Jakarta, less sales tax and import duty.
arch & Development Centre, Manila,

SECTION 2

PRODUCTION COST ESTIMATES FOR DR-EF ROUTE

	Unit	Specific consumption Alt 1	Alt 2	Alt 3	Unit price US $	Thailand Cost per ton, US Alt. 1	Alt. 2	Al[illegible]
I. SPONGE IRON								
Iron ore pellets ..	ton	0.75	0.75	0.75	48.00	36.00	36.00	[illegible]
Sized iron ore ..	ton	0.75	0.75	0.75	36.00	27.00	27.00	[illegible]
Natural gas ..	Gcal	2.80	2.80	2.80	5.60	15.70	15.70	[illegible]
Sub-total ..						78.70	78.70	7[illegible]
Labour and supervision ..						1.05	0.40	[illegible]
Electric power ..	kWh	140	120	115	0.05	7.00	6.00	[illegible]
Other conversion costs ..						10.15	8.00	[illegible]
Sub-total ..						18.20	14.40	1[illegible]
TOTAL ..						96.90	93.10	9[illegible]
II. LIQUID STEEL								
Sponge iron ..	ton	0.888	0.888	0.888		86.05	82.65	8[illegible]
Purchased scrap ..	ton	0.17	0.17	0.17	115.00	19.55	19.55	[illegible]
Plant return scrap ..	kg	45	45	45	-	-	-	
Flux, ferro-alloys and additives ..						13.10	13.10	[illegible]
Sub-total ..						118.70	115.30	11[illegible]
Labour and supervision ..						1.10	0.70	[illegible]
Electric power ..	kWh	650	650	625	0.05	32.50	32.50	3[illegible]
Graphite electrode ..	kg	6.75	6.75	6.50	2.60	17.55	17.55	1[illegible]
Other conversion costs ..						10.60	10.20	[illegible]
Sub-total ..						61.75	60.95	5[illegible]
TOTAL ..						180.45	176.25	17[illegible]
III. CONTINUOUS CAST SEMIS								
Billets								
Liquid steel ..	ton	1.055	1.055	1.055		190.40	185.95	18[illegible]
Labour and supervision ..						0.60	0.50	[illegible]
Electric power ..	kWh	25	25	25		1.25	1.25	
Other conversion costs ..						7.50	6.65	[illegible]
TOTAL ..						199.75	194.35	18[illegible]
Fixed charges at 20% of capital cost ..						91.75	69.00	6[illegible]
		PRODUCTION COST			..	291.50	263.35	25[illegible]
				Say	..	292	263	2[illegible]
Slabs								
Liquid steel ..	ton	1.055	1.055	1.055		190.40	185.95	18[illegible]
Labour and supervision ..						0.45	0.35	[illegible]
Electric power ..	kWh	20	20	20		1.00	1.00	
Other conversion costs ..						9.50	8.05	[illegible]
TOTAL ..						201.35	195.35	18[illegible]
Fixed charges at 20% of capital cost ..						108.25	81.55	7[illegible]
		PRODUCTION COST			..	309.60	276.90	26[illegible]
				Say	..	310	277	2[illegible]

SECTION 1

COST ESTIMATES FOR LF-EF ROUTE

Thailand				Malaysia				Indonesia			
Unit price US $	Cost per ton, US $ Alt. 1	Alt. 2	Alt. 3	Unit price US $	Cost per ton, US $ Alt. 1	Alt. 2	Alt. 3	Unit price US $	Cost per ton, US $ Alt. 1	Alt. 2	Alt. 3
48.00	36.00	36.00	36.00	48.00	36.00	36.00	36.00	48.00	36.00	36.00	36.00
36.00	27.00	27.00	27.00	36.00	27.00	27.00	27.00	36.00	27.00	27.00	27.00
5.60	15.70	15.70	15.70	8.00	22.40	22.40	22.40	2.60	7.30	7.30	7.30
	78.70	78.70	78.70		85.40	85.40	85.40		70.30	70.30	70.30
	1.05	0.40	0.30		1.10	0.45	0.35		0.80	0.30	0.25
0.05	7.00	6.00	5.75	0.05	7.00	6.00	5.75	0.04	5.60	4.80	4.60
	10.15	8.00	7.70		10.20	8.05	7.35		9.90	7.90	7.65
	18.20	14.40	13.75		18.50	14.50	13.85		16.30	13.00	12.50
	96.90	93.10	92.45		103.70	99.90	99.25		86.60	83.30	82.80
	86.05	82.65	82.10		92.10	88.70	88.15		76.90	73.95	73.50
115.00	19.55	19.55	19.55	70.00	11.90	11.90	11.90	120.00	20.40	20.40	20.40
-	-	-	-	-	-	-	-	-	-	-	-
	13.10	13.10	13.10		12.85	12.85	12.85		12.40	12.40	12.40
	118.70	115.30	114.75		116.85	113.45	112.90		109.70	106.75	106.30
	1.10	0.70	0.50		1.10	0.75	0.50		0.85	0.55	0.40
0.05	32.50	32.50	31.25	0.05	32.50	32.50	31.25	0.04	26.00	26.00	25.00
2.60	17.55	17.55	16.90	2.50	16.90	16.90	16.25	3.56	24.05	24.05	23.15
	10.60	10.20	8.50		10.60	10.25	8.50		10.05	9.75	8.50
	61.75	60.95	57.15		61.10	60.40	56.50		60.95	60.35	56.70
	180.45	176.25	171.90		177.95	173.85	169.40		170.65	167.10	163.00
	190.40	185.95	181.35		187.75	183.40	178.70		180.05	176.30	171.95
	0.60	0.50	0.40		0.70	0.55	0.40		0.50	0.45	0.30
	1.25	1.25	1.25		1.25	1.25	1.25		1.00	1.00	1.00
	7.50	6.65	6.50		7.50	6.65	6.50		7.50	6.65	6.50
	199.75	194.35	189.50		197.20	191.85	186.85		189.05	184.40	179.75
	91.75	69.00	66.85		91.75	69.00	66.85		91.75	69.00	66.85
..	291.50	263.35	256.35		288.95	260.85	253.70		280.80	253.40	246.60
..	292	263	256		289	261	254		281	253	247
	190.40	185.95	181.35		187.75	183.40	178.70		180.05	176.30	171.95
	0.45	0.35	0.25		0.50	0.40	0.25		0.40	0.30	0.20
	1.00	1.00	1.00		1.00	1.00	1.00		0.80	0.80	0.80
	9.50	8.05	6.75		9.50	8.05	6.75		9.50	8.05	6.75
	201.35	195.35	189.35		198.75	192.85	186.70		190.75	185.45	179.70
	108.25	81.55	72.65		108.25	81.55	72.65		108.25	81.55	72.65
..	309.60	276.90	262.00		307.00	274.40	259.35		299.00	267.00	252.35
..	310	277	262		307	274	259		299	267	252

SECTION 2

PRODUCTION COST ESTIMATES FOR B

	Unit	Specific consumption	Thailand: Unit price US $	Thailand: Cost per ton, US $ Alt. 1	Alt. 2	Alt. 3	Malaysia: Unit price US $	Malaysia: Cost per ton, Alt. 1	Alt. 2
BF COKE									
Coal ..	ton	1.70	68.00	115.60	115.60	115.60	66.00	112.20	112.20
Labour and supervision ..				2.70	1.65	1.35		2.80	1.75
Other conversion costs ..				12.80	10.70	9.70		13.05	10.95
Cost of carbonisation ..				131.10	127.95	126.65		128.05	124.90
Gross cost of coke ..				104.90	102.35	101.30		102.45	99.90
Credit for small size coke..				10.20	10.00	9.85		10.00	9.75
Cost of coke ..				94.70	92.35	91.45		92.45	90.15
. HOT METAL									
Sized iron ore ..	ton	1.60	33.00	52.80	52.80	52.80	33.00	52.80	52.80
BF coke ..	ton	0.615		58.25	56.80	56.25		56.85	55.45
Mn ore ..	ton	0.035	36.00	1.25	1.25	1.25	35.00	1.25	1.25
Credit for gas and small size coke ..				9.65	9.65	9.65		13.50	13.50
Sub-total ..				102.65	101.20	100.65		97.40	96.05
Labour and supervision ..				0.85	0.55	0.40		0.85	0.60
Other conversion costs ..				15.80	14.85	13.60		17.60	16.70
Sub-total ..				16.65	15.40	14.00		18.45	17.30
TOTAL ..				119.30	116.60	114.65		115.85	113.35
I. LIQUID STEEL									
Hot metal ..	ton	1.00		119.30	116.60	114.65		115.85	113.35
Purchased scrap ..	ton	0.05	115.00	5.75	5.75	5.75	70.00	3.50	3.50
Plant return scrap ..	ton	0.045	-	-	-	-	-	-	-
Flux, ferro-alloys and additives ..				13.75	13.75	13.75		13.55	13.55
Sub-total ..				138.80	136.10	134.15		132.90	130.40
Labour and supervision ..				0.85	0.50	0.35		0.85	0.55
Other conversion costs ..				19.35	19.00	17.85		19.35	19.05
Sub-total ..				20.20	19.50	18.20		20.20	19.60
TOTAL ..				159.00	155.60	152.35		153.10	150.00
CONTINUOUS CAST SEMIS									
Billets									
Liquid steel ..	ton	1.055		167.75	164.15	160.70		161.50	158.25
Labour and supervision ..				0.45	0.40	0.30		0.45	0.40
Other conversion costs ..				9.00	8.45	7.80		9.00	8.45
TOTAL ..				177.20	173.00	168.80		170.95	167.10
Fixed charges at 20% of capital cost ..				110.50	87.35	72.65		110.50	87.35
	PRODUCTION COST		..	287.70	260.35	241.45		281.45	254.45
		Say	..	288	260	241		281	254
Slabs									
Liquid steel ..	ton	1.055		167.75	164.15	160.70		161.50	158.25
Labour and supervision ..				0.20	0.20	0.10		0.20	0.20
Other conversion costs ..				8.75	7.85	6.85		8.75	7.85
TOTAL ..				176.70	172.20	167.65		170.45	166.30
Fixed charges at 20% of capital cost ..				114.75	91.05	73.35		114.75	91.05
	PRODUCTION COST		..	291.45	263.25	241.00		285.20	257.35
		Say	..	291	263	241		285	257

SECTION 1

APPENDIX 6-2

...TION COST ESTIMATES FOR BF-BOF ROUTE

Malaysia				Indonesia				Philippines			
Unit price US $	Cost per ton, US $ Alt. 1	Alt. 2	Alt. 3	Unit price US $	Cost per ton, US $ Alt. 1	Alt. 2	Alt. 3	Unit price US $	Cost per ton, US $ Alt. 1	Alt. 2	Alt. 3
66.00	112.20	112.20	112.20	72.60	123.40	123.40	123.40	78.00	132.60	132.60	132.60
	2.80	1.75	1.40		2.10	1.30	1.05		1.85	1.15	0.95
	13.05	10.95	9.95		12.30	10.70	9.45		12.05	10.20	9.45
	128.05	124.90	123.55		137.80	135.40	133.90		146.50	143.95	143.00
	102.45	99.90	98.85		110.25	108.30	107.10		117.20	115.15	114.40
	10.00	9.75	9.65		10.75	10.55	10.45		11.40	11.20	11.15
	92.45	90.15	89.20		99.50	97.75	96.65		105.80	103.95	103.25
33.00	52.80	52.80	52.80	33.00	52.80	52.80	52.80	32.00	51.20	51.20	51.20
	56.85	55.45	54.85		61.20	60.10	59.45		65.05	63.90	63.50
35.00	1.25	1.25	1.25	33.00	1.15	1.15	1.15	34.00	1.20	1.20	1.20
	13.50	13.50	13.50		4.90	4.90	4.90		36.00	36.00	36.00
	97.40	96.05	95.45		110.25	109.15	108.50		81.45	80.30	79.90
	0.85	0.60	0.40		0.65	0.45	0.30		0.60	0.40	0.30
	17.60	16.70	15.40		12.35	11.50	10.35		29.45	28.60	27.25
	18.45	17.30	15.80		13.00	11.95	10.65		30.05	29.00	27.55
	115.85	113.35	111.25		123.25	121.10	119.15		111.50	109.30	107.45
	115.85	113.35	111.25		123.25	121.10	119.15		111.50	109.30	107.45
70.00	3.50	3.50	3.50	120.00	6.00	6.00	6.00	95.00	4.75	4.75	4.75
-	-	-	-	-	-	-	-	-	-	-	-
	13.55	13.55	13.55		13.10	13.10	13.10		14.95	14.95	14.95
	132.90	130.40	128.30		142.35	140.20	138.25		131.20	129.00	127.15
	0.85	0.55	0.35		0.65	0.40	0.30		0.60	0.35	0.25
	19.35	19.05	17.85		18.55	18.30	17.25		20.75	20.50	19.20
	20.20	19.60	18.20		19.20	18.70	17.55		21.35	20.85	19.45
	153.10	150.00	146.50		161.55	158.90	155.80		152.55	149.85	146.60
	161.50	158.25	154.55		170.45	167.65	164.35		160.95	158.10	154.65
	0.45	0.40	0.35		0.35	0.30	0.20		0.30	0.25	0.20
	9.00	8.45	7.80		8.75	8.20	7.55		9.40	8.45	7.80
	170.95	167.10	162.70		179.55	176.15	172.10		170.65	166.80	162.65
	110.50	87.35	72.65		110.50	87.35	72.65		110.50	87.35	72.65
	281.45	254.45	235.35		290.05	263.50	244.75		281.15	254.15	235.30
	281	254	235		290	264	245		281	254	235
	161.50	158.25	154.55		170.45	167.65	164.35		160.95	158.10	154.65
	0.20	0.20	0.10		0.15	0.15	0.10		0.15	0.15	0.10
	8.75	7.85	6.85		8.55	7.65	6.65		9.05	8.15	7.15
	170.45	166.30	161.50		179.15	175.45	171.10		170.15	166.40	161.90
	114.75	91.05	73.35		114.75	91.05	73.35		114.75	91.05	73.35
	285.20	257.35	234.85		293.90	266.50	244.45		284.90	257.45	235.25
	285	257	235		294	267	244		285	257	235

SECTION 2

APPENDIX 8-1

TYPICAL LIST OF MAJOR PRODUCTION FACILITIES FOR BILLET PLANT

Equipment/Facilities

Mobile crane with magnet for handling scrap

Scrap preparation facilities for cutting/shearing, weighing etc.

Transport/handling equipment including forklift trucks, tractor-trailers etc.

Arc furnace complete with transformer, electricals, fume extraction system, spare roof ring etc.

Continuous billet casting machine complete with billet cut-off equipment, cooling bed, tundish, tundish preheaters etc.

Scrap charging buckets

Steel ladles

Slag pots

Storage and handling facilities for flux, ferro-alloys and additives

Transfer cars for scrap bucket, tundish etc

Arc furnace roof relining facilities

Arc furnace shell relining and fettling equipment

Tundish relining facilities

Ladle preparation facilities

ESTIMATED PRODUCTION COST FOR BILLETS EXCLUDI

(US $ per ton)

		Thailand				Malaysia				Singapore	
		Alt. 1	Alt. 2	Alt. 3	Alt. 4	Alt. 1	Alt. 2	Alt. 3	Alt. 4	Alt. 1	Alt. 2
Materials											
Imported scrap	..	82.95	82.95	82.95	82.95	77.40	77.40	77.40	77.40	88.50	88.50
Domestic scrap	..	63.60	63.60	63.60	63.60	38.70	38.70	38.70	38.70	47.00	47.00
Plant return scrap	..	-	-	-	-	-	-	-	-	-	-
Limestone	..	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.35	0.35
Ferro-alloys and additives	..	11.85	11.85	11.85	11.85	11.55	11.55	11.55	11.55	11.20	11.20
Sub-total	..	158.60	158.60	158.60	158.60	127.85	127.85	127.85	127.85	147.05	147.05
Other Items											
Labour & supervision	..	12.30	8.10	2.75	1.90	12.85	8.40	2.90	2.00	23.05	15.10
Electric power	..	37.50	36.25	35.00	35.00	37.50	36.25	35.00	35.00	41.25	39.90
Graphite electrode	..	18.20	17.55	16.90	16.90	15.75	15.20	14.60	14.60	16.80	16.20
Water & other utilities, refractories, general plant expenses etc	..	22.00	17.50	12.50	11.50	22.50	18.00	12.50	11.50	32.50	24.50
Moulds, lubricants etc		2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50
Repair & maintenance	..	5.90	5.25	3.75	3.15	5.90	5.25	3.75	3.15	5.90	5.25
Sub-total	..	98.40	87.15	73.40	70.95	97.00	85.60	71.25	68.75	122.00	103.45
Administration and Sales Expenses	..	8.00	7.00	7.00	7.00	7.00	6.00	6.00	6.00	8.00	8.00
PRODUCTION COST (excluding fixed charges)	..	265.00	252.75	239.00	236.55	231.85	219.45	205.10	202.60	277.05	258.50
Say	..	265	253	239	237	232	219	205	203	277	259

M. N. DASTUR & COMPANY (P) LTD
CALCUTTA

SECTION 1

... COST FOR FILLETS EXCLUDING FIXED CHARGES
(US $ per ton)

		Singapore				Indonesia				Philippines			
. 3	Alt. 4	Alt. 1	Alt. 2	Alt. 3	Alt. 4	Alt. 1	Alt. 2	Alt. 3	Alt. 4	Alt. 1	Alt. 2	Alt. 3	Alt. 4
.40	77.40	88.50	88.50	88.50	88.50	77.40	77.40	77.40	77.40	83.50	83.50	83.50	83.50
.70	3[illegible].70	47.00	47.00	47.00	47.00	66.35	66.35	66.35	66.35	52.55	52.55	52.55	52.55
	-	-	-	-	-	-	-	-	-	-	-	-	-
.20	.20	0.35	0.35	0.35	0.35	0.20	0.20	0.20	0.20	0.35	0.35	0.35	0.35
.55	11.55	11.20	11.20	11.20	11.20	11.10	11.10	11.10	11.10	12.55	12.55	12.55	12.55
.05	12[illegible].05	147.05	147.05	147.05	147.05	155.05	155.05	155.05	155.05	148.95	148.95	148.95	148.95
.90	2.00	23.05	15.10	5.15	3.55	9.65	6.30	2.15	1.50	8.60	5.60	1.90	1.30
.00	35.00	41.25	39.90	38.50	38.50	30.00	29.00	28.00	28.00	49.50	47.85	46.20	46.20
.60	14.60	16.80	16.20	15.60	15.60	24.95	24.05	23.15	23.15	19.95	19.25	18.50	18.50
.50	11.50	32.50	24.50	14.50	13.00	18.70	15.70	11.20	11.00	19.50	16.50	13.00	12.50
.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50
.75	3.15	5.90	5.25	3.75	3.15	5.90	5.25	3.75	3.15	5.90	5.25	3.75	3.15
.25	6[illegible].75	122.00	103.45	80.00	76.30	91.70	82.80	70.75	69.30	105.95	96.95	85.85	84.15
.00	6.00	8.00	8.00	7.00	7.00	7.00	7.00	7.00	7.00	8.00	7.00	7.00	7.00
.10	202.60	277.05	258.50	234.05	230.35	253.75	244.85	232.80	231.35	262.90	252.90	241.80	240.10
5	203	277	259	234	230	254	245	233	231	263	253	242	240

SECTION 2

APPENDIX 9-1

TYPICAL LIST OF MAJOR PRODUCTION FACILITIES FOR WIRE ROD MILL

Equipment/Facilities

Reheating furnace complete with billet pusher, blowers, recuperators etc and furnace charging and discharging equipment

Mill equipment

- 2-high horizontal stands of continuous 1st roughing
- 2-high horizontal stands of continuous 2nd roughing
- 2-high horizontal stands of first intermediate train
- 2-high alternate horizontal and vertical stands of second intermediate train
- 10-stand no-twist finishing block
- Cooling equipment, pinch roll, coil laying head etc
- Coil handling system

ESTIMATED PRODUCTION COST FOR WIRE ROD EXCLUDING
(US $ per ton)

	Thailand			Malaysia			Si
	Alt. 1	Alt. 2	Alt. 3	Alt. 1	Alt. 2	Alt. 3	Alt. 1
Materials							
Billets ..	339.20	339.20	339.20	328.60	328.60	328.60	318.00
Credit for scrap ..	(-)5.75	(-)5.75	(-)5.75	(-)3.50	(-)3.50	(-)3.50	(-)4.25
Sub-total ..	333.45	333.45	333.45	325.10	325.10	325.10	313.75
Other Items							
Labour & supervision ..	3.30	1.85	1.35	3.45	1.90	1.40	6.20
Electric power ..	7.50	7.50	7.50	7.50	7.50	7.50	8.25
Rolls, guides, water, consumables and general plant expenses ..	9.85	9.75	8.50	9.85	9.75	9.40	9.85
Fuel ..	2.55	2.55	2.55	3.60	3.60	3.60	12.40
Repair and maintenance ..	3.10	3.00	2.55	3.10	3.00	2.55	3.10
Sub-total ..	26.30	24.65	22.45	27.50	25.75	24.45	39.80
Administration and Sales Expenses ..	10.00	8.00	8.00	10.00	8.00	8.00	10.00
PRODUCTION COST (excluding fixed charges) ..	369.75	366.10	363.90	362.60	358.85	357.55	363.55
Say ..	370	366	364	363	359	358	364

SECTION 1

COST FOR WIRE ROD EXCLUDING FIELD CHARGES
(US$ per ton)

Malaysia		Singapore			Indonesia			Philippines		
lt. 2	Alt. 3	Alt. 1	Alt. 2	Alt. 3	Alt. 1	Alt. 2	Alt. 3	Alt. 1	Alt. 2	Alt. 3
328.60	328.60	318.00	318.00	318.00	318.00	318.00	318.00	318.00	318.00	318.00
(-)3.50	(-)3.50	(-)4.25	(-)4.25	(-)4.25	(-)6.00	(-)6.00	(-)6.00	(-)4.75	(-)4.75	(-)4.75
325.10	325.10	313.75	313.75	313.75	312.00	312.00	312.00	313.25	313.25	313.25
1.90	1.40	6.20	3.45	2.50	2.60	1.45	1.05	2.30	1.30	0.95
7.50	7.50	8.25	8.25	8.25	6.00	6.00	6.00	9.90	9.90	9.90
9.75	9.40	9.85	9.75	8.50	9.85	9.75	8.50	9.85	9.75	8.50
3.60	3.60	12.40	12.40	12.40	1.15	1.15	1.15	9.90	9.90	9.90
3.00	2.55	3.10	3.00	2.55	3.10	3.00	2.55	3.10	3.00	2.55
25.75	24.45	39.80	36.85	34.20	22.70	21.35	20.25	35.05	33.85	31.80
8.00	8.00	10.00	8.00	8.00	10.00	8.00	8.00	10.00	8.00	8.00
358.85	357.55	363.55	358.60	355.95	344.70	341.35	340.25	358.30	355.10	353.05
359	358	364	359	356	345	341	340	358	355	353

SECTION 2

APPENDIX 10-1

TYPICAL LIST OF MAJOR PRODUCTION FACILITIES FOR STRUCTURAL SHAPE MILL

Equipment/Facilities

Reheating furnace complete with pusher, blowers, recuperators etc and furnace charging and discharging equipment

Mill equipment

- 2-high horizontal and vertical stands of continuous roughing group of stands
- 2-high horizontal and vertical stands of continuous intermediate group of stands
- 2-high horizontal and vertical stands of continuous finishing group of stands
- Interstand loopers for the intermediate and finishing group of stands
- Pendulum shear before the first stand of roughing group
- Crop and cobble shears after roughing and intermediate stands
- Dividing shear after the finishing group of stands
- Finishing facilities comprising cooling beds, straightening machines, cold saws etc
- Scrap removal facilities
- EOT cranes

APPENDIX [illegible]

ESTIMATED PRODUCTION COST FOR STRUCTURALS EXCLUDI

(US $ per ton)

	Thailand			Malaysia			Sing
	Alt. 1	Alt. 2	Alt. 3	Alt. 1	Alt. 2	Alt. 3	Alt. 1
Materials							
Billet/bloom ..	355.20	355.20	355.20	344.10	344.10	344.10	330.00
Credit for scrap ..	(-)10.35	(-)10.35	(-)10.35	(-)6.30	(-)6.30	(-)6.30	(-)7.65
Sub-total ..	344.85	344.85	344.85	337.80	337.80	337.80	322.35
Other Items							
Labour and supervision ..	4.95	1.50	1.10	5.20	1.60	1.15	9.30
Electric power ..	5.00	5.00	5.00	5.00	5.00	5.00	5.50
Fuel and other utilities ..	2.50	2.50	2.50	3.60	3.60	3.60	12.35
Rolls, guides, refractories, general plant expenses, etc ..	7.70	6.85	6.25	7.70	6.85	6.25	7.70
Repair and maintenance ..	5.25	4.10	3.35	5.25	4.10	3.35	5.25
Sub-total ..	25.40	19.95	18.20	26.75	21.15	19.35	40.10
Administration and Sales Expenses	10.00	8.00	8.00	10.00	8.00	8.00	10.00
PRODUCTION COST (excluding fixed charges) ..	380.25	372.80	371.05	374.55	366.95	365.15	372.45
Say ..	380	373	371	375	367	365	372

SECTION 1

[illegible] FOR [illegible]ALS EXCLUDING FIXED CHARGES
(US $ per ton)

Malaysia			Singapore			Indonesia			Philippines		
1	Alt. 2	Alt. 3	Alt. 1	Alt. 2	Alt. 3	Alt. 1	Alt. 2	Alt. 3	Alt. 1	Alt. 2	Alt. 3
.10	344.10	344.10	330.00	330.00	330.00	330.00	330.00	330.00	330.00	330.00	330.00
.30	(-)6.30	(-)6.30	(-)7.65	(-)7.65	(-)7.65	(-)10.80	(-)10.80	(-)10.80	(-)8.55	(-)8.55	(-)8.55
.80	337.80	337.80	322.35	322.35	322.35	319.20	319.20	319.20	321.45	321.45	321.45
.20	1.60	1.15	9.30	2.85	2.05	3.90	1.20	0.85	3.45	1.05	0.75
.00	5.00	5.00	5.50	5.50	5.50	4.00	4.00	4.00	6.60	6.60	6.60
.60	3.60	3.60	12.35	12.35	12.35	1.15	1.15	1.15	9.90	9.90	9.90
.70	6.85	6.25	7.70	6.85	6.25	7.70	6.85	6.25	7.70	6.85	6.25
.25	4.10	3.35	5.25	4.10	3.35	5.25	4.10	3.35	5.25	4.10	3.35
6.75	21.15	19.35	40.10	31.65	29.50	22.00	17.30	15.60	32.90	28.50	26.85
0.00	8.00	8.00	10.00	8.00	8.00	11.00	9.00	9.00	14.00	12.00	12.00
.55	366.95	365.15	372.45	362.00	359.85	352.00	345.50	343.80	368.35	361.95	360.30
5	367	365	372	362	360	352	346	344	368	362	360

SECTION 2

APPENDIX 11-1

TYPICAL LIST OF MAJOR PRODUCTION FACILITIES FOR BRIGHT BAR PLANT

Equipment/Facilities

Bar preparation

- Black bar shearing machine
- Pickling tank
- Rinsing tank
- Lime tank
- Pickling cradle
- Rinsing cradle
- Lime cradle
- Steam boiler

Drawing and finishing

- End pointing machine
- Cold draw bench
- Straightening-cum-polishing machine
- Bright bar shearing machine
- Cold saw
- Automatic drawing line

APPENDIX 11-2

ESTIMATES OF PRODUCTION COST FOR BRIGHT BARS
(US $/per ton)

		Thailand	Malaysia	Singapore	Indonesia	Philippines
Materials						
Hot rolled black bars/ wire rod coil(1)	..	419.9	409.4	393.7	406.8	424.0
Less: Credit for scrap	..	(-) 4.6	(-) 2.8	(-) 3.4	(-) 4.8	(-) 3.8
Sub-total	..	415.3	406.6	390.3	402.0	420.2
Other Items						
Labour & supervision	..	13.8	14.4	25.8	10.8	9.6
Electric power	..	4.0	4.0	4.4	3.2	5.3
Water & other utilities, consumables and general plant expenses	..	17.0	19.1	23.0	13.8	20.8
Repair and maintenance	..	2.9	2.9	2.9	2.9	2.9
Sub-total	..	37.7	40.4	56.1	30.7	38.6
Administration & Sales Expenses		17.0	17.0	17.0	18.0	19.0
PRODUCTION COST (Excluding fixed charges)	..	470.0	464.0	463.4	450.7	477.8
	Say	470.0	464.0	463.0	451.0	478.0

NOTE
(1) Weighted average cost of input material on the basis of the product-mix considered.

APPENDIX 12-1

REVIEW OF AVAILABLE TECHNOLOGIES FOR SEAMLESS TUBE PRODUCTION

Seamless tube is generally made by piercing hot billets/ bloom into a hollow shell, elongating it into a thick wall cylinder, forging the cylinder to a rough tube on a mandrel and finally making the finished tube by hot sizing or reducing. The tubes thus made are used as 'mother' tubes for further reduction in hot or cold reducing mills. The finishing facilities of heat treatment, tube end finishing etc are more or less similar for the various tube making processes.

The processes which could be considered for production of seamless tubes are:

i) Continuous mandrel mill process
ii) Plug mill process
iii) Pilger mill process
iv) Assel mill process
v) Push bench process
vi) Diescher process
vii) Extrusion process

These processes are briefly reviewed below.

CONTINUOUS MANDREL MILL PROCESS

The continuous mandrel mill has generally 8 or 9 stands arranged in tandem. Rolled round bars are used as the feed-stock after piercing these to hollow shells. The hollow shells

Appendix 12-1 (cont'd)

are rolled on a long floating lubricated mandrel. The rolled tubes leave the mill with the mandrel inside them and the mandrel is extracted by a stripper at another station.

Mandrel mills are high production units of the order of 150,000 to 250,000 tons per year in the diameter range from 25 mm to 150 mm, with wall thickness from 2.5 mm to 15 mm and a wall-to-outside diameter ratio of 0.10 to 0.12. Rough rolled tube lengths vary between 18 m and 22 m with a coefficient of elongation of 5 to 7.5.

The process is suitable for thin and medium wall tubes due to the unstable and unsymmetric deforming operation. With this process, a large number of expensive rolls in different sizes and costly alloy steel long mandrels have to be maintained.

PLUG MILL PROCESS

Rolled round bloom is used as the feed material in this process. The blooms are fed to the plug mill after reheating and piercing to a hollow shell. The plug mill consists of a non-reversing 2-high stand through which the shell is rolled in a round pass over a stationary plug located in the centre of the pass and held by a long mandrel bar. Tubes are generally rolled in two passes. After each pass, the tube is returned to the entry side of the plug mill by the stripper rolls. The resultant tubes have frequently score marks in the bores which need to be finished on a reeling machine over a mandrel for inside and outside smoothness of the surface. Due to slow reeling operation, generally 2 reelers are employed per plug mill. The relatively short length of tubes with

Appendix 12-1 (cont'd)

inside score marks, which are more apparent with higher diameter reductions, prevent these tubes from further reductions to smaller sizes in a stretch reducing mill without considerable losses on account of the inside defects. The elongation ratio achievable in the plug mill varies from 1.5 to 2.1.

It is generally used for producing tubes from 60 to 400 mm outside diameter and wall thickness range of 3 mm to 40 mm. Tube lengths vary from 12 m to 16 m. Depending upon the size range of tube required, the production could be 250,000 to 300,000 tons per year.

PILGER MILL PROCESS

This process is most flexible and could almost be called a universal process, ideally suited for manufacturing in small batches a wide range of wall thicknesses, diameters, lengths and qualities of materials. Rounds or square billets can be employed as the feed stock.

The pilger mill is a heavy 2-roll mill. The rolls constantly rotate counter to the direction of the feed stock and form a pass of varying cross section. The hot pierced and elongated hollow or shell is held on a short lubricated mandrel bar supported by a hydraulic feeding carriage which feeds it to the pilger mill. When the cross section of the rolls form a pass of maximum size, a part length of the shell is fed forward by the carriage and this part is rolled as a tube during the remaining part of the revolution of the rolls. This operation is repeated till the shell has been "rotary forged" for its full length leaving a small 'bell end' at the tail end of shell through which the mandrel is extracted and the end cut by hot saw.

Appendix 12-1 (cont'd)

Pilger mills are generally used for the manufacture of seamless tubes having outside diameter of 50 to 700 mm and wall thickness of 3 to 100 mm with a ratio of 0.18 to 0.25 (with special roll groove) of wall thickness to outside diameter for heavy wall tubes. Upto 30 m long tubes can be rolled with normal wall thickness. Coefficient of elongation as high as 8 to 15 has been obtained on the pilger stand. To cover the above size range, various sizes of pilger mills are used. Depending upon the size range of tube required, the production with two pilger stands can vary from 40,000 to 180,000 tons per year. Cast ingots or semis can be employed for the production of seamless tubes by this process.

ASSEL MILL PROCESS

Rolled rounds are used as feed stock for the production of tubes on Assel mill. Blooms after reheating and piercing to a hollow shell are inserted in the Assel mill with a free floating mandrel inside. This mill has 3 rolls located at 120^{o} to their axes and are tapered having a hump which affects the major deformation of the shell wall. The rolled tube together with the mandrel is delivered to the stripper for withdrawing the mandrel bar. The coefficient of elongation in the Assel mill is achievable from 1.7 to 3.3.

This process is used for the production of heavy wall tubes with close tolerance in diameter and wall thickness particularly suitable for the production of ball and roller bearings. These mills are generally used for the manufacture of seamless tubes from 50 to 240 mm outside diameter and wall thickness ratios generally limited from 12:1 to 4:1. To cover

Appendix 12-1 (cont'd)

the above size range various sizes of Assel mills are employed. The production rates vary between 30,000 and 120,000 tons per year. The main drawback of the mill is that the lighter wall tubes tend to flow into the roll shoulders leading to triangulation and greater difficulty of mandrel extraction.

PUSH BENCH PROCESS

Rolled/continuously cast square blooms are used as feed stock for the production of seamless tubes by this process. Blooms are reheated, sized and pierced to a round bottle which is further elongated to a shell with a closed end. A mandrel is inserted into the shell and it is forced through a series of grooved or circular dies of diminishing sizes which swage the bottle along with mandrel until it emerges as a tube. In each set of roller dies, the pass is formed by three rolls arranged at 120°. The tube from the push bench along with the mandrel is further cross-rolled in a reeler where the mandrel is loosened and extracted by a pull out device.

Push bench followed by a stretch reducing mill is normally used for the manufacture of tubes in the size range of 16 mm to 168 mm with wall thickness varying from 2.5 mm to 12.5 mm. An elongation ratio of 3 to 14 is achievable and the tube lengths generally vary from 12 m to 14 m. The main limitation of the process is that it cannot be used for thick wall tubes and for longer lengths. This process is mostly used to produce "mother" tubes to be further heated and stretch reduced or cold worked on cold draw benches or cold pilger mills. Due to these limitations the yield is less as compared to other processes.

Appendix 12-1 (cont'd)

DIESCHER PROCESS

Round blooms are used after reheating and piercing to a hollow shell. This shell is cross rolled over a mandrel in a Diescher mill with supporting and driven top and bottom roll guides. The wall thickness reduction and elongation is achieved by two main rolls skewed at about 6° angle.

The Diescher mill followed by a stretch reducing mill is used for production of tubes in diameters ranging from 16 mm to 140 mm with wall thickness ratios from 4:1 to 30:1.

The major drawback of the Diescher mill is the short length of rolled tubes and the metal pick up on the revolving roll guides, resulting in poor surface of the rolled tubes. Another disadvantage lies in use of only rolled rounds because of lower elongation.

EXTRUSION PROCESS

Originally used for the manufacture of non-ferrous tubing, this process is being used for the manufacture of seamless steel tubes by hydraulic or mechanical extrusion presses. Certain existing extrusion presses produce plain carbon steel tubes but due to heavy cost of glass lubrication and high cost of tool wear and consumption, the extrusion process is better suited to the production of high alloy and extra heavy carbon steel tubes which can better support the higher conversion costs.

Appendix 12-1 (cont'd)

Both square and round blooms are used as feed material. In some cases the blooms are machined round and drilled with a central hole. Blooms after reheating and sizing (in case of square blooms) are lubricated with glass. Generally these are pierced/expanded in a vertical piercing/expanding press into a shell with larger bore. The shell is again reheated and glass lubricated both inside and outside and inserted into the container of an extrusion press where the tube is extruded over a mandrel through a properly supported die of appropriate cross section. The last thick portion of the tube is cut off as a discard by a hot saw located adjacent to the extrusion press. The tube is then deglassed with hydrofloric acid.

Some plants producing plain carbon steel standard tubes using graphite lubrication, combine pre-piercing and extrusion in one station, the billet having been descaled in a 2-high mill before bringing it to the extrusion press.

With hydraulic extrusion press followed by stretch reducing mills, tubes from 16 mm to 250 mm outside diameter can be produced having a wall thickness varying between 2.5 mm and 40 mm. By mechanical extrusion process followed by stretch reducing mills, tubes are generally produced from 16 mm to 102 mm outside diameter and wall thickness range from 2.5 mm to 12.5 mm.

Appendix 12-1 (cont'd)

TUBE MAKING PROCESSES UNDER DEVELOPMENT

Besides the established seamless tube making processes as described above, new processes like multi-stand pipe mill and multi-stand plug mill are also being developed.

In the multi-stand pipe mill, square/round blooms after reheating and sizing (in case of square blooms) are pierced into a hollow shell which is fed to a multi-stand continuous pipe mill. In this case also the mandrel is allowed to float but it is fed at a slower rate so that with a short length mandrel, a long tube can be produced. Such plants when commercially established will have high production capacities in the size range of about 100 mm to 350 mm outside diameter of tube.

In the multi-stand plug mill, round blooms after piercing are fed to a 3-stand plug mill which rolls the shell over a mandrel long enough to cover the distance between the stands. Here also the floating mandrel is fed at a slower rate while the tube is rolled at a faster rate such that longer length tube is produced over a mandrel of comparative shorter length. Such plants when commercially established, will also have high production capacities.

APPENDIX 12-2

TYPICAL LIST OF MAJOR PRODUCTION FACILITIES FOR SEAMLESS TUBE PLANT

Equipment/Facilities

- Oxy acetylene gas cutting bench
- Rotary hearth furnace
- Squeezer
- Horizontal piercing press
- Bottle holding furnace
- Elongator
- Pilger mills
- Hot saws
- Reheating furnace
- Sizing mill
- Stretch reducing mill and hot saws
- Cooling tables
- Rotary straighteners
- Cutting and levelling machines
- Magnetic particle inspection unit
- Hydrostatic pressure testers
- Threading and socketing machines
- Cold saws for cutting tubes
- Oiling units
- Packing and bundling units
- Socket making equipment
- Nozzling machines
- Pickling, rinsing and phosphating facilities
- Cold draw benches
- Normalising furnaces

ESTIMATED PRODUCTION COST FOR SEAMLESS TUBE
(US $ per ton)

		Thailand			Malaysia			Singapo[re]	
		Alt. 1	Alt. 2	Alt. 3	Alt. 1	Alt. 2	Alt. 3	Alt. 1	Alt. [2]
Materials									
Bloom	..	457.60	457.60	425.60	443.30	443.30	412.30	429.00	429.0
Credit for scrap	..	(-)27.60	(-)27.60	(-)23.00	(-)16.80	(-)16.80	(-)14.00	(-)20.40	(-)20.4
Sub-total	..	430.00	430.00	402.60	426.50	426.50	398.30	408.60	408.6
Other Items									
Labour and supervision	..	47.45	32.55	28.50	49.55	34.00	29.75	88.75	60.
Electric power	..	20.00	20.00	25.00	20.00	20.00	25.00	22.00	22.
Fuel	..	18.75	18.75	18.75	22.50	22.50	22.50	34.35	34.
Water and other utilities, consumables, general plant expenses, etc	..	18.85	15.15	14.10	19.40	15.50	14.45	29.20	22.2
Repair and maintenance	..	35.65	26.40	25.55	35.65	26.40	25.55	35.65	26.4
Sub-total	..	140.70	112.85	111.90	147.10	118.40	117.25	209.95	165.8
Administration and Sales Expenses	..	16.00	15.00	14.00	16.00	15.00	14.00	17.00	16.0
PRODUCTION COST (excluding fixed charges)	..	586.70	557.85	528.50	589.60	559.90	529.55	635.55	590.4
Say	..	587	558	529	590	560	530	636	590

SECTION 1

APPENDIX 12-3

...DUCTION COST FOR SEAMLESS TUBE
(US $ per ton)

Malaysia		Singapore			Indonesia			Philippines		
Alt. 2	Alt. 3	Alt. 1	Alt. 2	Alt. 3	Alt. 1	Alt. 2	Alt. 3	Alt. 1	Alt. 2	Alt. 3
443.30	412.30	429.00	429.00	399.00	429.00	429.00	399.00	429.00	429.00	399.00
(-)16.80	(-)14.00	(-)20.40	(-)20.40	(-)17.00	(-)28.80	(-)28.80	(-)24.00	(-)22.80	(-)22.80	(-)19.00
426.50	398.30	408.60	408.60	382.00	400.20	400.20	375.00	406.20	406.20	380.00
34.00	29.75	88.75	60.90	53.25	37.15	25.50	22.30	33.00	22.65	19.80
20.00	25.00	22.00	22.00	27.50	16.00	16.00	20.00	26.40	26.40	33.00
22.50	22.50	34.35	34.35	34.35	8.40	8.40	8.40	27.50	27.50	27.50
15.50	14.45	29.20	22.20	20.30	16.30	13.40	12.60	15.25	12.65	11.95
26.40	25.55	35.65	26.40	25.55	35.65	26.40	25.55	35.65	26.40	25.55
118.40	117.25	209.95	165.85	160.95	113.50	89.70	88.85	137.80	115.60	117.80
15.00	14.00	17.00	16.00	15.00	15.00	14.00	13.00	15.00	14.00	14.00
559.90	529.55	635.55	590.45	557.95	528.70	503.90	476.85	559.00	535.80	511.80
560	530	636	590	558	529	504	477	559	536	512

SECTION 2

APPENDIX 13-1

TYPICAL LIST OF MAJOR PRODUCTION FACILITIES FOR GI WIRE PLANT

Equipment/Facilities

Heat treatment and pickling

- Batch type annealing furnace
- Batch type pickling unit

Wire drawing

- 600 mm single block machine complete with electrics, piping and controls
- 400 mm single block machine complete with electrics, piping and controls
- 600 mm 5-block continuous machine complete with electrics, piping and controls
- 400 mm 7-block continuous machine complete with electrics, piping and controls

Galvanising

- 32 strand continuous hot dip galvanising line

APPENDIX 13-2

ESTIMATED PRODUCTION COST FOR G.I. WIRE EXCLUDING FIXE
(US $ per ton)

		Thailand			Malaysia			Singap	
		Alt. 1	Alt. 2	Alt. 3	Alt. 1	Alt. 2	Alt. 3	Alt. 1	Alt.
Materials									
Wire rods	..	435.80	435.80	435.80	425.30	425.30	425.30	409.50	409.
Zinc	..	30.10	30.10	30.10	29.00	29.00	29.00	28.00	28.
Credit for scrap	..	(-)4.8	(-)4.8	(-)4.8	(-)2.8	(-)2.8	(-)2.8	(-)3.4	(-)
Sub-total	..	461.10	461.10	461.10	451.50	451.50	451.50	434.10	434.
Other Items									
Labour and supervision	..	26.30	18.00	15.10	27.60	18.70	15.90	49.30	33.
Electric power	..	4.00	4.00	4.00	4.00	4.00	4.00	4.40	4.
Fuel	..	2.80	2.80	2.80	3.80	3.80	3.80	13.50	13.
Repair and maintenance	..	4.70	3.90	3.40	4.70	3.90	3.40	4.70	3.
Consumables and general plant expenses	..	10.70	9.80	9.60	10.70	9.80	9.60	10.70	9.
Sub-total	..	48.50	38.50	34.90	50.80	40.20	36.70	82.60	65.
Administration and Sales Expenses	..	13.00	13.00	13.00	13.00	13.00	13.00	13.00	13.
PRODUCTION COST (excluding fixed charges)	..	522.60	512.60	509.00	515.30	504.70	501.20	529.70	512.
Say	..	523	513	509	515	505	501	530	51

SECTION 1

APPENDIX 13-2

…CTION COST FOR G.I. WIRE EXCLUDING FIXED CHARGES
(US $ per ton)

Malaysia			Singapore			Indonesia			Philippines		
Alt. 1	Alt. 2	Alt. 3	Alt. 1	Alt. 2	Alt. 3	Alt. 1	Alt. 2	Alt. 3	Alt. 1	Alt. 2	Alt. 3
425.30	425.30	425.30	409.50	409.50	409.50	430.50	430.50	430.50	420.00	420.00	420.00
29.00	29.00	29.00	28.00	28.00	28.00	27.60	27.60	27.60	29.00	29.00	29.00
(-)2.8	(-)2.8	(-)2.8	(-)3.4	(-)3.4	(-)3.4	(-)4.8	(-)4.8	(-)4.8	(-)3.8	(-)3.8	(-)3.8
451.50	451.50	451.50	434.10	434.10	434.10	453.30	453.30	453.30	445.20	445.20	445.20
27.60	18.70	15.90	49.30	33.60	28.10	20.90	14.00	12.00	18.30	12.50	10.70
4.00	4.00	4.00	4.40	4.40	4.40	3.20	3.20	3.20	5.30	5.30	5.30
3.80	3.80	3.80	13.50	13.50	13.50	1.10	1.10	1.10	11.00	11.00	11.00
4.70	3.90	3.40	4.70	3.90	3.40	4.70	3.90	3.40	4.70	3.90	3.40
10.70	9.80	9.60	10.70	9.80	9.60	10.70	9.80	9.60	10.70	9.80	9.60
50.80	40.20	36.70	82.60	65.20	59.00	40.60	32.00	29.30	50.00	42.50	40.00
13.00	13.00	13.00	13.00	13.00	13.00	13.00	13.00	13.00	13.00	13.00	13.00
515.30	504.70	501.20	529.70	512.30	506.10	506.90	498.30	495.60	508.20	500.70	498.20
515	505	501	530	512	506	507	498	496	508	501	498

SECTION 2

APPENDIX 14-1

APPLICATIONS AND TYPICAL SPECIFICATIONS OF IMPORTANT SPECIAL STEELS

Steel Grade	Typical specification		Applications
	AISI/SAE	BS	
Carbon constructional	1040	EN-8	Axles, shafts, piston rods, gear racks, spindles, other automobile parts etc.
	1055	EN-9	- do -
Alloy constructional	5140	EN-18	Automotive steering parts
	4140	EN-19	Aircraft and truck parts, ordnance materials, cylinder lining, airscrew shafts.
	4340	EN-24	Heavy aircraft and truck parts, ordnance materials, high duty bolts, spindles etc.
	3310	EN-36A	Aero engine connecting rods, high duty bolts, spindles etc.
	-	EN-40C	Valves, spindles, cylinder linings, crank shafts
Spring steel	9260	EN-45	Helical springs, small components for automobile and railways etc.
	6150	EN-47	Leaf, helical and flat springs
Free cutting steel	1113	EN-1A	Machine parts, bolts, nuts, studs etc.
	1116	EN-7	- do -

APPENDIX 14-2

TYPICAL LIST OF MAJOR PRODUCTION FACILITIES FOR SPECIAL STEELS PLANT

Equipment/Facilities

Steelmelt shop

- Electric arc furnace complete with transformer
- Scrap charging buckets
- Oxygen lancing equipment
- Slag pots
- Ingot moulds & bottom pouring arrangement

Rolling mill

- Reheating furnace
- One 3-High stand
- Three 3-High/2-High stands
- Cooling bed complete with run-in and run-out table

Storage and handling

- Storage bunkers for burnt lime and ferro-alloys
- Clam shell bucket transfer car
- Steel teeming ladles

Ladle preparation

- Ladle driers
- Ladle stand
- Slide gate nozzle assembly

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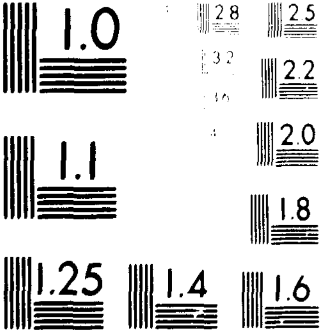

MICROCOPY RESOLUTION TEST CHART

Appendix 14-2 (cont'd)

Miscellaneous

Track scale for scrap bucket weighing

Shearing machine and cutting torches for scrap preparation

Roll turning facilities

Swing frame grinders, hot saw, cold shear, chipping hammers, etc.

ESTIMATED PRODUCTION COST FOR SPECIAL STEEL PRODUCTS EXCLUDI
(US $ per ton)

	Thailand		Malaysia		Singapore	
	Alt. 1	Alt. 2	Alt. 1	Alt. 2	Alt. 1	Alt. 2
Materials						
Steel scrap ..	155.35	155.35	122.65	122.65	143.65	143.65
Ferro-silicon ..	7.40	7.40	7.20	7.20	6.90	6.90
Ferro-manganese ..	8.25	8.25	8.00	8.00	7.70	7.70
Ferro-chrome ..	27.20	27.20	26.25	26.25	25.30	25.30
Ferro-molybdenum ..	32.20	32.20	31.50	31.50	30.00	30.00
Ferro-vanadium ..	3.10	3.10	3.00	3.00	2.90	2.90
Nickel ..	27.70	27.70	26.65	26.65	25.55	25.55
Limestone ..	0.55	0.55	0.55	0.55	0.95	0.95
Others ..	2.95	2.95	2.95	2.95	2.95	2.95
Sub-total ..	264.70	264.70	228.75	228.75	245.90	245.90
Other Items						
Labour & supervision ..	23.65	12.60	24.70	13.15	44.25	23.60
Electric power ..	54.00	54.00	54.00	54.00	59.40	59.40
Graphite electrodes ..	19.75	19.75	17.10	17.10	18.25	18.25
Ingot moulds ..	12.50	12.50	12.50	12.50	12.50	12.50
Refractories ..	30.40	30.40	30.40	30.40	30.40	30.40
Fuel, oxygen and other utilities ..	10.50	10.50	11.90	11.90	23.70	23.70
Rolls, lubricants, consumables and general plant expenses ..	37.60	36.10	37.60	36.10	37.60	36.10
Repair and maintenance ..	7.50	5.45	7.50	5.45	7.50	5.45
Sub-total ..	195.90	181.30	195.70	180.60	233.60	209.40
Administration and Sales Expenses	16.00	16.00	16.00	16.00	16.00	16.00
PRODUCTION COST (excluding fixed charges) ..	476.60	462.00	440.45	425.35	495.50	471.30
Say ..	477	462	440	425	496	471

SECTION 1

APPENDIX 14-3

...TION COST FOR SPECIAL STEEL PRODUCTS EXCLUDING FIXED CHARGES
(US $ per ton)

Malaysia		Singapore		Indonesia		Philippines	
Alt. 1	Alt. 2	Alt. 1	Alt. 2	Alt. 1	Alt. 2	Alt. 1	Alt. 2
122.65	122.65	143.65	143.65	151.85	151.85	143.65	143.65
7.20	7.20	6.90	6.90	6.50	6.50	8.90	8.90
8.00	8.00	7.70	7.70	7.95	7.95	7.95	7.95
26.25	26.25	25.30	25.30	25.60	25.60	27.85	27.85
31.50	31.50	30.00	30.00	30.70	30.70	32.90	32.90
3.00	3.00	2.90	2.90	2.95	2.95	3.15	3.15
26.65	26.65	25.55	25.55	26.30	26.30	28.10	28.10
0.55	0.55	0.95	0.95	0.50	0.50	0.95	0.95
2.95	2.95	2.95	2.95	2.95	2.95	3.05	3.05
228.75	228.75	245.90	245.90	255.30	255.30	256.50	256.50
24.70	13.15	44.25	23.60	18.50	9.85	16.45	8.80
54.00	54.00	59.40	59.40	43.20	43.20	71.30	71.30
17.10	17.10	18.25	18.25	27.10	27.10	21.65	21.65
12.50	12.50	12.50	12.50	12.50	12.50	12.50	12.50
30.40	30.40	30.40	30.40	28.80	28.80	36.00	36.00
11.90	11.90	23.70	23.70	8.75	8.75	20.40	20.40
37.60	36.10	37.60	36.10	37.60	36.10	37.60	36.10
7.50	5.45	7.50	5.45	7.50	5.45	7.50	5.45
195.70	180.60	233.60	209.40	183.95	171.75	223.40	212.20
16.00	16.00	16.00	16.00	16.00	16.00	16.00	16.00
440.45	425.35	495.50	471.30	455.25	443.05	495.90	484.70
440	425	496	471	455	443	496	485

SECTION 2

APPENDIX 15-1

REVIEW OF ALTERNATIVE TECHNOLOGIES FOR THE PRODUCTION OF STAINLESS STEEL

GRADES AND APPLICATION

Stainless steel is essentially an alloy of iron, carbon and chromium generally containing carbon less than 0.1 per cent and chromium above 4 per cent. Nickel is the next major alloying element after chromium. The other alloying elements used are molybdenum, copper, aluminium, silicon etc. Stainless steels can be divided into three main categories, namely, austenitic, ferritic and martensitic steels as follows:

1. Austenitic: Nickel and chromium contents totalling not less than 23 per cent; the minimum content of chromium being 16 per cent and of nickel 7 per cent.

2. Ferritic: Straight chromium steels with over 11.5 per cent chromium and such low carbon contents that they cannot be hardened by heat treatment.

3. Martensitic: Straight chromium steels with chromium from 12-18 per cent and carbon content varying from 0.15 per cent to 1.20 per cent, and which can be hardened by heat treatment.

Stainless steel is mainly required as flat products. Its multifarious use can be classified under five heads, namely:

1. Domestic appliances and requisites such as utensils, sinks, refrigerators, pressure cookers, razor blades, watch straps, cutlery etc.

Appendix 15-1 (cont'd)

2. Domestic and commercial equipment such as furniture, sterilisers, measuring tapes, locks and keys etc.

3. Transport equipment such as passenger coaches.

4. Industrial equipment, for example, dairy and fertilizer equipment and chemical equipment.

5. Welded tubes for fertilizer equipment, metal furniture etc.

STEELMAKING

Ever since commercial scale production of stainless steels was established in the early 1920's, these steels have been made mostly in basic electric arc furnaces, and to a very limited extent in coreless induction furnaces.

Stainless steel scrap could be melted without carbon pick-up or large chromium losses in channel type and coreless type induction furnaces. Substantial tonnages of stainless steels were being made in these furnaces in the 1930's and 40's. However, with increasing sizes of arc furnaces becoming available, induction furnaces are not being adopted for stainless steelmaking on account of their small capacity and operating problems. Modern plants almost exclusively adopt the electric arc furnace as the primary steelmaking unit.

Electric Arc Furnace Process

The conventional electric arc furnace process consists of four basic steps:

Appendix 15-1 (cont'd)

1. Melting down the charge with about 0.5 per cent carbon content in the bath and a chromium content not exceeding 10.0 per cent;

2. Blowing in oxygen in the bath at the rate of 15 to 25 cu m per ton within a short period of 15 to 20 minutes, allowing bath temperature to rise to 1800°-1850°C and reducing bath carbon to about 0.05 per cent;

3. Cooling down and reduction of chromium oxide from the slag back into the bath by additions of ferro-silicon and chrome-silicon;

4. Finishing the heat by checking analysis, making necessary alloying additions under reducing slag to get the specified chemistry, and adjusting the temperature before tapping.

In this process of steelmaking, the arc furnace is efficiently utilised for step one only. For the other three steps, which together take almost as much time as the first step, the power requirement is only fraction of the total input possible to the furnace. The high temperature attained during oxygen blowing are also very harmful to the furnace refractories.

The disadvantages of the conventional process have been overcome, to a large extent, by the more recent practice employing a duplex process. In this process, melt-down with the full development of chromium and nickel required to give the final analysis, followed by some temperature adjustment and slagging off is carried out in the arc furnace. Decarburising and finishing operations are carried out by a secondary refining process in a vessel specially designed for this purpose. This results in better utilisation of arc furnace capacity and increases the productivity by reducing the heat time of the furnace.

Secondary Refining

There are three major secondary refining processes now in use:

1. The vacuum oxygen decarburisation (VOD) process developed by Witten Edelstahlwerke of West Germany between 1962 and 1965;

2. The argon-oxygen decarburisation (AOD) process developed by Union Carbide of USA in 1967/68;

3. The CLU (Creusot Loire-Uddeholm) steam-oxygen bottom blown process, the first full scale production unit of which was commissioned at Degerfors Works, Sweden in 1973.

VOD process: In the VOD process, the molten metal containing not more than 0.50 per cent carbon and 0.2 per cent silicon is tapped at about 1650°C into a basic lined ladle having a large free board. The ladle is fitted with a slide gate nozzle, which permits thorough preheating of the ladle, and prolonged treatment of the metal in the ladle without risk of damage. The ladle is placed in a vacuum chamber which is vacuum-sealed within a cover. The chamber is evacuated by steam ejector system. Throughout the treatment period the steel is stirred continuously by injecting small quantities of argon through a refractory porous plug fitted in the ladle bottom. For vacuum decarburisation, oxygen is injected below the metal surface by an oxygen lance introduced

Appendix 15-1 (cont'd)

through a vacuum sealed port on the cover of the vacuum chamber. The temperature of the metal is either maintained or allowed to rise slightly, the heat generated by the carbon-oxygen reaction being adequate to compensate the heat losses through radiation, conduction and the evacuated gases. After the treatment, reductants are added under vacuum to revert chromium from the slag back into the metal, and corrective additions made to adjust the temperature and composition of the steel. The entire process, from tapping of the metal into the ladle to completion of the refining treatment and removal of the ladle from the vacuum chamber, may take 2 to 2.5 hours.

<u>AOD process</u>: In the AOD process, the charge is melted in the arc furnace together with all the chromium and nickel necessary. The carbon and silicon contents of the molten metal need not be as closely controlled as in the case of the VOD process and can range from 0.8 to 1.5 per cent. The molten metal is deslagged and transferred to the AOD vessel which is similar in shape to a converter. Argon and oxygen are injected through tuyeres permanently mounted on one side near the bottom of the vessel. The proportions of oxygen and argon are varied from 3:1 at the beginning of the treatment period to 1:3 towards the end of the treatment period. The duration of the oxygen blowing decarburisation period may vary from 1.5 to 2 hours, depending on the starting carbon content. The metal temperature is allowed to rise to 1730°-1740°C towards the end of the decarburisation blow for effective carbon removal down to 0.02 per cent and below, if required. After the carbon has been reduced to the desired

low level, a fresh reducing lime-silicon slag is made up and the bath is stirred with argon. The excess heat in the blown metal is adequate to melt the slag. The analysis of the steel is then checked and adjusted with necessary finishing additions.

CLU process: In the CLU process, the charge melted with the full complement of nickel and chromium in the arc furnace is transferred to a vessel where oxygen and steam are blown into the bath through annular tuyeres in the bottom of the vessel. The steam shield surrounding the oxygen stream dissociates into hydrogen and oxygen on coming into contact with the molten metal, the endothermic reaction helping to keep down the temperature at the tuyere mouth. The oxygen reacts with the carbon, and the hydrogen reduces the partial pressure of carbon monoxide inside the reaction vessel. However, the steel tends to pick up hydrogen, and this has to be reduced to less than 10 ppm by using argon at the end of the process. The main advantage of this process over the AOD process is that the consumption of expensive argon is greatly reduced. The refining time for reducing carbon from 1.6 per cent to less than 0.015 per cent is 70 minutes. Total time in the converter is two and a half hours. Metal temperature rises to about 1650°C at the beginning and then remains fairly constant.

All the three secondary refining processes described above have the following advantages in common:

Appendix 15-1(cont'd)

1. Refining of charges with full chromium and nickel contents down to very low carbon levels, less than 0.02 per cent if required, with high chromium recovery efficiencies of the order of 96 to 98 per cent;

2. No need to use high cost low carbon ferro-chrome, except possibly small amounts as finishing additions for final composition adjustment;

3. Production of extra low carbon grades with less than 0.03 per cent carbon, which do not need to be stabilised with titanium or niobium additions for freedom from weld sensitiveness to intergranular corrosion, at not much greater cost than the standard grades.

Casting

Continuous casting of stainless steel into slab is now an established practice. Earlier vertical machines were used for stainless steel slab casting. But during the past decade or so curve mould machines have also become popular.

The continuous casting process offers many advantages over the conventional ingot casting practice. It obviates a number of intermediate facilities involved in the ingot casting route, such as ingot moulds, mould cars, mould yard, stripper yard, soaking pits and primary rolling mills. The plant layout can be compact and the manpower requirement will be lower. But the major savings result from the higher yields of the order of 8 per cent to 10 per cent from liquid steel to semis.

Appendix 15-1 (cont'd)

The quality of continuous cast semis is comparable to, and in some cases even better than, those produced from ingots. Developments such as the use of submerged nozzle and powder flux for casting, and the use of argon stirring of the liquid steel in the ladle for ensuring temperature uniformity have helped in improving further the quality of the continuous cast products.

Stainless steel slabs are being regularly cast in many steel plants to give products of satisfactory quality. For example, Atlas Steel in Canada are casting stainless steel slabs in a vertical machine since 1954, and have installed later, a curved mould machine at Tracy, Quebec. The Nippon Steel Corporation in Japan are also operating a continuous casting machine since 1960 at their Hikari Works. In recent years, most of the plants manufacturing stainless steel have adopted continuous casting.

HOT STRIP ROLLING

Hot rolling of slabs into strip can be carried out in any one of the following types of mills:

i) Semi-continuous strip mill
ii) Steckel mill
iii) Hot planetary mill

For hot rolling strip of about 600 mm width, an 800 mm semi-continuous strip mill with one reversing roughing stand and five continuous finishing stands would be necessary. Such an installation will have a capacity of over 250,000 tons per

Appendix 15-1 (cont'd)

annum and cannot be justified for outputs less than 100,000 tons.

A steckel mill consists of a single 4-high reversing stand with hot coilers inside furnaces on both sides of the mill. The heated slab is first reduced to about 15 mm thickness in a 2-high or 4-high reversing roughing stand with edger, and passed on to the steckel mill. In the steckel mill, the plate is reduced to 3 to 5 mm thick strip in 10 to 12 passes, the strip being maintained hot by the take-up coilers on either side located inside a furnace heated to about 1150°C. A 760 mm steckel mill installation of this type would have a capacity of about 100,000 tons per year. Hot rolled strip quality is not as good as that obtained on a semi-continuous strip mill.

The hot planetary mill basically consists of a pair of heavy back-up rolls, each surrounded by a number of small diameter work (planetary) rolls, the ends of which are held in cases. The back-up rolls are driven and the work rolls rotate in the opposite direction driven by friction between the slab and the back-up rolls. The slab is fed into the mill against the direction of rotation of the work rolls by means of feed rolls which also give a reduction of 15 to 20 per cent. On the exit side, a planishing mill smoothens the waviness of the strip by giving a small reduction on the strip. The strip is coiled after being cooled down to some extent by water spraying. The reheating furnace, which is usually a continuous type high-heat head furnace, is placed very near the mill thereby reducing scale loss.

Appendix 15-1 (cont'd)

Advantages of Planetary Mill

Among the many advantages claimed for strip rolling in the planetary mill, the following may be mentioned:

i) Lower capital investment which is only about one-quarter to one-fifth of the investment required for a semi-continuous or continuous strip mill for the same width of strip.

ii) Floor space requirement of a planetary mill is about 50 per cent of that necessary for a semi-continuous and about 30 to 35 per cent of that needed for a continuous mill.

iii) In planetary mill, the initial slab rolling temperature can be lower than in the case of other mills. The high rate of work in reducing from slab to strip in a matter of seconds causes a considerable temperature rise and the strip leaves the mill hotter than the slab entering the mill.

In the conventional strip mill, the reheating furnace temperature is usually much higher (up to 300°C) than the required finishing temperature, to allow for the considerable cooling of the slab by radiation as it passes down the roller tables between the mills and by the roll cooling sprays and the high pressure scale-removing jets. The saving in heating cost is substantial, as fuel costs rise rapidly with relatively small increase in temperature in the upper range of heating.

iv) Lower conversion cost resulting from less manpower requirement, less power consumption per ton of output and lower roll costs.

Appendix 15-1 (cont'd)

v) Greater gauge accuracy and higher standard of surface finish due to lower rolling temperature controllable within precise limits, less scaling, contact with almost cold work rolls, practically no slippage between rolled (materials) and rolling (work rolls) surface and virtual absence of crown.

vi) Reduced scale loss, due to lower heating temperature and fast heating cycle.

vii) Flexibility in rolling. The planetary mill permits great flexibility in rolling schedules. The thickness and width of the strip can be changed without even stopping the mill thus permitting rolling of small lots of materials economically. The conventional rolling schedules of rolling progressively narrower strip in continuous mills are not required to be followed.

Eighteen hot planetary mills have so far been installed throughout the world, of which about a dozen are engaged in commercial rolling of plain carbon, alloy and stainless steels.

From the above, it is obvious that for hot rolling of stainless strip in relatively small tonnages, the most suitable choice is the planetary mill. Plants operating planetary mills for stainless and other higher alloy steel strip rolling claim that they are economic, even if they are operated only a few shifts a week.

COLD STRIP ROLLING

For cold rolling stainless steel strip, Sendzimir cluster mill (1-2-3-4 type) with small diameter work rolls is

Appendix 15-1 (cont'd)

practically an automatic choice, as no other type of mill can accomplish the work as well and at such low overall cost. Austenitic stainless steel work hardens very rapidly. If the standard type of 4-hi cold mill with large diameter work rolls, normally used for cold rolling low carbon steel strip, is used for austenitic stainless steel, only 25 to 30 per cent cold work can be given before the strip work hardens to such an extent that it will have to be annealed before any further cold rolling is done. With the small diameter fully hardened work rolls in Sendzimir cluster mill, as much as 85 per cent cold reduction can be given on austenitic stainless steel strip before another annealing is required. Normal practice is to give 65 to 70 per cent cold reduction and anneal before further cold reduction.

APPENDIX 15-2

TYPICAL LIST OF MAJOR PRODUCTION FACILITIES FOR STAINLESS STEEL PLANT

Equipment/Facilities

Steelmelt shop

- Electric arc furnace complete with transformer
- Vacuum refining unit complete with steam ejector system
- Continuous casting machine for slabs with tundish preheating facilities etc
- Slab discharging and cooling facilities
- Material storage and handling facilities, e.g. addition bins, scrap buckets, transfer cars, weigh feeders, steel ladles, slag pots etc.
- EOT cranes
- Ladle relining and heating facilities
- Arc furnace relining and fettling facilities

Hot strip mill

- Slab conditioning facilities, including automatic slab grinders
- Slab reheating furnace
- Hot planetary mill including edger, planishing mill and coiler
- Flying shear, descalers etc
- EOT cranes

Coil build-up line including uncoiling reels, leveller, shear, welding and grinding facilities, side trimming unit, bridle rolls, recoiling reel etc.

Appendix 15-2 (cont'd)

Annealing and pickling facilities including annealing furnaces, quenching station, shot blasting equipment, spray rinse, pickling tank, strip dryer, strip recoiler etc.

Cold rolling and finishing

Strip grinding line

Sendzimir cold rolling mill

Skin pass mill

Shearing, squaring and slitting facilities

Inspection and packing facilities

EOT cranes

APPENDIX 15-3

ESTIMATED PRODUCTION COST FOR STAINLESS CR SHEET/STRIP EXCLUDI
(US $ per ton)

		Thailand			Malaysia			Singapor	
		Alt. 1	Alt. 2	Alt. 3	Alt. 1	Alt. 2	Alt. 3	Alt. 1	Alt.
terials									
urchased steel scrap	..	70.90	70.90	70.90	56.15	56.15	56.15	65.55	65.
igh C Fe-Cr	..	198.90	198.90	198.90	193.05	193.05	193.05	185.25	185.
ow C Fe-Cr	..	137.25	137.25	137.25	132.50	132.50	132.50	127.75	127.
ilico-chrome	..	10.05	10.05	10.05	9.75	9.75	9.75	9.35	9.
ow C Fe-Mn	..	10.80	10.80	10.80	10.45	10.45	10.45	10.05	10.
erro-silicon	..	11.00	11.00	11.00	10.65	10.65	10.65	10.25	10.
ickel	..	616.00	616.00	616.00	592.00	592.00	592.00	568.00	568.
lux and additives	..	2.00	2.00	2.00	2.00	2.00	2.00	3.00	3.
Sub-total	..	1,056.90	1,056.90	1,056.90	1,006.55	1,006.55	1,006.55	979.20	979.
her Items									
abour and supervision	..	234.60	131.10	92.00	244.80	136.80	96.00	438.60	245.
Electric power	..	98.00	95.00	92.00	98.00	95.00	92.00	107.80	104.
raphite electrode	..	30.70	29.90	28.60	29.50	28.75	27.50	28.30	27.
efractories	..	14.75	14.75	14.75	14.75	14.75	14.75	14.75	14.
Fuel	..	8.85	8.85	8.85	12.65	12.65	12.65	43.45	43.
Oxygen	..	7.25	7.25	7.25	7.25	7.25	7.25	7.25	7.
Other utilities, rolls, consumables, general plant expenses etc	..	195.00	140.00	111.50	200.00	140.00	111.50	280.00	195.
Repair and maintenance	..	225.00	150.00	116.50	225.00	150.00	116.50	225.00	150.
Sub-total	..	814.15	576.85	471.45	831.95	585.20	478.15	1,145.15	787.
ministration and Sales Expenses	..	35.00	30.00	25.00	35.00	30.00	25.00	40.00	35.
PRODUCTION COST (excluding fixed charges)	..	1,906.05	1,663.75	1,553.35	1,873.50	1,621.75	1,509.70	2,164.35	1,801.
Say	..	1,906	1,664	1,553	1,874	1,622	1,510	2,164	1,80

SECTION 1

AINLESS CR SHEET/STRIP EXCLUDING FIXED CHARGES
(US $ per ton)

ysia		Singapore			Indonesia			Philippines		
t. 2	Alt. 3	Alt. 1	Alt. 2	Alt. 3	Alt. 1	Alt. 2	Alt. 3	Alt. 1	Alt. 2	Alt. 3
56.15	56.15	65.55	65.55	65.55	69.55	69.55	69.55	65.55	65.55	65.55
3.05	193.05	185.25	185.25	185.25	177.45	177.45	177.45	204.75	204.75	204.75
2.50	132.50	127.75	127.75	127.75	129.30	129.30	129.30	140.45	140.45	140.45
9.75	9.75	9.35	9.35	9.35	9.60	9.60	9.60	10.30	10.30	10.30
10.45	10.45	10.05	10.05	10.05	10.30	10.30	10.30	11.05	11.05	11.05
10.65	10.65	10.25	10.25	10.25	9.60	9.60	9.60	13.20	13.20	13.20
92.00	592.00	568.00	568.00	568.00	584.00	584.00	584.00	624.00	624.00	624.00
2.00	2.00	3.00	3.00	3.00	2.00	2.00	2.00	3.00	3.00	3.00
6.55	1,006.55	979.20	979.20	979.20	991.80	991.80	991.80	1,072.30	1,072.30	1,072.30
36.80	96.00	438.60	245.10	172.00	183.60	102.60	72.00	163.20	91.20	64.00
95.00	92.00	107.80	104.50	101.20	78.40	76.00	73.60	129.35	125.40	121.45
28.75	27.50	28.30	27.60	26.40	42.00	40.95	39.15	33.65	32.75	31.35
14.75	14.75	14.75	14.75	14.75	14.15	14.15	14.15	17.70	17.70	17.70
12.65	12.65	43.45	43.45	43.45	4.10	4.10	4.10	34.75	34.75	34.75
7.25	7.25	7.25	7.25	7.25	7.25	7.25	7.25	7.25	7.25	7.25
40.00	111.50	280.00	195.00	146.50	170.00	125.00	101.50	160.00	120.00	96.50
50.00	116.50	225.00	150.00	116.50	225.00	150.00	116.50	225.00	150.00	116.50
85.20	478.15	1,145.15	787.65	628.05	724.50	520.05	428.25	770.90	579.05	489.50
30.00	25.00	40.00	35.00	25.00	35.00	30.00	25.00	35.00	30.00	25.00
621.75	1,509.70	2,164.35	1,801.85	1,632.25	1,751.30	1,541.85	1,445.05	1,878.20	1,681.35	1,586.80
622	1,510	2,164	1,802	1,632	1,751	1,542	1,445	1,878	1,681	1,587

SECTION 2

APPENDIX 16-1

BRIEF REVIEW OF AVAILABLE TECHNOLOGIES FOR HOT STRIP ROLLING

The hot rolling of slab into strip can be done on any one of the following types of mills:

i) Continuous mill
ii) Semi-continuous mill
iii) Planetary mill
iv) Steckel mill

CONTINUOUS MILL

A continuous mill breaks down the slab in a combination of a number of roughing stands placed in line before a similar series of finishing stands. The production capacity of such mill depends upon the width of slab it can roll, and the total number of stands. Besides, it is influenced by the grade of steel being rolled which governs the rolling speed. For example, a 1420 mm (56") continuous mill can give an output of 2 million to 3 million tons on tonnage steels and about 50 to 60 per cent output on alloy and special steels.

SEMI-CONTINUOUS MILL

A semi-continuous mill is different from a continuous mill, in that the roughing is done with the aid of a reversing stand, backed up by a second roughing stand in some cases. Finishing is done with a number of stands in line, in the same

Appendix 16-1 (cont'd)

manner as in the continuous mill. For a tonnage steel plant, a 1420 mm (56") semi-continuous mill will have a capacity of about 1 million tons of hot strip per year.

PLANETARY MILL

The planetary mill, though fairly well established for the production of narrow strip, has not gained acceptance for the production of wide strip. Of the existing installations numbering about 15, only three are designed for the rolling of strip wider than 1200 mm, and 10 for width ranging from 325 to 600 mm. None of the wide planetary mills, including the 52" wide mill at Norbottens, Sweden, 51" wide mill at NYK, Kawasaki, Japan and 57" wide mill at Tracey, Quebec, Canada has given trouble-free operation. The main problems with planetary mills are excessive maintenance and high degree of operational skill required, which becomes increasingly difficult to cope with as the mill width increases. Therefore, in spite of the low investment claimed for this type of mill, planetary mill is not recommended for the production of relatively wide strip.

STECKEL MILL

In the steckel mill, a reversing roughing stand, either two-high or four-high is used in conjunction with a reversing finishing stand, generally four-high. The heated slab is rolled in the roughing stand into a straight length breakdown 12 mm to 20 mm thick, in five to nine passes, depending upon grade of steel, the width and thickness of the slab and the drive rating of the mill. The breakdown then passes to the finishing stand which is provided with two hot coiling drums, one on the entry and one on the delivery side, located inside

Appendix 16-1 (cont'd)

heating furnaces fairly close to the mill stand. The strip is reduced to finished thickness, generally 1.8 to 3 mm, in five to nine passes, again depending upon the materials, the starting and finished thickness and width, and the drive rating of the mill. After each pass the strip is taken by the coiler drum inside the furnace and maintained at the rolling temperature appropriate to the grade of steel being rolled, so that the stock is rolled at a fairly uniform temperature throughout, and the number of passes taken and rolling time do not become critical factors from the point of view of strip quality. Since a single reversing stand performs the work of five to seven finishing stands of a semi-continuous mill, the steckel mill capacity is lower than that of a semi-continuous mill of comparable width.

The quality of the product from a steckel mill is generally inferior to that of a semi-continuous mill product, both in respect of surface finish and gauge uniformity. Steckel mill strip has "rolled in scale" as the coil is maintained at a high temperature for a prolonged period. Another reason for this defect is the difficulty in effectively descaling the strip in the limited distance between mill stand and the coiling drum. The above limitations seriously restrict the use of hot rolled strip for critical grades and application. For example, hot rolled strip which have to be further cold rolled for being fed to electrolytic tinning lines are generally not of acceptable international standards if rolled in steckel mills. Serious problems have been reported from existing steckel mill in operation at Chimbote Plant, Peru and at the NSC Plant, Illigan, where the hot band produced from steckel mill was not considered satisfactory for further cold rolling of strip for electrolytic tinning application.

Appendix 16-1 (cont'd)

Till a few years back, the steckel mill had the advantage of smaller gauge variation across the width, compared to the semi-continuous mills. However, with the modern developments in automatic gauge control system with fast response time and roll shape control, in the last few years, the products from the semi-continuous and continuous strip mills have become comparable in this respect to those from the steckel mill.

The ends of the coil produced in steckel mill are thick and entail additional cropping which reduces the yield of the coils by about 2 per cent. The rate of roll wear is high and more frequent attention has to be given to roll adjustment during rolling. Further, the rolls have to be changed frequently to maintain surface quality. As the coiling drum works inside a hot furnace, its maintenance also poses some problems. Therefore, the operational and maintenance skill required to keep a steckel mill running continuously, to produce acceptable quality of strip, is considerably higher.

APPENDIX 16-2

TYPICAL LIST OF MAJOR PRODUCTION FACILITIES FOR HOT STRIP MILL

Equipment/Facilities

Slab reheating furnace with slab loading and depiler table, furnace charging table, pushers, pusher-type furnace of 150-200 tons/hr capacity, electrics, instruments and controls

Hot strip mill

- Furnace delivery table
- Mill entry table
- Scale breaker
- Reversing 4-high roughing stand
- 4-high finishing mill stands
- Interconnecting tables, delay and cooling tables
- Down coilers
- Coil cooling and transfer system
- Hydraulic, pneumatic, and lubrication systems

Shearing line for hot rolled strip

Handling equipment including slab handling device, electromagnets, grab buckets, scale and crop wagons, transfer cars 'C' hooks and porter bars

Cranes and other material handling equipment

APPENDIX 16-3

ESTIMATED PRODUCTION COST FOR HR COIL/SHEET EXCLUDING FIXED CHARGES
(US $ per ton)

	Thailand	Malaysia	Singapore	Indonesia	Philippines
Materials					
Slab	273.00	267.75	257.25	262.50	267.75
Credit for scrap	(-) 5.75	(-) 3.50	(-) 4.25	(-) 6.00	(-) 4.75
Sub-total ..	267.25	264.25	253.00	256.50	263.00
Other Items					
Labour and supervision	1.30	1.35	2.40	1.00	0.90
Electric power ..	6.25	6.25	16.90	5.00	8.25
Fuel	6.00	17.20	11.00	2.70	8.80
Water and other utilities, consumables, general plant expenses etc.	5.15	5.20	5.70	5.00	4.95
Repair and maintenance	3.20	3.20	3.20	3.20	3.20
Sub-total ..	21.90	23.20	29.20	16.90	26.10
Administration & Sales Expenses	8.70	8.60	8.50	8.20	8.00
PRODUCTION COST (Excluding fixed charges)	297.85	296.05	290.70	281.60	297.10
Say ..	298	296	291	282	297

APPENDIX 17-1

BRIEF REVIEW OF AVAILABLE TECHNOLOGIES FOR COLD STRIP ROLLING AND FINISHING

Cold rolling and finishing of hot rolled strip generally comprises the following main operations:

i) Pickling
ii) Cold rolling
iii) Surface cleaning of cold rolled strip
iv) Annealing
v) Skin passing
vi) Finishing operations including shearing or slitting
vii) Metallic coating of the surface such as tinning, galvanising etc.
viii) Inspection, packing and despatch

PICKLING

The first step for processing hot rolled strip to finished cold rolled strip is to pickle the surface. Pickling is used for removing the scales or oxide layer formed on the strip during the hot rolling process, to build up the coils for subsequent operations and to oil the strip surface to prevent further rusting and to act as a lubricant while cold rolling. Pickling is done with acidic solutions and can be performed either by batch operation or in a continuous pickling line. Batch pickling is generally adopted when a relatively lower tonnage of strip is to be pickled. The quality of strip obtained by batch pickling is not comparable to that obtained by the continuous pickling process. Continuous pickling is done either with sulphuric acid or with hydrochloric acid as the

Appendix - 17-1 (cont'd)

pickling medium. Hydrochloric acid is preferred as the pickling medium in modern cold rolling installations, as sulphuric acid has higher consumption rates and problems are faced with the disposal of effluents, particularly of ferrous sulphate produced in huge quantities.

Continuous pickling can be performed either by passing the strip through ordinary acid tanks or by using electrolytic pickling tanks where pickling rate increases substantially compared to the former.

The main line equipment for pickling unit consists of pay-off, shear, welder, pinch rolls/bridle rolls, strip storage accumulators, scale breaker, pickling tank, rinse tank, driers, levellers, shear and side trimmer, scrap baller/chopper, oiling facility, rewind unit, fume exhaust unit and neutralisation unit.

COLD ROLLING MILL

For cold reduction of strip to lower gauge, either 4-high reversing mills or four to six stand tandem mills are used. For rolling of strip to tinplate gauge of about 0.2 mm, generally five stand tandem mills are used. Reversing mills are preferred only in such cases where relatively lower tonnages of material are to be processed. Depending upon the coil weight, the speed of rolling and the width of the strip being processed, a reversing 4-high mill of about 1,500 mm width can give an output in the range of 150,000 to 300,000 tons per year, compared to an output of about 600,000 to 1,000,000 tons per year from a five-stand tandem mill of about 1,500 mm width. Product rolled from a four-high cold reversing mill with modern automatic gauge control system is comparable to that rolled from a five-stand tandem cold mill.

Appendix 17-1 (cont'd)

SURFACE CLEANING

Rolling lubricant residues left on the strip are removed from the strip surface prior to or during further processing of cold rolled strip. For sheet gauge material, rolling oil is usually removed by 'burnt off' process in box annealing furnaces. But in case of production of the strip for other use like tin coating, additional processing of strip called 'degreasing' is required for cleaning the surface.

CR strip for tinplate production is degreased by using alkaline detergent solutions such as caustic soda, sodium orthosilicate and tri-sodium phosphate. Degreasing is generally done in electrolytic degreasing tanks through which the strip is passed continuously. The unit comprises mainly of pay-off, shears, welder, cleaning tank, rinse tanks, drier, pinch rolls, bridle rolls, loop pit and tension reels.

ANNEALING

To render the flat rolled products suitable for their intended end uses, sheets and strip are usually given heat treatment to effect changes in their mechanical properties. Heat treatment may be classified as.

a) Batch type process, which can be done by box annealing or open coil annealing, or
b) Continuous type process, such as continuous annealing, strand annealing and normalising.

Box annealing equipment consists of bases, inner covers, furnace and cooling hoods. Open coil annealing is less time consuming compared to box annealing but this time advantage is offset by additional operations such as

Appendix 17-1 (cont'd)

'tight-to-loose' and 'loose-to-tight' operations. Open coil annealing is used when some deliberate changes are required in chemical composition of the sheet or its surface.

In continuous annealing, strip is given annealing treatment for a short time and treatment cycle is determined largely by temperature distribution in the furnace, dimension of the furnace and the strip speed.

Batch annealing is preferred where relatively thicker material are to be processed or where coarser grains are required, but for higher capacity, it requires more space and handling of material is relatively increased. Continuous annealing is used generally for lower gauges of CR strip. Now-a-days continuous annealing lines processing up to 1.2 mm thick strip have been installed and are working satisfactorily. The new continuous annealing line at Nippon Steels, Kimitsu Works can process CR strip of 0.4 to 1.2 mm thickness and 750 to 1,240 mm width and has capacity of about 34,000 tons per month. Continuous annealing lines generally consist of pay-offs, shears, welder, electrolytic cleaning unit, entry looping tower, furnace, exit looping tower/car, tensions reels. Temper mill and oiling facilities can also be provided in line. Thus, continuous annealing lines can do the operations such as cleaning, annealing and temper rolling in line and thus minimise operational cost to a very high extent. Combination of box annealing furnaces and a continuous annealing line is suggested for a cold rolling mill complex of about a million ton capacity processing tin-plates and sheet gauge material.

Appendix 17-1 (cont'd)

SKIN PASSING

Annealed coils are skin passed to improve the hardness and strength of the outer surface of the strip and leave the inner base material ductile and also to eliminate stretcher strain problems. Single stand or twin stand 4-high mills are used for skin passing tinplate and sheet gauge annealed strip. Twin stand 4-high mills are preferred when tinplate tonnage to be processed is high.

Skin pass mill consists of pay-off, tension rolls, shear, mill stand/stands, tension reel and conveyors.

FINISHING FACILITIES

Finishing facilities in a cold rolling mill complex include shearing lines and slitting lines. Coating lines such as galvanising and tinning lines are also provided. However, for the purpose of this report, coating lines are separately discussed and are not considered as a part of cold rolling mill complex.

SHEARING/SLITTING LINES

The line equipment mainly consists of pay-off, pinch rolls, loop pits, side trimmer/slitter, shear, pilers/ recoiler and oiler. Generally two types of shears are used:

a) Those for cutting the strip along the width of the strip as in case of shearing lines.

b) Those for cutting the strip continuously along the length of the moving strip as in case of slitters.

Appendix 17-1 (cont'd)

Flying shear of either guillotine type or rotary type is used in continuous shearing lines. Guillotine type shears have got limitations as they are capable of cutting effectively up to a speed of about 125 m per min max. Rotary type flying shears can be used for strip speeds up to 300 m per min.

APPENDIX 17-2

TYPICAL LIST OF MAJOR PRODUCTION FACILITIES FOR COLD STRIP MILL

Equipment/Facilities

Pickling line complete with coil feeding preparation and storage equipment, pickling and rinse tanks, with strip drying facility, side trimmer, oiling and cooling equipment and acid treatment plant

4-High single stand or five stand tandem mill complete with entry equipment, mill stand/stands with automatic gauge control system, tension reel etc.

Continuous annealing line complete with entry coil preparation and charging equipment, degreasing and annealing unit with strip accumulators, exit equipment etc.

Box annealing furnace complete with bases, covers, cooling hoods, furnaces etc.

Single stand/two stand 4-High skin pass mill complete with unwinding and rewinding facilities, mill stand/stands etc.

Shearing/slitting lines complete with unwinding, shearing/slitting, piling/cooling units etc.

Handling equipment

ESTIMATES OF PRODUCTION COST FOR CR COI

(US $ per ton)

		Thailand		Malaysia		
		Alt. 1	Alt. 2	Alt. 1	Alt. 2	Al
Materials						
Hot rolled coil	..	384.50	384.50	373.80	373.80	3
Credit for scrap	..	(-)5.75	(-)5.75	(-)3.50	(-)3.50	(-
Sub-total	..	378.75	378.75	370.30	370.30	3
Other Items						
Labour and supervision	..	4.85	1.95	5.05	2.00	
Electric power	..	10.00	10.00	10.00	10.00	
Fuel	..	0.75	0.75	0.90	0.90	
Water and other utilities, consumables, general plant expenses etc	..	10.40	7.00	10.50	7.00	
Repair and maintenance	..	9.35	5.15	9.35	5.10	
Sub-total	..	35.35	24.85	35.80	25.00	
Administration and Sales Expenses	..	12.40	12.10	12.20	12.00	
PRODUCTION COST (excluding fixed charges)	..	426.50	415.70	418.30	407.30	4
Say	..	427	416	418	407	

SECTION 1

APPENDIX 17-3

... OF PRODUCTION COST FOR CR COIL/SHEET
(US $ per ton)

Malaysia		Singapore		Indonesia		Philippines	
Alt. 1	Alt. 2	Alt. 1	Alt. 2	Alt. 1	Alt. 2	Alt. 1	Alt. 2
373.80	373.80	363.10	363.10	373.80	373.80	379.15	379.15
(-)3.50	(-)3.50	(-)4.25	(-)4.25	(-)6.00	(-)6.00	(-)4.75	(-)4.75
370.30	370.30	358.85	358.85	367.80	367.80	374.40	374.40
5.05	2.00	9.05	3.60	3.80	1.50	3.35	1.35
10.00	10.00	11.00	11.00	8.00	8.00	13.20	13.20
0.90	0.90	1.40	1.40	0.35	0.35	1.10	1.10
10.50	7.00	12.50	7.80	9.90	6.75	9.70	6.70
9.35	5.10	9.35	5.10	9.35	5.10	9.35	5.10
35.80	25.00	43.30	28.90	31.40	21.70	36.70	27.45
12.20	12.00	12.20	11.60	12.00	11.70	12.30	12.10
418.30	407.30	414.25	399.35	411.20	401.20	423.40	413.95
418	407	414	399	411	401	423	414

SECTION 2

APPENDIX 18-1

TYPICAL LIST OF MAJOR PRODUCTION FACILITIES FOR PLATE MILL

Equipment/Facilities

- Slab cutting machine
- Reheating furnace
- Scale breaker unit
- Vertical edger unit
- 4-high reversing plate mill
- Hot dividing shear
- Levelling unit
- Cooling and inspection bends
- Side trimming/slitting unit
- Cut-to-length shear
- Transfer conveyors
- Handling equipment

ESTIMATED PRODUCTION COST FOR PLATE EXCL

(US $ per ton)

		Thailand		Malaysia	
		Alt. 1	Alt. 2	Alt. 1	Alt. 2
Materials					
Slab	..	325.00	325.00	318.75	318.75
Credit for scrap	..	(-)20.70	(-)20.70	(-)12.60	(-)12.60
Sub-total	..	304.30	304.30	306.15	306.15
Other Items					
Labour & supervision	..	3.80	1.95	3.95	2.05
Electric power	..	5.00	5.75	5.00	5.75
Fuel	..	6.75	6.75	8.10	8.10
Water and other utilities, consumables, general plant expenses etc	..	6.90	6.00	7.00	6.00
Repair and maintenance	..	5.85	2.95	5.85	2.95
Sub-total	..	28.30	23.40	29.90	24.85
Administration and Sales Expenses		10.00	9.80	10.10	9.90
PRODUCTION COST (excluding fixed charges)	..	342.60	337.50	346.15	340.90
Say	..	343	338	346	341

SECTION 1

M.N. DASTUR & COMPANY (P) LTD
CALCUTTA

APPENDIX 18-2

...TION COST FOR PLATE EXCLUDING FIXED CHARGES
(US $ per ton)

Malaysia		Singapore		Indonesia		Philippines	
Alt. 1	Alt. 2	Alt. 1	Alt. 2	Alt. 1	Alt. 2	Alt. 1	Alt. 2
318.75	318.75	306.25	306.25	312.50	312.50	318.75	318.75
(-)12.60	(-)12.60	(-)15.30	(-)15.30	(-)21.60	(-)21.60	(-)17.10	(-)17.10
306.15	306.15	290.95	290.95	290.90	290.90	301.65	301.65
3.95	2.05	7.10	3.65	3.00	1.55	2.65	1.35
5.00	5.75	5.50	6.35	4.00	4.60	6.60	7.60
8.10	8.10	12.40	12.40	3.00	3.00	9.90	9.90
7.00	6.00	8.50	6.85	6.50	5.75	6.30	5.70
5.85	2.95	5.85	2.95	5.85	2.95	5.85	2.95
29.90	24.85	39.35	32.20	22.35	17.85	31.30	27.50
10.10	9.90	10.00	9.70	9.50	9.20	10.00	9.80
346.15	340.90	340.30	332.85	322.75	317.95	342.95	338.95
346	341	340	333	323	318	343	339

SECTION 2

APPENDIX 19-1

BRIEF REVIEW OF AVAILABLE TECHNOLOGIES FOR ELECTROLYTIC TINNING

Before cold rolled, electrolytically cleaned, annealed, skin passed coil is fed to the electrolytic tinning line, off gauge portion of the strip is removed and the strip is trimmed to the desired width in coil preparation line.

In electrolytic tinning, the steel strip is first cleaned with alkaline solution, pickled and then coated with tin. For tin coating either acid bath using stannous tin (Sn^{++}) or basic electrolytic bath using stannic tin (Sn^{++++}) can be used. Acid electrolytes are generally preferred because of the advantage of obtaining double coating weight for the same current density than that for basic electrolyte.

With acid electrolyte, either ferrostan or Halogen type electrolytic tinning lines are used. Ferrostan lines using stannous sulphate and phenol sulphonic acid are used with current densities up to 45 amps per dm^2 or more with a cathode efficiency of 95 per cent or better. Such operating conditions permit the use of a smaller plating tank. Alkaline stannate lines are similar in design, but require larger sized plating units because they operate with a relatively lower current density of 6 to 7 amps per dm^2. Halogen lines use acid halogen electrolyte with the plating units arranged in two levels. In this process, strip is coated on one surface first, then the strip travel direction is reversed and the other side is coated. Halogen lines have a higher coating

Appendix 19-1 (cont'd)

rate compared to ferrostan lines and hence are used where relatively higher tonnages are required. Electrolytic tinning lines with acid electrolytic bath can be installed with capacities ranging from about 75,000 tons per year to about 350,000 tons per year. At Usinor, France, an acid electrolytic tinning line was set up in 1973 with an installed capacity of about 350,000 tons per year. After electrolytic tinning, the coating is smelted and quenched in water which imparts a bright and reflecting surface to the strip and makes it more corrosion-resistant and suitable for soldering. The strip surface is subsequently passivated in chromic acid and then oiled.

The electrolytically coated coil coming out from the tinning line can be sold as such in coil form or sheared to desired cut length in shearing lines, where the defective sheets are removed from the prime sheet. A few tin plate sheet piles having some defective sheets are again sorted out in reassorting lines where such defective sheets are inspected and removed.

APPENDIX 19-2

TYPICAL LIST OF MAJOR PRODUCTION FACILITIES FOR ELECTROLYTIC TINNING LINE

Equipment/Facilities

Coil preparation unit including uncoiler, pinch roll, shear, welding unit, side trimmer, coiler etc.

Electrolytic tinning line including uncoiler, pinch rolls, shears, welder, looping towers, electrolytic cleaning unit, rinsing unit, electrolytic pickling unit, electrolytic tinning unit, driers, resistance melted coating unit, thickness gauge, passivation unit, oiling unit, bridle, coiler etc.

Shearing lines including uncoiler, pinch roll, thickness gauge, pin hole detector unit, shear, classifier, auxiliary units etc.

Re-assorting line including roller table, pile lifter, inspection conveyor, thickness gauge and pilers etc.

Weighing machines

Anode cast house

Handling equipment

APPENDIX 19-3

ESTIMATED PRODUCTION COST FOR TINPLATE EXCLUDING FIXED CHARGES
(US $ per ton)

		Thailand	Malaysia	Singapore	Indonesia	Philippines
Materials						
C.R. coil	..	493.95	477.30	460.65	471.75	555.00
Credit for scrap	..	(-)10.35	(-)5.60	(-)6.80	(-)9.60	(-)7.60
Sub-total	..	483.60	471.70	453.85	462.15	547.40
Other Items						
Labour & supervision	..	6.00	6.25	11.20	4.70	4.15
Electric power	..	6.25	6.25	6.90	5.00	8.25
Consumables including tin and acids	..	70.00	70.00	70.00	70.00	70.00
Fuel oil, water and other utilities, general plant expenses, etc	..	7.10	7.25	9.75	6.50	6.30
Repair and maintenance	..	9.50	9.50	9.50	9.50	9.50
Sub-total	..	98.85	99.25	107.35	95.70	98.20
Administration and Sales Expenses	..	17.40	17.10	16.80	16.70	19.40
PRODUCTION COST (excluding fixed charges)	..	599.85	588.05	578.00	574.55	665.00
Say	..	600	588	578	575	665