



No. 48

**THE FEASIBILITY STUDY REPORT
ON THE INTEGRATED FLAT STEEL PLANT
IN THE KINGDOM OF THAILAND**

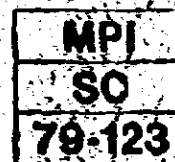
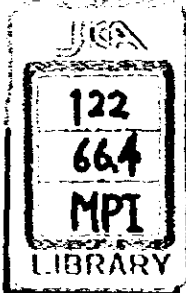
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Dec. 79

December, 1979

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**Japan International
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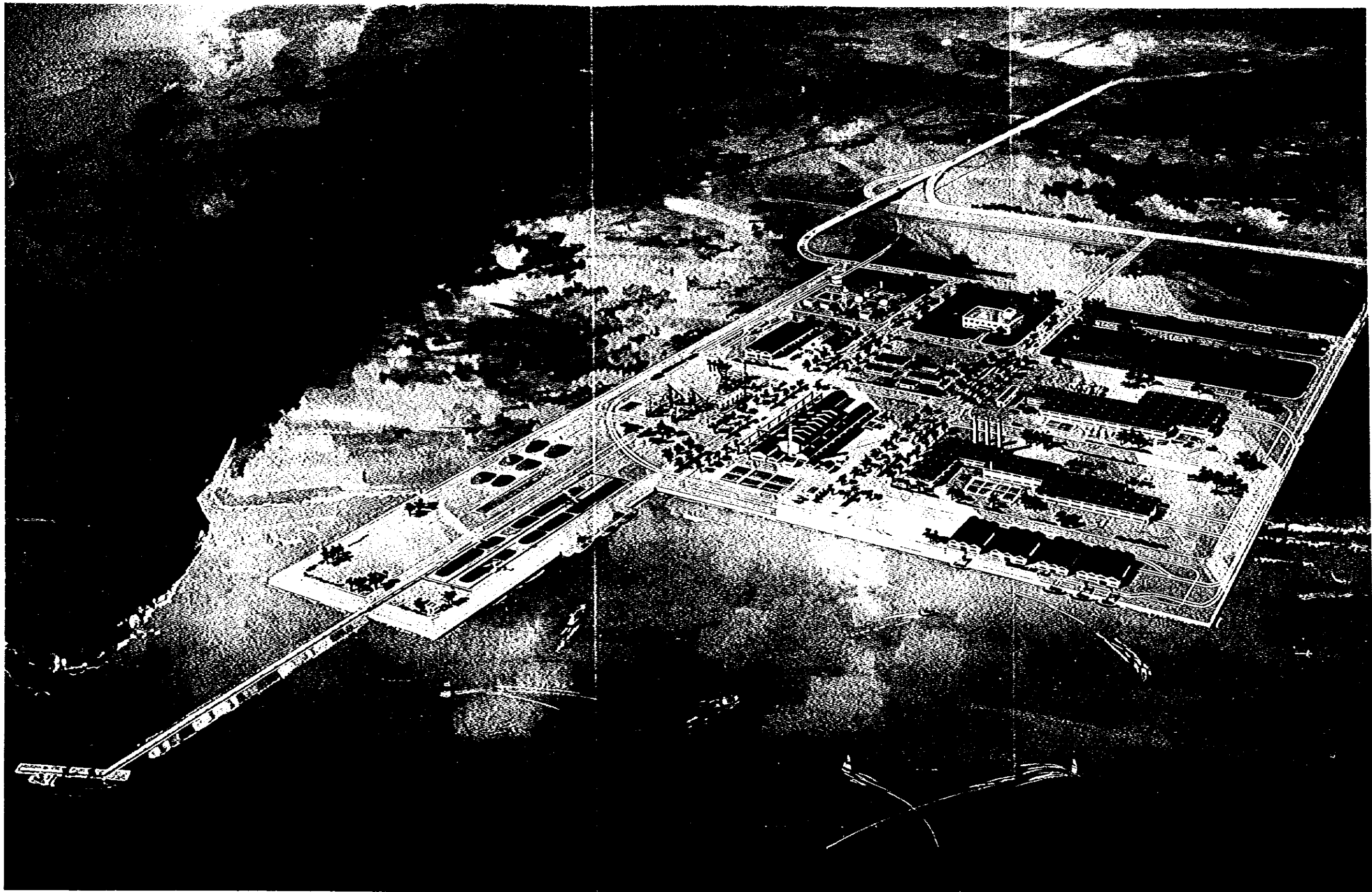
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THE INTEGRATED STEEL PLANT AT LAEM CHABANG IN THE KINGDOM OF THAILAND

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FOREWORD

The Japanese Government decided in compliance with a request of the Royal Thai Government to conduct a feasibility study for the intergrated flat steel plant in the Kingdom of Thailand and commissioned its execution to the Japan International Cooperation Agency.

The Agency, prior to the implementation of the study, despatched a so-called contact mission consists of two representatives of the Japanese Government, one each from the Ministry of International Trade and Industry and the Japan International Cooperation Agency to work out the terms of reference for the study.

Following the establishment of the terms of reference, the Agency organized under the cooperation of the Japanese Government authorities concerned and the Japan Iron and Steel Federation, a 13-man Survey Team headed by Mr. Sachio Hatori of Nippon Kokan K.K. and sent it to Thailand from February 24 through March 10, 1979.

While in Thailand, the Survey Team conducted extensive discussions with the members of office of the Board of Investment of the Royal Thai Government and government agencies concerned, and made two trips to the proposed sites at Laem Chabang and Sattahip for the on-site survey.

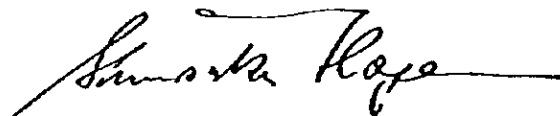
Three officials of office of the Board of Investment visited Japan in July, 1979, to examine and discuss the findings of the study compiled in the interim report.

The final report was completed in November 1979. The study was the first of its

kind ever undertaken by the Japanese Government in this specific field. The wholehearted cooperation of the Board of Investment and other government agencies concerned to the Survey Team was substantial for the very fruitful discussions and the very extensive collection of the relevant data as achieved.

As mentioned in the Report, the proposed integrated flat steel plant, when completed, will make significant contributions to the economic development of Thailand. We believe that the Report will serve as a useful guide to the development of the steel industry and of the national economy of Thailand. And we hope that the Royal Thai Government will make a full use of this Report to materialize the proposed project on the integrated flat steel plant.

Last but not least, we wish to express our sincere appreciation for the generous assistance and cooperation extended by the Board of Investment and other government agencies concerned of the Kingdom of Thailand.



Shinsaku Hogen
President
Japan International
Cooperation Agency

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General Contents

Foreword		
Chapter 1	Introduction	1
Chapter 2	Summary	11
Chapter 3	The Steel Industry at Present and in the Future	39
Chapter 4	Basic Plan for the New Steel Plant	133
Chapter 5	Site Selection and Related Infrastructures	165
Chapter 6	Implementation Programme	233
Chapter 7	Raw Materials	257
Chapter 8	Natural Gas, Electricity and Water	283
Chapter 9	Labour and Organization	299
Chapter 10	Estimation of Construction Cost	319
Chapter 11	Estimation of Production Cost	327
Chapter 12	Financial Analysis	377
Chapter 13	Impact on Economy and Society	399
Chapter 14	Recommendations	413
Chapter 15	Detail Description of Equipment and Facilities	423
Appendix		674

CONTENTS

Chapter 1	Introduction	1
Chapter 2	Summary	11
2.1	The Steel Industry at Present and in the Future	11
2.2	Basic Plan for the New Steel Plant	15
2.3	Site Selection and Related Infrastructure	17
2.4	Implementation Programme	20
2.5	Raw Materials	21
2.6	Natural Gas, Electricity and Water	23
2.7	Labour and Organization	24
2.8	Financial Projections	26
2.9	Impact on Economy and Society	31
2.10	Recommendations	33
2.11	Equipment and Facilities	34
Chapter 3	The Steel Industry at Present and in the Future	39
3.1	Economic Situation	39
3.2	Present Status of Thai Steel Industry	59
3.3	Steel Demand Forecast I (1985 and 1990)	87
3.4	Steel Demand Forecast II (1995 and 2000)	107
3.5	Steel Prices and Price Performance in ASEAN Nations	117
3.6	Possibility of Exporting Flat Products	128
Chapter 4	Basic Plan for the New Steel Plant	133
4.1	Basic Concept	133
4.2	Type of Products and the Outputs	135
4.3	Comparison between BF/BOF Route and DR/EAF Route	137
4.4	Production Plan and Flow	144
4.5	Main Production Equipment	153

4.6	Material Flow and Associated Data	153
4.7	Construction and Operation Schedules	161
4.8	Relationship between Production and Demand	163
Chapter 5	Site Selection and Related Infrastructures	165
5.1	Basic Conditions for Site Selection	169
5.2	Natural Conditions at Three Proposed Sites	169
5.3	Comparison of Three Proposed Sites	179
5.4	Layout for the Integrated Steel Plant	220
5.5	Land Preparation	222
5.6	Planning and Construction of Port Facilities	223
5.7	Prerequisite Preparation Programme for Infrastructure Related Facilities	230
Chapter 6	Implementation Programme	233
6.1	Construction Schedule	233
6.2	Preparation before the Project Implementation	237
6.3	Organization during Construction Stage	240
6.4	Recruitment and Training Programme	242
6.5	Preparation for Construction Facilities	245
6.6	Start-up Production Plan	248
6.7	Effect of One Year Delay of the Start-up	255
Chapter 7	Raw Materials	257
7.1	Iron Oxide	258
7.2	Scrap	270
7.3	Ferroalloys	272
7.4	Burnt Lime	276
7.5	Fluorite	279
7.6	Miscellaneous	280
7.7	Quantity of Purchase, Consumption and Inventory	280

Chapter 8	Natural Gas, Electricity and Water	283
8.1	Natural Gas	283
8.2	Electricity	289
8.3	Water	295
Chapter 9	Labour and Organization	299
9.1	Organization and Personnel	299
9.2	Labour Cost	307
9.3	Training	311
9.4	Necessary Factors for Smooth Operations	318
Chapter 10	Estimation of Construction Cost	319
10.1	Assumptions and Basic Concepts for Estimation	319
10.2	Construction Cost Required for the 1st Stage	321
10.3	Direct Construction Cost Required for the 2nd Stage	324
10.4	Classification of Construction Cost into Fixed Assets	326
Chapter 11	Estimation of Production Cost	327
11.1	Basic Concepts in Cost Accounting	327
11.2	Assumptions of Cost Accounting	330
11.3	Results of Cost Accounting	336
Annex:	Cost Calculation Details	344
Chapter 12	Financial Analysis	377
12.1	Assumptions for Financial Analysis	377
12.2	Results of Financial Projections	384
12.3	Financial Analysis	393
Chapter 13	Impact on Economy and Society	399
13.1	General	399
13.2	Saving of Foreign Currency	402
13.3	Effect of Employment	404
13.4	Effect of Technological Transfer	405

13.5	Impact on Environment	412
Chapter 14	Recommendations	413
14.1	Provision of Incentives	413
14.2	Improvement of Infrastructure	415
14.3	Gurantee for Supply of Utilities	417
14.4	Surveys Relating to the New Steel Plant	420
14.5	Recruitment of Competent Labour Force	421
14.6	Establishment of the Project Promotion Organization	422
14.7	Improvement of Statistical Data	422
Chapter 15	Detail Description of Equipment and Facilities	423
15.1	Raw Material Receiving and Handling Facilities	423
15.2	Direct Reduction Plant	437
15.3	Steelmaking Shop	467
15.4	68-inch Hot Strip Mill Plant	529
15.5	56-inch Cold Strip Mill Plant	557
15.6	Utilities	585
15.7	Analyzing Facilities	629
15.8	Material Testing Equipment	637
15.9	Maintenance Facilities	643
15.10	Intraworks Transportation Facilities	655
15.11	Product Handling Facilities	659
15.12	Production Control System	669
Appendix		
I.	Non Flat Steel Plant	675
1.	Direct Reduction Plant	675
2.	Steelmaking Shop	681
3.	Rod and Wire Mill	696
II.	Estimated Cost of DRI Produced in the 400,000 t/y DR Plant	713

LIST OF TABLES

Chapter 3

Table 3.1.1	Share of GDP by Industrial Sectors	41
Table 3.1.2	Sectoral Composition of GDP at Constant 1972 Prices ..	42
Table 3.1.3	GDP Growth Rate at Constant 1972 Prices	43
Table 3.1.4	Gross Domestic Expenditure at Constant 1972 Prices ...	44
Table 3.1.5	Proportion of GFCF of Domestic and Imported Origin ..	45
Table 3.1.6	The Investment Expenditure Targets of Fourth Economic Development Plan at Current Prices	46
Table 3.1.7	Gross Domestic Product Originating from Manufacturing at 1972 Prices	48
Table 3.1.8	Comparison Between Actual Economic Performance and the Plan Targets by Industrial Origin	52
Table 3.1.9	Regional Shares of GDP in the 4th Economic Development Plan at Constant 1972 Prices	53
Table 3.1.10	Trends in Income Distribution & Regional Shares of GDP at Constant 1962 Prices	54
Table 3.1.11	Regional Classification of GDP at Current Prices in 1977	55
Table 3.1.12	Energy Consumption by Source of Energy	57
Table 3.1.13	Imports of Petroleum Products	57
Table 3.2.1	Main Existing Steel Plants & Their Productions in Thailand (As of June 1977)	60
Table 3.2.2	Steel Mill Capacity & Steel Mill Products of Thailand (As of June 1977)	65
Table 3.2.3	Past Trend of Steel Imports	68
Table 3.2.4	Country Classification of Steel Export to Thailand in 1977	69
Table 3.2.5	Change in Imported Steel Products	70
Table 3.2.6	GDP Growth Rate and Apparent Steel Consumption (final products base)	71

Table 3.2.7	Apparent Consumption of Steel Mill Products	72
Table 3.2.8	Classification of ASC by Final Products	73
Table 3.2.9	Apparent Crude Steel Consumption Per Capita	75
Table 3.2.10	Steel Consumption Analysis (1975, '76, '77 Avr.) by Major Industrial Sectors	77
Table 3.2.11	Bangkok Metropolitan Area (BMA) Permitted for Construction	79
Table 3.2.12	Local Production of Parts for Commercial Vehicles	84
Table 3.2.13	Main Economic Indicators of Regional Distribution (1977) and ASC	85
Table 3.2.14	Geographical Distribution of Steel Consumption (1975-1977 Analysis)	86
Table 3.3.1	Economic Frame through 1990	90
Table 3.3.2	Gross Fixed Capital Formation at Constant 1972 Prices	91
Table 3.3.3	Comparison of Demand Forecast by Various Methods ...	94
Table 3.3.4	Trend of Steel Intensity through 1990	95
Table 3.3.5	Steel Consumption Forecast (1985) by Major Industrial Sectors	97
Table 3.3.6	Industrial Classification of Steel Demand (1985)	99
Table 3.3.7	Production Classified by Steel Product through 1990 ...	100
Table 3.3.8	Balance of Supply & Demand (1977, 1985 & 1990)	103
Table 3.3.9	Demand for Flat Steel Products by Rolling Mills (1985 & 1990).....	104
Table 3.3.10	Geographical Distribution of Steel Demand (1985)	105
Table 3.3.11	Apparent Steel Consumption through 1990	106
Table 3.4.1	Estimated GDP until 2000 at 1972 Prices	109
Table 3.4.2	GDP and Steel Intensity (1977 ~ 2000).....	111
Table 3.4.3	Predicted Scale of Thai Economy in 2000	112
Table 3.4.4	Economic and Steel Consumption Indicators for Korea in 1977 and Spain in 1969	114
Table 3.4.5	Historical Data on Steel Consumption in Selected Countries	115

Table 3.4.6	Summary of Steel Demand Forecasts for 1995 ~ 2000 ..	116
Table 3.5.1	Trends in European Export and Domestic Steel Prices	123
Table 3.5.2	Trends in Unit Price of Steel Imports in Thailand	125
Table 3.5.3	Import Price of Steel Products in Four ASEAN Nations in 1977	125
Table 3.5.4	Price Trends in Selected Steel Products in Thailand	126
Table 3.5.5	Export Prices by Steel Products in Selected Countries	127
Table 3.6.1	Steel Demands in ASEAN Nations from 1975 to 1985 ..	131
Table 3.6.2	Gap between Demand and Supply of Steel in ASEAN Nations in 1980 and 1985	131
Table 3.6.3	Demand and Supply of Steel in the Philippines in 1974, 1977 and 1978	132

Chapter 4

Table 4.1.1	Demand Forecasts	133
Table 4.2.1	Production Plan by Type of Products	136
Table 4.2.2	Demand and Production by Mills	136
Table 4.3.1	Comparison of Construction Cost between BF/BOF and DR/EAF	140
Table 4.3.2	Comparison of Production Cost between DRI and Pig Iron	142
Table 4.3.3	Comparison of Molten Steel Production Cost	143
Table 4.4.1	Annual Outputs from Main Facilities	145
Table 4.4.2	Product-mix in Hot Strip Mill	146
Table 4.4.3	Product-mix in Cold Strip Mill	146
Table 4.4.4	Typical Sizes of Hot Strip Mill Products	147
Table 4.4.5	Typical Sizes of Cold Strip Mill Products	147
Table 4.4.6	Range of Product Size	148

Table 4.5.1	Main Facilities	154
Table 4.6.1	Summary of Consumption and Generation – 1st Stage ..	157
Table 4.6.2	Summary of Consumption and Generation – 2nd Stage ..	159
Table 4.7.1	Critical Periods for Construction and Operation	161

Chapter 5

Table 5.2.1	Climatological Data for the Period 1951 – 1975, Laem Chabang	170
Table 5.2.2	Climatological Data for the Period 1951 – 1975, Saltahip	171
Table 5.3.1	Comparison of Working-age Population in Chon Buri and Rayong	212
Table 5.3.2	Preliminary Comparative Study on Three sites	215
Table 5.3.3	Comparative Study on Infrastructure Investment Costs at Three Sites	219

Chapter 6

Table 6.2.1	Key Dates for Main Items	240
Table 6.4.1	Recruitment at Various Stages	244
Table 6.6.1	Commissioning Period for Major Facilities	248
Table 6.6.2	Production Plan – 1st Stage	251
Table 6.6.3	Equipment to be added at the 2nd Stage	252
Table 6.6.4	Start-up Production Programme	253
Table 6.6.5	Quantities of Purchase, Consumption and Inventory.....	254

Chapter 7

Table 7.1	Main Raw Materials Required for the Project	257
Table 7.1.1	Summary of Ore Quality Requirements by Major Commercial DR Processes	260
Table 7.1.2	Selected Iron Ore Deposits in Thailand	264
Table 7.1.3	Production and Consumption of Iron Ore in Thailand ...	265

Table 7.1.4	Evaluation of High Grade Iron Ores of Major Existing Mines	266
Table 7.1.5	Parameters of Selected Imported Iron Ore Sources	268
Table 7.2.1	Size of Vessel for Each Scrap Source	271
Table 7.3.1	Supply Sources of Ferrosilicon	273
Table 7.3.2	Supply Sources of Ferromanganese	275
Table 7.4.1	Chemical Analysis of Limestones Sampled at South-east Thailand	276
Table 7.5.1	Production and Export of Fluorite in Thailand	279

Chapter 8

Table 8.1.1	Characteristics of Natural Gas	285
Table 8.1.2	Gas Price in Various Units	286
Table 8.2.1	Electric Power Receiving Conditions	294
Table 8.2.2	Price of Electricity	294
Table 8.3.1	Water Requirement of the New Steel Plant	296
Table 8.3.2	Potable Water Requirement	297

Chapter 9

Table 9.1.1	Number of Personnel at the Preparation Stage	300
Table 9.1.2	Number of Personnel at the Construction Stage	302
Table 9.1.3	Personnel at the 1st Stage	305
Table 9.1.4	Working System	306
Table 9.1.5	Personnel at Various Stages	308
Table 9.1.6	Personnel at the 2nd Stage	309
Table 9.2.1	Average Unit Labour Cost	310
Table 9.2.2	Basic Salary and Bonus	310
Table 9.3.1	Number of Trainees to be Trained in Developed Countries	312

Table 9.3.2	Training Schedule at the Operation Stage (the case of steelmaking shop)	314
-------------	--	-----

Chapter 10

Table 10.2.1	Direct Construction Cost for the 1st Stage	321
Table 10.2.2	Fund Requirements for the 1st Stage	322
Table 10.3.1	Direct Construction Cost through the 2nd Stage	325

Chapter 11

Table 11.1.1	Cost Centre	329
Table 11.2.1	Purchase Price of Raw Materials and Utilities	331
Table 11.3.1	Production Cost of Major Products	338
Table 11.3.2	Cost of Utilities	338
Table 11.3.3	Cost Summarized Sheet	341
Table 11.3.4	Sensitivity Analysis of Production Cost	343
Table 11.3.5	Cost Sheet by Cost Centre : DR	345
Table 11.3.6	Cost Sheet by Cost Centre : EAF	346
Table 11.3.7	Cost Sheet by Cost Centre : CC	347
Table 11.3.8	Cost Sheet by Cost Centre : Hot Rolling	348
Table 11.3.9	Cost Sheet by Cost Centre : Cold Rolling	349
Table 11.3.10	Cost Sheet by Cost Centre : Hot Finishing	350
Table 11.3.11	Cost Sheet by Cost Centre : Cold Finishing	351
Table 11.3.12	Cost Sheet by Product : HR Coil	352
Table 11.3.13	Cost Sheet by Product : HR Sheet	353
Table 11.3.14	Cost Sheet by Product : CR Coil	354
Table 11.3.15	Cost Sheet by Product : CR Sheet	355
Table 11.3.16	Cost Sheet by Product : CRC for Tin Plate	356

Table 11.3.17	Cost Sheet by Product : CRC for GI Sheet	357
Table 11.3.18	Auxiliary Divisions	358
Table 11.3.19	Other Divided Cost Centres	371

Chapter 12

Table 12.1.1	Payment and Raising of Funds During Construction Period	378
Table 12.1.2	Sales Projection	380
Table 12.1.3	Working Capital	382
Table 12.2.1	Projected Profit and Loss (Case A)	385
Table 12.2.2	Projected Profit and Loss (Case B)	387
Table 12.2.3	Projected Cash Flow (Case A)	389
Table 12.2.4	Projected Cash Flow (Case B)	391
Table 12.3.1	Sales Profit—Case A	394
Table 12.3.2	Sales Profit—Case B	395

Chapter 13

Table 13.1.1	Industrial Interdependence, Forward and Backward Linkage (examples of Italy, Japan and U.S.A.) ..	401
Table 13.2.1	Foreign Currency Saving Effect	403
Table 13.5.1	SOx Diffusion for Hot Mill Furnace (2nd Stage)	409
Table 13.5.2	Environmental Criteria for SOx	409
Table 13.5.3	Characteristics of Wastes after Neutralization & Coagulation	410
Table 13.5.4	Characteristics of Wastes after CAS Treatment	411
Table 13.5.5	Heat Exhaust from the Steel Plant (2nd Stage)	411

Chapter 14

Table 14.3.1	Requirements for Natural Gas, Power and Water	418
--------------	---	-----

Chapter 15

Table 15.1.1	Capacity Calculation of Berth	427
Table 15.1.2	List of Raw Material Receiving and Handling Equipment and Facilities	428
Table 15.1.3	Personnel for Raw Material Receiving and Handling	430
Table 15.2.1	Comparison of Selected Processes Using Natural Gas	448
Table 15.2.2	Basic Design Data of DR Plant (1st Stage)	450
Table 15.2.3	Unit Consumption of DRI	462
Table 15.2.4	Main Equipment List	463
Table 15.2.5	Personnel for DR Plant	465
Table 15.3.1	Production Programme of Steelmaking Shop	469
Table 15.3.2	Main Facilities of Steelmaking Shop	469
Table 15.3.3	Personnel for Steelmaking Shop	470
Table 15.3.4	Main Materials Blending Ratio and Production Yields	479
Table 15.3.5	Non-working Time of EAF	479
Table 15.3.6	Operating Conditions of EAF	482
Table 15.3.7	Specification of DRI	484
Table 15.3.8	Specifications and Consumption of Raw Materials and Others	486
Table 15.3.9	Chemical Compositions of Sub-materials	486
Table 15.3.10	List of Specifications for EAF Equipment	497
Table 15.3.11	Annual Consumption of Raw Materials, Fluxes and Others	502
Table 15.3.12	Annual Consumption of Utilities for EAF	503

Table 15.3.13	Continuous Casting Production Plan and Standard Yield	505
Table 15.3.14	Product-mix for Hot Strip Mill	505
Table 15.3.15	Dimensions of Slab	505
Table 15.3.16	Continuous Casting Non-working Hours	506
Table 15.3.17	Continuous Casting Preparation Time	508
Table 15.3.18	Casting Speed and Time	510
Table 15.3.19	Major Specifications of Continuous Casting Machine ..	518
Table 15.3.20	List of Specifications for Continuous Casting Facilities	523
Table 15.3.21	Annual Consumption of Utilities and Main Materials for Continuous Casting	526
Table 15.4.1	Annual Production (As-rolled Hot Coil)	535
Table 15.4.2	Typical Size of Products (As-rolled Hot Coil)	535
Table 15.4.3	Operating Conditions	536
Table 15.4.4	Number of Main Equipment	540
Table 15.4.5	Specifications of Main Equipment	541
Table 15.4.6	Production Capacity of Rolling Line	548
Table 15.4.7	Consumption of Utilities	553
Table 15.4.8	Amount of By-products	553
Table 15.4.9	Personnel for Hot Strip Mill Plant	555
Table 15.5.1	Annual Production	564
Table 15.5.2	Typical Size of Products	564
Table 15.5.3	Operating Conditions	565
Table 15.5.4	Number of Main Equipment	570

Table 15.5.5	Specifications of Main Equipment	571
Table 15.5.6	Production Capacity of Cold Strip Mill	576
Table 15.5.7	Consumption of Utilities	581
Table 15.5.8	Amount of By-products	582
Table 15.5.9	Personnel for Cold Strip Mill Plant	583
Table 15.6.1	Annual Consumption of Utilities – 1st Stage/ 2nd Stage	589
Table 15.6.2	Natural Gas Balance	591
Table 15.6.3	Electric Power Demand	594
Table 15.6.4	Main Equipment of Substation	602
Table 15.6.5	Process Steam Balance	606
Table 15.6.6	Boiler Facility	608
Table 15.6.7	Plant Air	608
Table 15.6.8	Air Compressor Facility	609
Table 15.6.9	Demand of Oxygen, Nitrogen & Argon	612
Table 15.6.10	Equipment List of Oxygen Plant	613
Table 15.6.11	Water for the New Steel Plant (1st Stage)	620
Table 15.6.12	Details of Water Treatment Facilities for Hot Rolling Mill	626
Table 15.6.13	Personnel for Utilities Section (1st Stage)	628
Table 15.7.1	Samples and Analyzer in Analysis Centre	632
Table 15.7.2	Equipment List	633
Table 15.7.3	Personnel for Analysis Centre	636

Table 15.8.1	Equipment List	639
Table 15.8.2	Personnel for Material Testing Centre	641
Table 15.9.1	Equipment Specifications for Central Maintenance Shop	647
Table 15.9.2	Organization for Maintenance Department	653
Table 15.9.3	Personnel for Maintenance Department	654
Table 15.10.1	Quantities of Transportation (1st Stage).....	656
Table 15.10.2	Equipment List	657
Table 15.11.1	Product Handling Quantities	660
Table 15.11.2	Product Handling Quantities by Transportation Methods	661
Table 15.11.3	Product Berth and Loader Plant	664
Table 15.11.4	Equipment Specifications	666
Table 15.11.5	Personnel for Transportation Section	668
Table 15.12.1	Equipment List	673

Appendix

Table (A)1	Basic Design Data of DR Plant	678
Table (A)2	Equipment List	679
Table (A)3	Basic Production Plan	681
Table (A)4	Main Facilities	682
Table (A)5	Equipment List	687

Table (A)6	Production Plan	691
Table (A)7	Equipment List	694
Table (A)8	Annual Production	696
Table (A)9	Pass Schedule	699
Table (A)10	Working Conditions	671
Table (A)11	Description of Rolling Mills	704
Table (A)12	Specifications of Main Equipment	705
Table (A)13	Mill Capacity	709
Table (A)14	Utility Consumption	710
Table (A)15	Amount of By-products	710
Table (A)16	Production Cost of DRI	714

LIST OF FIGURES

Chapter 3

Fig. 3.2.1	Location of the Main Existing Steel Works	67
------------	---	----

Chapter 4

Fig. 4.4.1	Production Flow – 1st Stage	149
Fig. 4.4.2	Production Flow – 2nd Stage	150
Fig. 4.4.3	Process Flow of the Integrated Steel Plant	151
Fig. 4.6.1	Material Flow – 1st Stage	155
Fig. 4.6.2	Material Flow – 2nd Stage	156
Fig. 4.7.1	Implementation Plan of Steel Project	162
Fig. 4.8.1	Demand and Supply of Flat Rolled Products	164

Chapter 5

Fig. 5.1.1	General Location Map for Three Alternative Sites	167
Fig. 5.2.1	Probability Distribution of Precipitation in Bangkok	172
Fig. 5.2.2	Wind Rose (Laem Chabang)	174
Fig. 5.2.3	Wind Rose (Sattahip)	175
Fig. 5.2.4	Tidal Range (Laem Chabang)	177
Fig. 5.2.5	Tidal Range (Sattahip)	177
Fig. 5.2.6	Wave Heights and Frequencies in Laem Chabang	178
Fig. 5.3.1	Production Capacity and Required Unit Land Space Relationship	179
Fig. 5.3.2	Plot Plan of Integrated Steel Plant at Laem Chabang	181
Fig. 5.3.3	Topography and Proposed Layout at Laem Chabang Site	183
Fig. 5.3.4	Topography and Proposed Layout at Sattahip C Site (Ban Nam Tok)	187

Fig. 5.3.5	Plot Plan of Integrated Steel Plant at Sattahip A	189
Fig. 5.3.6	Topography and Proposed Layout at Sattahip A Site (Hat Yao)	191
Fig. 5.3.7	Soil Profile at Laem Chabang	193
Fig. 5.3.8	Deep Sea Port of Laem Chabang (Layout 2,000)	195
Fig. 5.3.9	Deep Sea Port of Laem Chabang	197
Fig. 5.3.10	Port of Sattahip	201
Fig. 5.3.11	Pier Layout of Sattahip Port	203
Fig. 5.3.12	Plan of Bang Phra Reservoir	207
Fig. 5.4.1	Conceptual Flow Chart on Layout	221
Fig. 5.6.1	Ship Size and Berth Depth	225
Fig. 5.6.2	Annual Production Capacity and Berth Length Relationship	227

Chapter 6

Fig. 6.1.1	Construction Scheduling Chart	235
Fig. 6.3.1	Construction Headquarters Organization	241
Fig. 6.5.1	Monthly Concrete Work Progress	246
Fig. 6.6.1	Start-up Plan – 1st Stage	250
Fig. 6.6.2	Effect of Delayed Start-up	256

Chapter 7

Fig. 7.1.1	Selected Iron Ore Deposits in Thailand	262
Fig. 7.4.1	Limestone Deposits in Thailand	277
Fig. 7.5.1	Fluorite Deposits in Thailand	281

Chapter 8

Fig. 8.1.1	Natural Gas Production Plan	286
Fig. 8.1.2	On-shore Pipeline Route of Natural Gas	287

Fig. 8.1.3	Natural Gas Consumption in the New Steel Plant	288
Fig. 8.2.1	Power Development Plan of EGAT	292
Fig. 8.2.2	Electric Power Consumption in the New Steel Plant	293

Chapter 9

Fig. 9.1.1	Organization at the Preparation Stage	300
Fig. 9.1.2	Organization at the Construction Stage	301
Fig. 9.1.3	Organization at the Operation Stage	304
Fig. 9.3.1	Training Schedule at the Operation Stage (the Case of Steelmaking Shop)	313

Chapter 11

Fig. 11.3.1	Production Cost Flow	337
Fig. 11.3.2	Production Cost Structure Diagramme	342

Chapter 12

Fig. 12.3.1	Break-even Point Analysis	397
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Chapter 15

Fig. 15.1.1	Flow Chart of Raw Material Handling (1st Stage)	424
Fig. 15.1.2	Flow Chart of Raw Material Handling (2nd Stage)	425
Fig. 15.1.3	Sketch of 1,500 t/h Unloader	431
Fig. 15.1.4	Layout of Raw Material Receiving and Handling Facilities	433
Fig. 15.1.5	Layout of Sub-material Receiving and Handling Facilities	435
Fig. 15.2.1	Flow Sheet of Armco Process	440
Fig. 15.2.2	Flow Sheet of Purofer Process	442

Fig. 15.2.3	Flow Sheet of NSC Process	444
Fig. 15.2.4	Flow Sheet of HyL Process	447
Fig. 15.2.5	Layout of DR Plant	453
Fig. 15.2.6	Material Flow of DR Plant (1st Stage)	455
Fig. 15.2.7	Flow Sheet of Midrex Process	457
Fig. 15.2.8	Flow Sheet of Desulphurizing Process (Stretford Process)	461
Fig. 15.3.1	Material Flow of Steelmaking Shop	471
Fig. 15.3.2	Plant Layout of Steelmaking Shop – (1)	473
Fig. 15.3.3	Plant Layout of Steelmaking Shop – (2)	477
Fig. 15.3.4	Electric Arc Furnace – (1)	489
Fig. 15.3.5	Electric Arc Furnace – (2)	491
Fig. 15.3.6	Process Flow of Electric Arc Furnace	499
Fig. 15.3.7	Casting Schedule of Continuous Casting	507
Fig. 15.3.8	Casting Schedule of Sequence Casting	508
Fig. 15.3.9	Simulation – Casting Cycle – (1)	513
Fig. 15.3.10	Simulation – Casting Cycle – (2)	515
Fig. 15.3.11	Continuous Casting Machine Side View	519
Fig. 15.3.12	Process Flow of Continuous Casting	527
Fig. 15.4.1	Process Flow	534
Fig. 15.4.2	Material Flow	550
Fig. 15.4.3	Plant Layout	551
Fig. 15.5.1	Process Flow	562
Fig. 15.5.2	Material Flow	578
Fig. 15.5.3	Plant Layout	579

Fig. 15.6.1	Location of Utility Facilities and Distribution Line Routes	587
Fig. 15.6.2	Natural Gas Distribution Flow	592
Fig. 15.6.3	Single Line Diagramme (230 kV & 66 kV)	595
Fig. 15.6.4	Single Line Diagramme (22 kV & 3.3 kV)	597
Fig. 15.6.5	Flicker Prevention Facilities	601
Fig. 15.6.6	Boiler Layout Plan	607
Fig. 15.6.7	Compressor Facility Layout Plan	610
Fig. 15.6.8	Flow Diagramme of Oxygen Plant	614
Fig. 15.6.9	Layout Plan of Oxygen Plant	615
Fig. 15.6.10	Oxygen, Nitrogen and Argon Gas Flow Sheet	617
Fig. 15.6.11	Water Distribution Flow (1st Stage)	621
Fig. 15.6.12	Hot Strip Mill Water Treatment Flow Diagramme	623
Fig. 15.6.13	Plot Plan of Water Treatment Facilities for Hot Rolling Mill	624
Fig. 15.6.14	Layout of Water Treatment Facilities for Hot Rolling Mill	625
Fig. 15.9.1	Layout of Maintenance Shop	652
Fig. 15.11.1	Layout of Product Berth Facilities	667
Fig. 15.12.1	General System Flow Chart	672

Appendix

Fig. (A)1	Material Flow of DR Plant	677
Fig. (A)2	Layout of Steelmaking Shop (For Non-Flat Product)	685
Fig. (A)3	Continuous Casting Flow Sheet	690
Fig. (A)4	Bar/Rod Mill General Layout	711

LIST OF ABBREVIATIONS, CONVERSIONS AND EQUIVALENTS

Numerical Abbreviations and Conversions

mm	– millimetre
cm	– centimetre
m	– metre
km	– kilometre
in	– inch (1 in = 2.54 cm)
ft	– foot (pl. feet) (1 ft = 0.305 m)
cm ²	– square centimetre
m ²	– square metre
ha	– hectare (1 ha = 10,000 m ² = 2.471 acres)
ft ²	– square foot (1 ft ² = 0.0929 m ²)
Rai	– (1 Rai = 1,600 m ²)
m ³	– cubic metre
Nm ³	– normal cubic metre
MMm ³	– million cubic metres
ft ³ , cu ft	– cubic foot (1 ft ³ = 0.0283 m ³)
SCF	– standard cubic foot
MMSCF	– million standard cubic feet
g	– gramme
kg	– kilogramme
t, tonne	– metric ton (1 tonne = 1,000 kg)
lb (s)	– pound (1 lb = 0.454 kg)
gr, grain	– (1 grain = 0.064 g)
sec	– second
min	– minute
h	– hour

Numerical Abbreviations and Conversions (cont'd)

d	— day
mon	— month
y	— year
l	— litre
gal	— gallon (1 British gallon = 4.546 litre, 1 US gallon = 3.785 litres)
bbl (s)	— barrel (1 barrel = 31.5 U.S. gallons)
A	— ampere
V	— volt
W	— watt
MW	— mega watt
kVA	— kilo volt ampere
MVA	— mega volt ampere
kWh	— kilo watt hour
MWh	— mega watt hour
HP, HP	— horse power
°C	— degree centigrade
°F	— degree Fahrenheit
kcal	— kilo calorie
Gcal	— giga calorie
BTU	— British thermal unit (1 BTU = 0.252 k cal)
%	— per cent
tr	— trace
ppm	— parts per million
pH	— hydrogen ion concentration
g/Nm ³	— gramme per normal cubic metre
grain/100 SCF	— grain per 100 standard cubic feet (= 0.0241 g/Nm ³)

Numerical Abbreviations and Conversions (cont'd)

kg/cm ² g	– kilogramme per square centimetre gauge
PIW	– pound per inch width
mb (s)	– millibar (1 mb = 10 ⁻³ bar, 1 bar = 10 ⁶ dyn/cm ²)
mmAq	– mm aquar (= water)
sp. gr.	– specific gravity
m/sec	– metre per second
t/day	– tonne per day
tpy, t/y	– tonne per year
MMSCFD	– million standard cubic feet per day

Abbreviations of Governmental Organizations

BOI	– Office of the Board of Investment
DTEC	– Department of Technical and Economic Cooperation
EGAT	– Electricity Generating Authority of Thailand
MOC	– Ministry of Communications
MOI	– Ministry of Industry
NEA	– National Energy Administration
NESDB	– Office of the National Economic and Social Development Board
NGOT	– National Gas Organization of Thailand
SRT	– State Railway of Thailand

Abbreviations of Other Organizations

ASEAN	– Association of South-East Asian Nations
ATH	– August Thyssen-Hütte Aktiengesellschaft
BSC	– British Steel Corporation

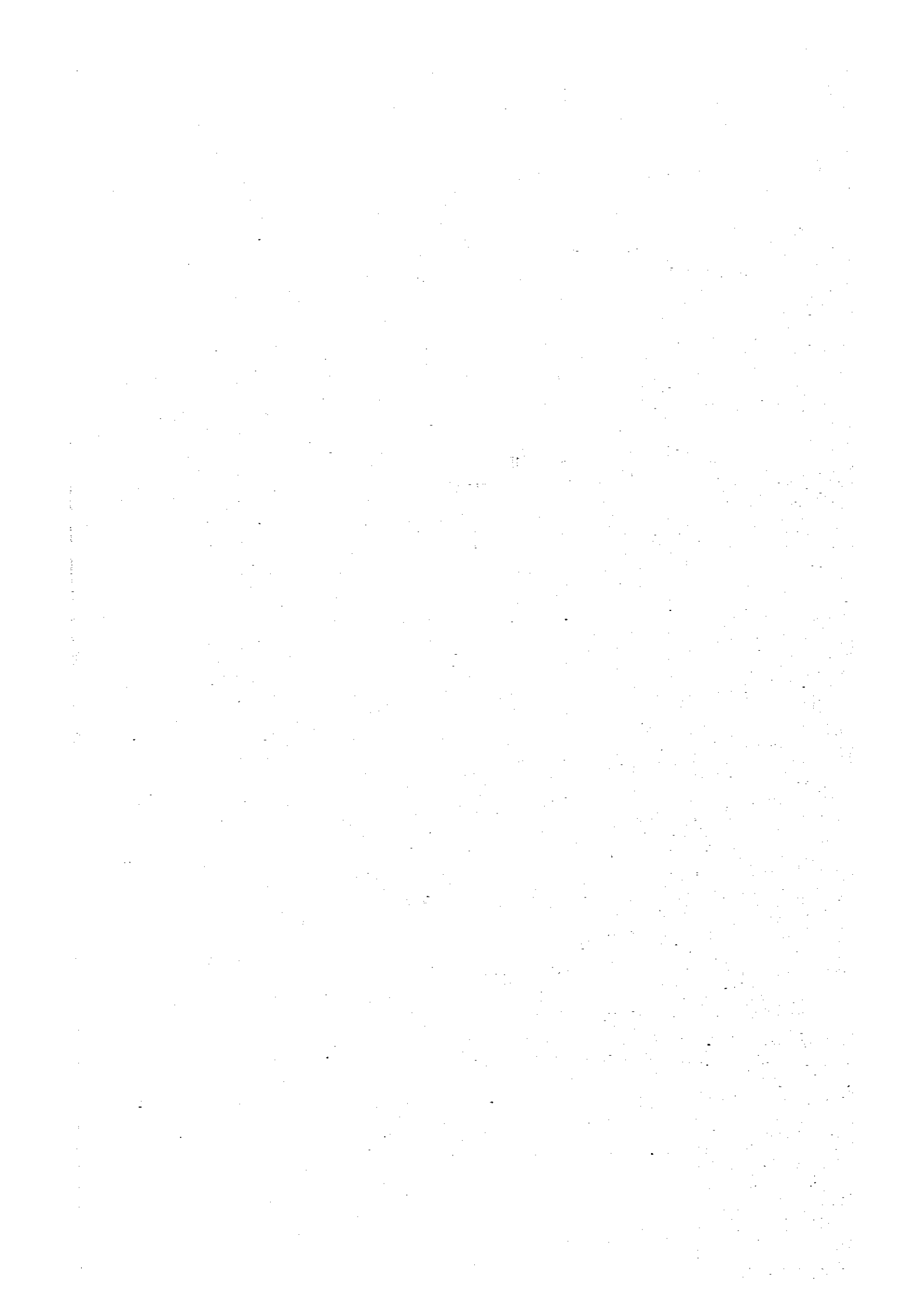
ECSC	– European Coal and Steel Community
ESCAP	– Economic and Social Commission for Asia and Pacific
GAPBESI	– Association of Indonesian Steel Manufacturers
IISI	– International Iron and Steel Institute
JICA	– Japan International Cooperation Agency
JISF	– The Japan Iron and Steel Federation
NASCO	– National Steel Corporation, R. of Philippines
NEDECO	– Netherlands Engineering Consultants
OPEC	– Organization of Petroleum Exporting Countries

Other Abbreviations

DMT	– dry metric ton
DWT	– dead weight tonnage
MSL	– mean sea level
C & F	– cost and freight
CIF	– cost, insurance and freight
ASC	– apparent steel consumption
GDCF	– gross domestic capital formation
GDP	– gross domestic product
GFCF	– gross fixed capital formation
GNP	– gross national product
IIP	– index of industrial product
SI	– steel intensity
DCF	– discounted cash flow
ROE	– return on equity
ROI	– return on investment
IDC	– interest during construction
BF	– blast furnace

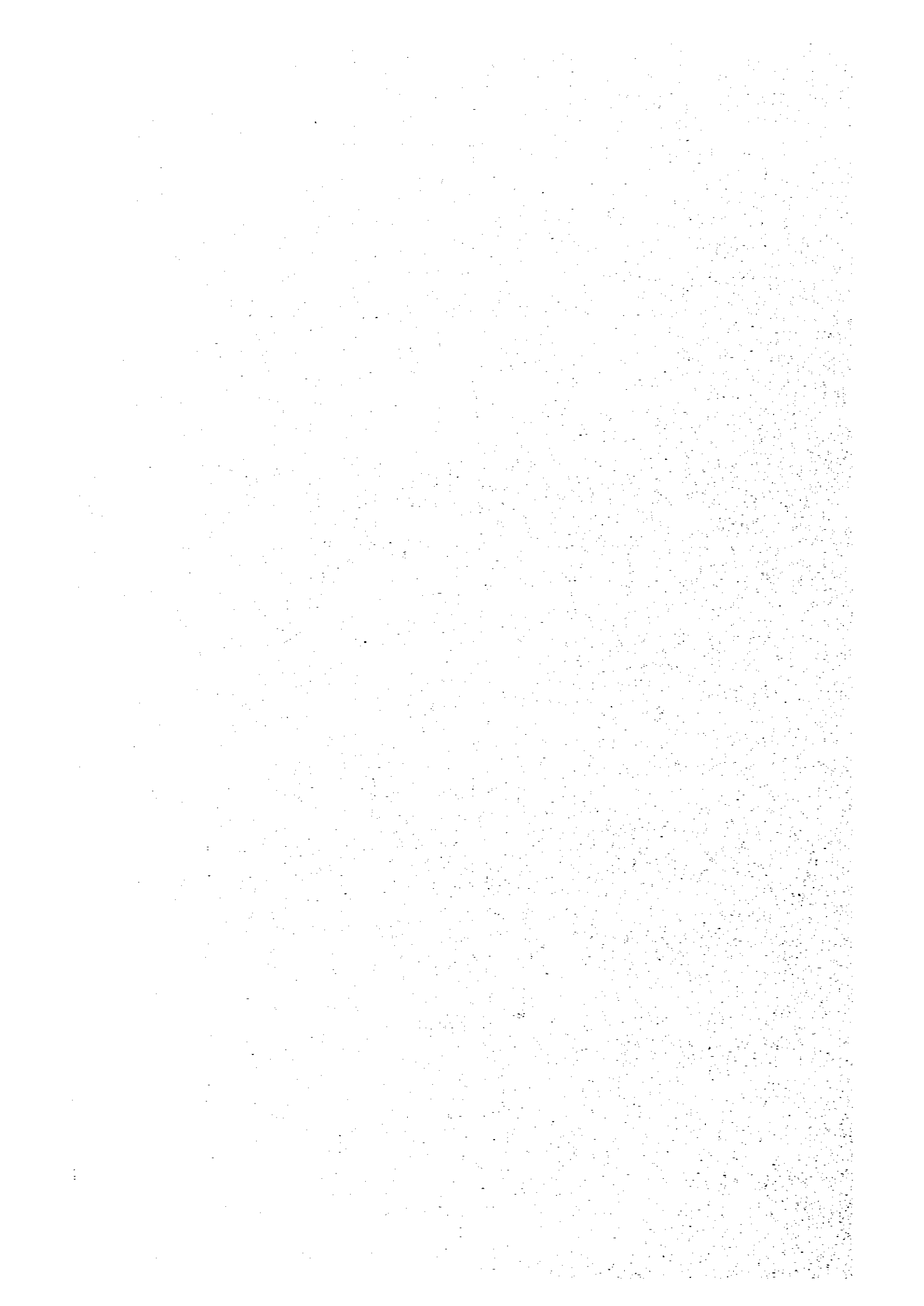
Other Abbreviations (cont'd)

BOF	— basic oxygen furnace
CC	— continuous casting
CR	— cold rolling or cold rolled sheet
DR	— direct reduction
EAF	— electric arc furnace
HR	— hot rolling or hot rolled sheet
UHP	— ultra high power
ETL	— electrolytic tinning line
FSB	— finishing scale breaker
EDP	— electronic data processing
AGC	— automatic gauge control
BIC	— bar in coil
CRC/CRS	— cold rolled coil/cold rolled sheet
DRI	— direct reduced iron (called often sponge iron)
ERW	— electric resistance welding
GI	— galvanized iron sheet
HRC/HRS	— hot rolled coil/hot rolled sheet
LGS	— light gauge section
PC	— prestressed concrete
RC	— reinforced concrete
SRC	— structural reinforced concrete
VSF	— vertical scale breaker



CHAPTER I

INTRODUCTION



CHAPTER 1 INTRODUCTION

This is a report on the findings of a feasibility study carried out by the Japan International Cooperation Agency on an integrated flat steel plant in the Kingdom of Thailand. The Survey Team visited the Kingdom of Thailand from February 24 through March 10, 1979 to conduct the study.

The Royal Thai Government has been studying the construction of a new integrated steel plant designed for the import substitution of a sharply increasing steel demand and for the possible utilization by the steel industry of natural gas found in the Gulf of Thailand soon to be available for industrial use.

Accordingly, it was the purpose of the Survey Team to carry out studies on the current situation and future prospects of the conditions surrounding the proposed integrated steel plant project by the Royal Thai Government. The Survey Team has undertaken the study setting a goal of the first stage of production at meeting with the 1985 demand for flat products projected by demand forecasts and that of the second stage of expanded production at supplying the 1990 demand.

In working out the layout of the integrated steel plant, the Survey Team has given a due consideration to the future production of non-flat products such as sections and bars as well. As noted in the Report, the Survey Team has worked out steel demand forecasts, and, based on these forecasts, has studied and evaluated the scope of the proposed integrated steel plant, the technological, economic and social aspects and of the construction and operation of the new steel plant. It hereby presents recom-

mentations on the conditions essential to the construction and management of the steel plant.

The steel plant is expected to supply basic materials indispensable to economic development, creating a great many employment opportunities in the southeastern part of Thailand. Also, it is expected to contribute to the attainment homogeneous economic development which will serve as the core of industrialization of Thailand with technology transfers from developed countries.

As will be found in the ensuing chapters, the Survey Team employed multilateral approaches to formulate a plan for the proposed integrated steel plant, which, in the view of the Survey Team, is the largest possible and most desirable in Thailand. It is hoped that the Royal Thai Government will fully examine the substance of the Report and that the realization of the proposed steel plant project will be pursued using this as a practical guide.

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Study Team Itinerary in Thailand

Date		Contents
Feb. 18	Sun.	Lv. Tokyo Av. Bangkok
Feb. 19	Mon.	Department of Technical & Economic Cooperation Board of Investment Embassy of Japan Japan International Cooperation Agency, Bangkok Office
Feb. 20	Tue.	Board of Investment Ministry of Industries Japan External Trade Organization's Bangkok Office
Feb. 21	Wed.	Industrial Estate Authority Natural Gas Organization of Thailand
Feb. 22	Thu.	State Railway of Thailand Board of Investment Economic & Social Commission for Asia and Pacific, United Nations Private Companies ——— 1, 2, 3, 4, 5, 6 (Refer to Note)
Feb. 23	Fri.	Site Survey ——— Sattahip
Feb. 24	Sat.	Site Survey ——— Laem Chabang
Feb. 26	Mon.	Department of Mineral Resources Bank of Thailand Water Resources Planning Subcommittee Ministry of Industries Private Companies ——— 7, 8, 9 (Refer to Note)
Feb. 27	Tue.	National Economic & Social Development Board Meteorological Department Board of Investment
Feb. 28	Wed.	Private Companies ——— 10, 11, 12 (Refer to Note)

Study Team Itinerary in Thailand (cont'd)

Date		Contents
Mar. 1	Thu.	Hydrographic Department, Loyal Thai Navy Civil Engineering Department, Chulalongkorn University Electricity Generating Authority of Thailand Private Companies ——— 13, 14, 15, 16 (Refer to Note)
Mar. 2	Fri.	Investment Service Center, BOI Department of Town & Country Planning, Ministry of Interior Department of Public Works, Ministry of Interior Department of Highways Office of National Environment Board Private Companies ——— 17, 18, 19 (Refer to Note)
Mar. 5	Mon.	Industrial Finance Corporation of Thailand Ministry of Communications Provincial Electricity Authority Irrigation Department Metropolitan Water Works Authority National Energy Administration Private Companies ——— 20, 21, 22, 23 (Refer to Note) Site Survey ——— Laem Chabang, Sattahip and Related Water Reservoirs
Mar. 6	Tue.	National Economic & Social Development Board Private Companies ——— 24, 25, 26, 27 (Refer to Note)
Mar. 7	Wed.	Port Authority of Thailand
Mar. 8	Thu.	Department of Technical and Economic Co-operation Private Company ——— 28 (Refer to Note)
Mar. 9	Fri.	Board of Investment Embassy of Japan Japan International Cooperation Agency, Bangkok Office
Mar. 10	Sun.	Lv. Bangkok Av. Tokyo

Note:

Private Company List

1. Thai Pineapple Canning Industries Co., Ltd.
2. Kallawis Engineering Co., Ltd.
3. Fujidenki Engineering Co., Ltd.
4. Boriboon Steel Industries Co., Ltd.
5. Sino-Thai Engineering & Construction Co., Ltd.
6. Watana Phaisal Engineering Co., Ltd.
7. Thai-Ohbayashi Corp., Ltd.
8. Tokyo Bank Co., Ltd. Bangkok Branch
9. G.S. Ceramics Co., Ltd.
10. Thai Steel Pipe Industries Co., Ltd.
11. G.S. Steel Co., Ltd.
12. Thai Tinplate Mfg. Co., Ltd.
13. Sangkasi Thai Co., Ltd.
14. Thai-Meidensha Co., Ltd.
15. Thai Bridgestone Co., Ltd.
16. Universal Mining Co., Ltd.
17. Sahaviriya Plate & Sheet Co., Ltd.
18. Sahaviriya Light Gauge Steel Co., Ltd.
19. Thai Special Steel Co., Ltd.
20. Sathask Driam Co., Ltd.
21. Mitsui Bank Co., Ltd. Bangkok Branch
22. Kawasaki Thailand Co., Ltd.
23. Thai Kobe Welding Co., Ltd.
24. The Siam Iron & Steel Co., Ltd.
25. Thai Hino Industries Co., Ltd.
26. Union Oil of Thailand Co., Ltd.
27. Sanyo Universal Electric Co., Ltd.
28. Toyota Motor Thailand Co., Ltd.

Member of Reporting Mission on Draft Report

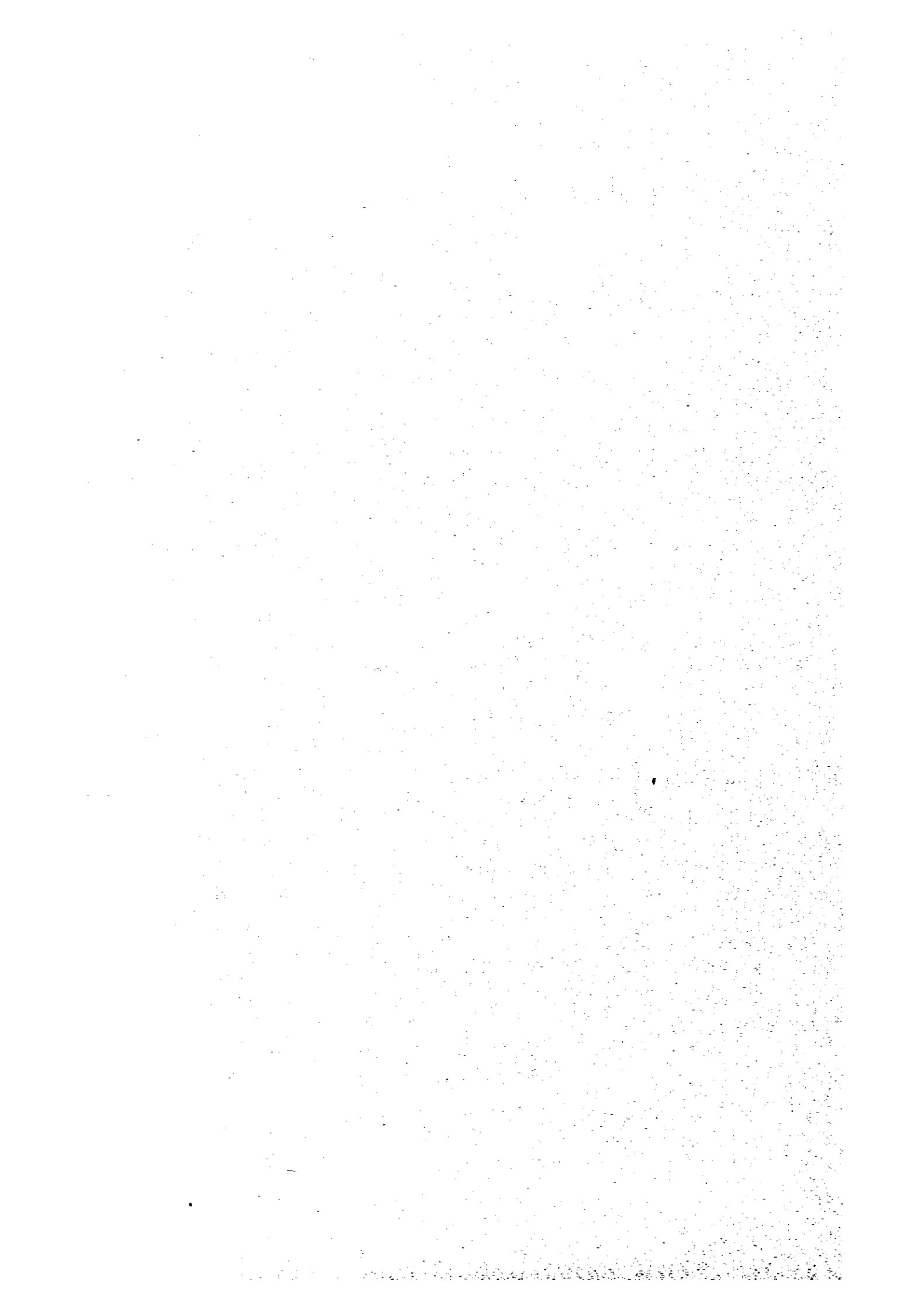
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Dec. 23	Sun.	Lv. Bangkok	Ar. Tokyo

CHAPTER 2

SUMMARY



CHAPTER 2 SUMMARY

2.1	The Steel Industry at Present and in the Future	11
(1)	Steel Demand Forecast I (1985 and 1990)	11
(2)	Steel Demand Forecast II (1995 and 2000)	14
2.2	Basic Plan for the New Steel Plant	15
(1)	Basic Concept	15
(2)	Annual Production in Each Plant	16
(3)	Construction Schedule and Operation Plan	16
2.3	Site Selection and Related Infrastructure	17
2.4	Implementation Programme	20
(1)	Preparation before the Project Implementation	20
(2)	Construction Schedule	20
(3)	Commissioning Programme	21
2.5	Raw Materials	21
2.6	Natural Gas, Electricity and Water	23
(1)	Natural Gas	23
(2)	Electricity	23
(3)	Water	24
2.7	Labour and Organization	24
(1)	Organization and Personnel	24
(2)	Training	25
2.8	Financial Projections	26
(1)	Construction Cost	26
(2)	Production Cost	27
(3)	Financial Analysis	29
2.9	Impact on Economy and Society	31
(1)	Impact on Economy	31

(2) Impact on Society	32
(3) Impact on Environment	33
2.10 Recommendations	33
2.11 Equipment and Facilities	34

CHAPTER 2 SUMMARY

2.1 The Steel Industry at Present and in the Future

(1) Steel Demand Forecast I (1985 and 1990)

i. Present situation of steel demand

With the progress of industrialization in the economy of Thailand, the steel demand has been gradually increased in the 1970's. In the year of 1966, apparent crude steel consumption in Thailand was not more than 650,000 tonnes, but it increased to 1,070,000 tonnes in 1970 and 2,100,000 tonnes in 1977, with per capita apparent steel consumption (ASC) of 48 kg (crude base). That is to say, the annual growth rate of ASC (finished rolled products base) for the latter 7 years recorded 10.0 per cent, outgrowing 6.7 per cent of average annual growth rate of the economy in the corresponding period, with the elasticity value of ASC to gross domestic product (GDP) being as high as 1.49. Further analysis of the steel consumption shows the fact that the annual growth rate of flats (such as sheets and plates, light gauge sections, welded pipe and so on) was 12.7 per cent, higher than that of non-flats (7.8 per cent) and the share of flats enlarged to 49 per cent in 1977, comparing to 41 per cent in 1970. Another characteristic is drawn from the end-use analysis of the year 1975-1977:

- a. The average of total steel consumption in these three years was 1,270,000 tonnes (finished rolled products base).
- b. The construction sector took a big share of 60.5 per cent, while the industrial machinery sector was 8.9 per cent, the container and metal boxes manufacturing sector was 5.7 per cent. Three fourth of total consumption went to these three sectors.
- c. These characteristics reflected in the distribution of steel mill products; the dominant share of 45.1 per cent was bars and wire rods. Next to this was that of uncoated hot rolled sheets and cold rolled sheets (13.1 per cent) and the others are as shown below: galvanized sheet: 10.6 per cent, tin plate: 5.3 per cent and welded pipe: 8.5 per cent.

ii. Demand forecast

According to the above mentioned consumption analysis, the demand forecast was carried out up to the year 1990. As a conclusion, the demand forecast adopted in this study is 2,450,000 tonnes for the year 1985 and 3,553,000 tonnes for the year 1990. Annual growth rate from 1977 to these two years are expected to be 5.9 per cent and 6.6 per cent respectively.

a. Economic frame

It is a prerequisite for the forecast of future steel demand to have some projected annual growth rate of the economy and to fix the pattern of economic growth. In this work, the annual growth rate of GDP (in real terms) from 1978 through 1990 is set to be 7.0 per cent. This 7.0 per cent is derived from the following reasons;

- the actual economic growth rate (by GDP base, in real terms) from 1970 through 1978 has been 7.0 per cent,
- the “Fourth Five Year Plan” (through 1981) of Thai Government

- puts its economic target rate at the same 7.0 per cent, and
- while the economic growth rate is expected to be 7.5 per cent in 1979, the majority of local economists and entrepreneurs expressed their view in the interview that the annual growth rate of 7.0 per cent would be most realistic and probable in the future of Thailand.

The recent trend of GDP growth rate and its future prospect are as follows:

(%)

GDP growth rate by sectors		Actual				Forecast		
		Yearly growth rate to the previous year			Annual growth rate		Annual growth rate	
		1976	1977	1978	'77/'70	'78/'70	'85/'78	'90/'78
Industry	14.7	14.0	11.0	9.1	9.4	9.4	9.3	
Agriculture	4.3	▲1.7	9.4	4.1	4.7	4.8	4.8	
Service	6.6	7.3	5.4	6.8	6.7	6.0	5.8	
GDP total	8.4	6.9	8.7	6.7	7.0	7.0	7.0	

Note: ▲ decline

b. Conclusion of the forecast

The steel demand forecast in 1985 is estimated to be 2,450,000 tonnes, employing the method of accumulating the consumption of each end-use sector. The annual growth rate from the year 1977 is 5.9 per cent. The major increase in demand will be seen in the automotive and transporting equipment industries. For the year 1990, after comparing several figures calculated by various macro methods, final figure selected is 3,553,000 tonnes, the figure initially obtained by the correlation regression with GDP, then modified in relation to the aforementioned figure of 1985. Annual growth rate from the year 1977 is 6.6 per cent. The demand of flat products for the year 1985 and 1990 is 1,201,000

tonnes, 1,758,000 tonnes respectively. The break down of this forecast by rolling mills is as shown below:

(Unit: thousand tonnes, %)

	(A) Present (Av. 1975 to 1977)	Forecast		Annual growth rate	
		(B) 1985	(C) 1990	(B)/(A)	(C)/(B)
Cold rolling mill	305	581	832	7.4	7.4
Hot rolling mill	644	1,260	1,845	7.7	7.9
Plate mill	13	22	30	6.0	6.4

From these figures, each capacity and production level by rolling mill are decided for the integrated flat steel plant in Thailand.

(2) Steel Demand Forecast II (1995 and 2000)

Except for the energy consumption projection by the Electric Generating Authority of Thailand (EGAT) and the population projection by a Government agency, any kind of data on economic forecast to look 20 years ahead from now, for the year 2000, are hardly available in Thailand.

As a means to work out macroeconomic forecast for this distant future, the historical cross-sectional approach was adopted on the basis of actual economic data until 1977 and 1978.

As the approach of sectoral accumulation by consumption will not be qualified to forecast for such a long distant future of 20 years, the demand forecast by type of products was not worked out.

The steel demand for the years 1990 and 2000 is projected as follows:

(Unit: 1,000 tonnes, %)

	Projection		Growth rate	
	1995	2000	1995/1990	2000/1990
Steel products	5,200	7,800	7.9	8.2
Crude steel	6,900	10,400	7.8	8.2

2.2 Basic Plan for the New Steel Plant

(1) Basic Concept

- a. The present study is devoted to the integrated steel plant of the size and substance capable of producing flat products compatible with the demand in Thailand for the years 1985 and 1990 as the goal years.
- b. A two-stage plan has been established for the construction and operation of the steel plant: the 1st stage plan to meet the 1985 demand and the 2nd stage to meet the 1990 demand. With the plan, the following outputs are designed;

1st stage	1.3 million tonnes of molten steel/y
2nd stage	2.0 million tonnes of molten steel/y

- c. Comparison between the Sattahip district and the Laem Chabang district has convinced that the latter is more favourable as the site for the steel plant, consideration was given to allow an expansion of the steel mill for production of non-flat products.
- d. A production route considered is direct reduction(DR)-electric arc furnace(EAF)-continuous casting(CC)-hot strip mill-cold strip mill.

- e. Products include heavy and medium plates, hot rolled and cold rolled sheets, coils for tin plate, galvanized sheet and welded pipe.

(2) Annual Production in Each Plant

(Unit: tonnes)

Plant	Product	1st stage	2nd stage
Direct reduction plant	DRI	1,211,000	1,912,000
Electric arc furnace	Molten steel	1,295,000	2,044,000
Continuous casting machine	Surface treated slab	1,205,000	1,903,000
Hot strip mill	(As rolled)	1,169,000	1,846,000
Cold strip mill	(As rolled)	500,000	841,000

(3) Construction Schedule and Operation Plan

	Item	Description	Remarks
1st stage	Construction period	54 months from the date of construction started	
	Start-up	The 54th month from the date of construction started	
	From commissioning to full-fledged operation	30 months from the date of start-up	84 months from the date of construction started

	Item	Description	Remarks
2nd stage	Date of starting construction	The 21st month from the date of the 1st stage start-up	75th month from the 1st stage construction started
	Construction period	36 months from the date of construction started	
	Start-up	The 36th month from the date of construction started	
	From commissioning to full-fledged operation	18 months from the date of start-up	129 months from the date of 1st stage construction started

If decision-making is drawn immediately after submission of this study report and assuming that the construction of the steel plant progresses on schedule for the minimum period given above, the start-up in the 1st stage falls in October 1984, and that in the 2nd stage in July 1989.

2.3 Site Selection and Related Infrastructures

For a 2.6 million tonnes per year integrated steel plant with 4,000,000 m² (400 ha) of land, three proposed sites – Laem Chabang, Sattahip A (Hat Yao) and Sattahip C (Ban Nam Tok) – on the east coast of the Gulf of Thailand, the so-called Eastern Seaboard Area, were investigated, studied and compared with each other from various technical and economic angles, including land preparation, port and harbour, gas, electricity, industrial water, topography, subsoil condition, meteorology, oceanology, road, railway, labour, city planning, and environment. As a result, Laem Chabang is found to be the odds-on favourite. The present study has been pushed forward with respect to installation layout plan, estimation of construction costs, flow of raw materials and products, buildup of infrastructural facilities, and other various activities, on presupposition that Laem Chabang is suitably sited for the steel plant. Compared with other two sites, Laem Chabang is more favourable in view of port and harbour

planning, electricity supply, labour availability, and city planning. All these have become the clincher in the selection of the site for the integrated steel plant.

As regards the port and harbour facilities, a raw material receiving sea berth (310 m) of -18.5 m capable of accommodating a large ore carrier up to 150,000 DWT class and product loading quays (400 m) of -5 to -6 m are planned for the 1st stage in anticipation of the increase in the size of Thai and other countries' vessels to be handled in the future. Part of the product loading quay (100 to 200 m) should be constructed in advance for the purpose of unloading construction equipment and materials, and scrap in later dates.

The area of land to be prepared is set at 417.5 ha (2,600 Rai). About 16 million m³ of soil materials for land reclamation must be obtained by dredging the channels, basins, and berths and also by cutting the nearby terrain. The planned ground level is mean sea level (MSL) + 4.00 m. Shortages of data about topography and subsoil conditions have prohibited the present study from touching upon the foundation structures. The electric power requirement for the integrated steel plant is estimated at 240 MW for the 1st stage and 360 MW for the 2nd stage, and an overhead transmission line of two circuits rated at 230 kV should be extended from Si Racha. The demand for industrial water is estimated at 50,000 m³/day (14 MMm³/year) for the 1st stage and 70,000 m³/day (22 MMm³/year) for the 2nd stage, and a 900 mm diameter pipeline should therefore be extended from Bang Phra reservoir which is large enough with a storage capacity of 100 MMm³.

As regards the roads, There is no problem with the roads. An access road will be constructed to interconnect the site to National Highway Route No. 3.

Regarding the railways, it is desired that plan by the State Railway of Thailand (SRT) to construct the lines from Changwat Chachoengsao to Laem Chabang and Sattahip will take shape, as they will contribute much toward the transportation of sub-materials, products, construction equipment, the materials

and supplies for the operation of the steel plant, and also toward the commutation of workers.

As regards gas supply, a pipeline of 20 inches diameter or larger should be extended to the site as a branch from the main line running from the terminal near Ban Nam Tok on the east of Sattahip to the south of Bangkok by way of Bang Pakong. The extension to Laem Chabang is estimated at about 30 km. The gas demand will be 54 MMSCFD for the 1st stage and 86 MMSCFD for the 2nd stage.

So far as the labour availability is concerned, the site should preferably be close to Bangkok. In view of this, Laem Chabang is advantageous because it is located near urbanized areas such as Chon Buri and Si Racha. Much is expected for the realization of the industrial allocation plan and city development plan now under way by the Industry Estate Authority (IEA), the Department of Town and Country (DTC) and the Ministry of Industry (MOI).

On the other hand, Sattahip A is advantageous in that the existing Port of Sattahip is available to it. But it is no parallel to Laem Chabang from the viewpoint of land availability, port and harbour plan, electric power supply, labour, city planning, etc. The same may be said about Sattahip C. It should be added by the way that Port of Sattahip which is capable of accommodating ocean-going vessels of 10,000 to 20,000 DWT class can be used for unloading construction equipment and materials.

2.4 Implementation Programme

(1) Preparation before the Project Implementation

During the period from the Government decision to proceed the steel plant project to the commencement of the construction, the following has to be done by the Government: selection of the construction site, method for fund raising, decision of project implementation organization, selection of an engineering consultant, acquisition of the land, basic surveys relevant to civil work, port and harbour facilities, and infrastructural improvements among other things.

(2) Construction Schedule

- a. Fifty-four months should be allowed for from the date of "Go" notice until the date of start-up. The infrastructure for the steel plant has to be completed by the Royal Thai Government to meet the schedule.
- b. Key dates for the main utility and service items to be ready before the start-up date will be as follows:

	From the date of start-up
Electric power	-6 months
Natural gas	-6 months
Industrial water	-6 months
Receiving of raw materials	-4 months
Railway service	-5 months

(3) Commissioning Programme

- a. Commissioning of the respective equipment and facilities after start-up must range from minimum 21 months to maximum 30 months.
- b. Full-fledged commercial operation in the 1st stage must fall on the 84th month after commencement of construction, and on the 129th month for the 2nd stage after commencement of the 1st stage construction.
- c. A plan embodying procurement of raw materials and other materials that is compatible with initiation of operation and commissioning of the respective equipment and facilities must be organized.

2.5 Raw Materials

The raw materials required in the DR/EAF route include iron ore (lump/iron ore pellets), scrap, ferroalloy, lime, fluorite and gas. The feasibility study is based on the principle that these raw materials are of Thai origin or production. In this study, iron-and-steel making raw materials are classified into those to be procured locally in Thailand and those to be imported, with consideration given to the present status of mineral resource researches and developments being conducted in Thailand.

Judging from the result of the present study, lime, fluorite and gas can be procured in Thailand and the other raw materials have to be imported.

The required iron ore in the DR/EAF route must be of high grade (66% Fe minimum and 67% Fe or more preferably). With consideration given to the properties of iron ore, the supply capacity of mines, purchase prices, diversification of risks, and other technical and economic factors, five kinds of pellets and one kind of lump ore have been selected as supply sources from other countries.

Although the local scrap and ferroalloys can be utilized, their quantities do not suffice more than that required by the existing electric arc furnace steelmakers, so it is concluded that these raw materials should be imported.

Considering the factor involved in transport of lime (lime making requires the amount of limestone about 1.8 times in quantity), it is designed that limestone is calcined at the nearest limestone mines and then transported up to the proposed steel plant in the form of burnt lime.

Fluorite should be of Thai origin. Currently, it is exported for chemical and steelmaking use, and it is the most reliable among all raw materials in respect of supply capacity. As to gas, description will be referred to 2.6.

Quantities of main raw materials required for the project are shown in the following table.

(Unit: tonnes/yr)

Raw materials		1st stage	2nd stage	Remarks
Iron oxides (Iron ore lump/ pellets)		1,765,000	2,789,000	Based at 67% Fe, in iron oxides
Scrap		282,900	445,800	Ratio of scrap to DRI at 20:80. The figures include return scrap
Ferro- alloys	Ferro- manganese	7,250	11,400	
	Ferro- silicon	900	1,400	
Burnt lime		90,700	143,100	
Fluorite		3,200	5,100	
Aluminium		2,600	4,100	
Carburizing material		4,700	7,400	

2.6 Natural Gas, Electricity and Water

(1) Natural Gas

It is expected that gas from the Gulf of Thailand to be exploited under the development programme by the Natural Gas Organization of Thailand (NGOT) will be supplied to the thermal power station in 1981.

The output of natural gas will be 150 million standard cu ft/day (MMSCFD) at the initial stage and will be expanded to 500 MMSCFD in 1984. Whereas the amount of gas to be used at this steel plant is estimated to be 54 MMSCFD in the 1st stage and 86 MMSCFD in the 2nd stage.

It is considered that the composition of natural gas has sufficient quality to be used in the steel plant. However, it is necessary to know the amount of organic sulphur content for protection of catalizer in the gas reformer at the DR plant.

The price of gas has not been determined as yet but it will be set at a level somewhat lower than that of heavy oil. With the present study, the price is set at \$1.70 per 1,000,000 BTU.

(2) Electricity

According to the power development programme being promoted by the hand of the EGAT, the total power generation capacity appears to reach 4,300 MW in 1984, whereas the demand power at the steel plant in the 1st stage will be approximately 240 MW, and 360 MW in the 2nd stage. This indicates that it is necessary to include the steel plant's power demand in the EGAT's development programme.

The steel plant has to receive power supply at 230 KV, 450 MVA x 2 circuits, so power distribution lines have to be installed by the EGAT to the site. The price of electricity is set at 0.62 bahts/kWh based on the charge system

as of March 1979.

(3) Water

A great amount of water is used in the steel plant and the majority of it is planned to be circulated. Demand for industrial water in the 1st stage will be 50,000 m³/day, and 70,000 m³/day in the 2nd stage. It should be natural that the industrial water is provided by the public service. What has to be considered is to conduct hydrological surveys as to the amount of water to be available for the steel plant, and to establish a right for the use of industrial water from the water source with multiple purposes.

The price of industrial water is set at 1.5 bahts/m³ which is marginally lower than the unit price of provincial water service. The steel plant also will need 2,200 m³ of potable water/day in the 1st stage, and 3,200 m³/day in the 2nd stage.

2.7 Labour and Organization

(1) Organization and Personnel

The organization and personnel for the various stages of the project of the new integrated flat steel plant are as shown in the following table.

Various kinds of preparations are started from the second half of the construction stage for the plant operation, while the organization and personnel are completed 3 months in advance for the smooth carrying out of operations.

The number of personnel is 3,743 for the 1st stage, and 4538 for the 2nd stage, and this also includes many engineers and skilled workers. Thus, what is the most important is to secure a large number of qualified managers, engineers, and skilled workers.

Labour productivity will be 322 slab tonnes per capita annually at the 1st

stage and 419 at the 2nd stage, which are of a high level even when it is compared with those of developed countries.

Organization and personnel at various stages of the project are shown in the following table.

		Schedule	Organization	Manpower
Preparation stage		-57 months ~ -54 before start (3 months)	4 sections (General affairs, Finance, Personnel, Operation)	19 persons
Construction stage		-54 ~ operation start (54 months)	13 sections (General services 4, Construction 9)	48
Operation stage	1st stage		7 departments, 20 sections (Production, Control, Materials & Transportation, General services, Sales, Purchase)	3,743
	2nd stage		Same as above	4,538

(2) Training

It is also important to provide workers with programmes which go along with the start of operations.

First of all, the key personnel (240 persons, 653 man-months) are sent to developed countries to receive "on-the-job training" for a certain period of time at suitable steel mills. After their return they become the key personnel to carry out the operations of the new steel plant. However, at the initial stage, it is necessary for the smooth start-up to receive technical guidances from experts (126 persons, 688 man-month) from developed countries.

Moreover, even after the operations are going smoothly, it is necessary to set up a training programme based on a set curriculum designed by the personnel section.

2.8 Financial Projections

(1) Construction Cost

Construction costs were projected in accordance with the following criteria.

(Criteria for estimation)

a. Time of estimation and applicable currencies

Imports April 1979 . . . International market price
(U.S. dollars)

Local procurement . . . April 1979 . . . Domestic market price
(bahts)

b. Exchange rate. 1 U.S. dollar = 20.465 bahts (as of April 1979)

c. Price fluctuation Not reflected in the estimate.

d. Taxes on imported equipment and materials. Exempted.

Total fund requirements, including indirect costs, for the 1st stage construction (1.2 million tonnes of slab/y) of the new steel plant amount to 1,407 million dollars.

Direct construction cost amounts to 954 dollars/tonne, and the total construction cost, including indirect cost and interest during construction, amounts to 1,138 dollars/tonne.

Since the total direct construction cost for the 2nd stage is approx. 345 million dollars, the completion of the 2nd stage construction (1.9 million tonnes of slab/y) will bring the direct construction cost down to 784 dollars/tonne.

Of the fund requirements, 312 million dollars (equivalent to the local procurement portion) will be earmarked for capital, and the balance of 1,095 million dollars will be financed by long-term loans.

Fund requirements and their financing are summarized as follows:

	Amount (mill \$)	Amount per slab tonne (\$)	Percentage distribution (%)
Direct construction cost	1,144	954	(81.4)
Engineering fee	42	36	(3.0)
Training cost and operation guidance fee	12	10	(0.9)
Organization expenses	6	5	(0.4)
Subtotal	1,204	1,005	(85.7)
Interest during construction	160	133	(11.4)
Total construction cost	1,366	1,138	(97.1)
Preparation spare parts	41		(2.9)
Total fund requirements	1,407		(100.0)
Capital	312		
Long-term loans	1,095		

(2) Production Cost

Cost accounting was based on the following assumptions.

(Assumptions for calculation)	
a. Price level	April 1979
b. Raw materials, other materials	To be imported except for those locally available.
c. Prices of oxide pellets and lump are ...	Estimated import prices to Thailand, based on international market prices.
d. Depreciation	Straight-line method.
Service life	20 years for buildings and structures 15 years for machinery and fixtures
e. Taxes and duties	Import duty incentives on raw and essential materials are not taken into account.

Production costs of major products under normal operating conditions are as follows:

(Unit: dollars/tonne)

Product	Full cost	Variable cost
DRI	97.2	87.8
Molten steel	201.6	195.2
Slab	230.2	222.8
Hot rolled coil	286.3	248.5
Cold rolled coil	338.4	299.6

The share of each element in total manufacturing cost is shown in the following production cost structure diagramme: variable costs account for 65.5% and fixed costs for 34.5%.

(%)

By-products	Δ 6.8		
Variable cost	65.5	Raw materials	29.9
		Sub-materials	3.3
		Natural gas	9.3
		Electricity	13.3
		Electrode	5.4
		Refractories	5.4
		Other variable supplies	5.7
Fixed cost	34.5	Labour cost	2.0
		Maintenance materials & others	8.1
		Depreciation	24.4

The results of sensitivity analysis of production cost, indicating the effect on total cost of 10% changes in major production cost elements are as follows:

(Unit: dollars/tonne)

	DRI	HR Coil	CR Coil
Normal cost	97.2	286.3	338.4
Operation rate $\pm 10\%$	± 3.5	± 14.1	± 18.8
Capital cost * $\pm 10\%$	± 3.1	± 12.0	± 15.9
Pellet price $\pm 10\%$	± 4.6	± 4.9	± 5.0
Natural gas price $\pm 10\%$	± 2.1	± 2.7	± 3.1
Electricity price $\pm 10\%$	± 0.5	± 3.9	± 4.4
Interest rate $\pm 10\%$	± 1.2	± 4.3	± 5.3
Labour cost $\pm 10\%$	± 0.1	± 0.5	± 0.5

Note: Capital cost includes depreciation, interest & maintenance material cost

(3) Financial Analysis

Assumptions for financial analysis are as follows:

(Assumptions for financial projections)

- a. Project period for financial projections
... 20 years (5 years for construction, 15 years for operation period)
- b. Planned production1.2 million tonnes on slab basis for the 1st stage.
- c. Date of calculationApril 1979
- d. Capital312 million dollars
- e. Long-term loans1,095 million dollars (interest rate: 9%)
(of which interest during construction: 160 million dollars)
- f. Short-term loansInterest (12%)

The following two cases were assumed for sales prices, and various analyses were made for each case.

Case A Sales prices based on the present users' prices.

Case B The Prices obtained by adding 55 dollars/tonne to, or by imposing 14.3% additional protective duty on the Case A prices. (A level at which ROI becomes 10%).

Cash flows, and profits and losses for each case will be as follows: '

(Unit: mill dollars)

Project year	Case A		Case B	
	Profit & loss (After tax)	Net cash flow balance	Profit & loss (After tax)	Net cash flow balance
1	-112	-123	-79	-92
2	-17	-40	40	18
3	5	-17	66	44
4	17	-5	76	55
5	26	4	87	65
6	30	7	91	67
7	40	17	100	77
8	50	27	110	87
9	60	37	114	91
10	70	47	111	88
11	74	153	126	205
12	74	154	126	205
13	74	154	126	205
14	74	154	126	205
15	74	248	126	299

Profits and losses by type of products for each case will be as follows:

In Case A, the profit of hot rolled coil is 14.8 dollars/t and that of cold rolled coil is 16.6 dollars/t.

In Case B, the profit of hot rolled coil is 69.8 dollars/t and that of cold rolled coil is 71.6 dollars/t.

(Unit: dollars/tonne)

	Product	Sales price				Total cost	Profit
			Production cost	General admin. expense	Interest		
Case A	HRC	351	286.3	7.1	42.8	336.2	14.8
	CRC	416	338.4	8.4	52.6	399.4	16.6
Case B	HRC	406	286.3	7.1	42.8	336.2	69.8
	CRC	471	338.4	8.4	52.6	399.4	71.6

The rates of return are calculated as follows by the DCF method.

In Case A, ROI is 6.25 and ROE is 5.59, while in Case B, ROE is 14.08 by setting ROI at 10.00.

	Case A	Case B
Return on investment, ROI (%)	6.25	10.00
Return on equity, ROE (%)	5.59	14.08

2.9 Impact on Economy and Society

(1) Impact on Economy

When the proposed integrated steel plant is constructed and goes into operation, the economic impact will be far-reaching extending all over the Thai economy.

Of all the industries, the steel industry ranks first in the generation of both forward and backward linkage effects. It is above all the integrated steel plant that generates the greatest effect. It will be extensive ranging from the creation of employment opportunities and new industries to the spread of technology and to the improvement in the balance of international payments.

In particular, since the proposed integrated steel plant is intended to

utilize domestic natural gas, the effect will be further intensified coupled with the impact on regional development.

The proposed integrated steel plant project is expected at its final stage to offer 4,500 employment opportunities and create additional 2,500 jobs outside. Such employment opportunities will contribute significantly to a balanced regional distribution of population, not to mention the impact on new industrialization in the southern part of Thailand.

As for the impact on the balance of international payments, the annual savings in foreign exchange will amount to 425 million dollars through import substitution, adding great momentum to the economic development of the nation.

At the same time, with progress in industrialization and sophistication of the industrial structure, the related economic activities will be further activated. According to a survey estimate, the overall rippling effect will ultimately result in the creation of 100,000 employment opportunities in the region.

(2) Impact on Society

The steel industry being a key industry, its successful development will serve to confirm the confidence in industrialization and promote the development of a wide range of supporting industries. And the spread of technology and the accompanying impact on education and training will stimulate the promotion of science and technology and the improvement in the substance of education and training.

Further, the regional distribution of population and the creation of a new industrial zone will greatly favour the homogeneous economic development of the nation, leading to the formation of a most welcome society in the Kingdom of Thailand.

(3) Impact on Environment

The use of large amounts of natural gas and industrial water by the steel plant will result to generate discharges and thereby the surrounding environment will be somewhat affected. However, the extent will be extremely minor degree. Calculations indicate that the concentration of SO_x when dispersed on the ground is approximately 10% of the severest value of the environment criteria of the other countries. The dusty exhaust air from the DR plant and the steelmaking shop is arrested by the various types of dust collectors and then exhausted outside after treatment.

Waste water from the cold rolling mill plant will be treated in the water treatment plant and then discharged in a state of clean water, without containing harmful chemicals. Because the treated waste water will not be discharged into the river but directly into the sea, it will never affect the ecosystem in the river.

For the provision of pollution control equipment, a sum of about \$13 million is expected to be invested for such equipment and about \$1.6 million is expected to be spent per annum for the operation. Consequently, it is estimated that the cost per steel products share approximately \$3/tonne.

The present study has the assumption that in implementing the steel plant project, the owner of the plant has to prepare an Environmental Impact Statement and submit it to the National Environment Board.

2.10 Recommendations

Recommendation from the present study emphasize that the Royal Thai Government strongly and positively put into practice the following requirements in the construction and operation of the new steel plant.

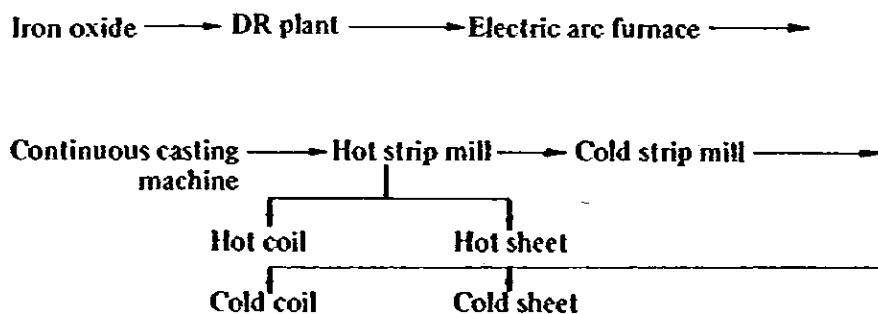
- a. Incentives should be provided for taxes, utility prices, tariffs, fund raising, financing, fostering of allied industries and the encouragement for

domestic production.

- b. Consolidation of infrastructure including land, port and harbour, railway, total community development, etc. should be carried out.
- c. Supply of electricity, gas and water and other utilities should be guaranteed.
- d. Surveys required for the provision of the new steel plant, such as topographic surveys, sounding surveys, soil investigations, water analyses, mineral resource researches, and analyses of natural gas composition should be carried out.
- e. To secure all levels of competent universities, colleges, professional training schools and occupational special schools should be improved and/or established.
- f. It is desired to establish a project promotion organization for the purpose of realization of this project.
- g. It is desired to improve the statistical data.

2.11 Equipment and Facilities

In this study, the following manufacturing processes are employed. The schematic processes are:



The equipment and facilities, and their ancillary equipment required for the processes are as shown on the following table.

	Output		Equipment			Remarks
	1st stage	2nd stage	Designation	Equipment		
				1st stage	2nd stage (addition)	
Raw material handling facilities			Unloader	1,500 t/h x 1	1,500 t/h x 1	
Iron oxide	*1 1,765,000 t/y		Stacker	1,500 t/h x 1	1,500 t/h x 1	*1 Quantity handled.
Scrap	*1 138,500 t/y	*1 2,789,000 t/y	Reclaimer	700 t/h x 1	--	
		*1 216,600 t/y	Crane	35 t x 2	--	
Direct reduction plant			Direct reduction furnace	600,000 t/y x 2	600,000 t/y x 1	
DRI	1,211,000 t/y	1,912,000 t/y	Briquetting facilities	20 t/h x 1	20 t/h x 1	
			Desulphurization equipment	60,000 Nm ³ /h x 1	30,000 Nm ³ /h x 1	
Electric arc furnace			Electric arc furnace	150 t/h x 4	150 t/h x 2	
Molten steel	1,295,000 t/y	2,044,000 t/y				
Continuous casting machine			Continuous slab casting machine	2 strands x 2	2 strands x 1	
Slab	1,230,000 t/y	1,942,000 t/y				

(cont'd)

	Output		Designation	Equipment		Remarks
	1st stage	2nd stage		1st stage	2nd stage (addition)	
Hot strip mill Coil and sheet	#2 1,169,000 t/y	#2 1,846,000 t/y	Reheating furnace Roughing mill Finishing mill Down coiler Skinpass mill Shearing line Recoiling & slitting line	2 1 6 stands x 1 2 1 1 1	1 1 -- 1 -- -- --	#2 Quantity rolled Product specification Coil thickness: 1.2 ~ 12.7 mm Coil width: 600 ~ 1,600 mm Sheet length: ~ 10,000 mm Coil unit weight: 8t max.
Cold strip mill Coil and sheet	#2 479,000 t/y	#2 804,000 t/y	Pickling line Cold tandem mill Cold reversing mill Cleaning line Batch annealing furnace Continuous annealing line Skinpass mill Shearing & slitting line Shearing line Coil preparation line	1 5 stands x 1 -- 2 1 set -- 2 stands x 1 1 -- 1	-- 1 stand to be added to total 6 stands 1 -- Addition 1 1 stand x 1 -- 1 1	#2 Quantity rolled Product specification Coil thickness: 0.15 ~ 3.2 mm Coil width: 50 ~ 1,300 mm Sheet length: 1,000 ~ 4,000mm Coil unit weight: 8t max.

(cont'd)

	Output		Equipment			Remarks
	1st stage	2nd stage	Designation	1st stage	2nd stage (addition)	
Utility equipment			Natural gas equipment	1 set	Addition	Pressure reducing equipment and flare stack. Incoming voltage: 230 kV
			Electric power equipment	1 set	Addition	
			Boiler equipment	15 t/h x 3	15 t/h x 1	
			Compressed air equipment	13,000 Nm ³ /h x 3	---	
			Oxygen generating equipment	1,600 Nm ³ /h x 3	1,600 Nm ³ /h x 1	
			Nitrogen generating equipment	1,000 Nm ³ /h x 3	1,000 Nm ³ /h x 1	
			Water facility	900,000 m ³ /d	To be added to total 1,300,000 m ³ /d	
Analysis equipment			Physical analysis equipment	1 set	---	Analysis of raw materials, products and by-products
			Chemical analysis equipment	1 set	---	
Material testing equipment			Mechanical testing equipment	1 set	Addition	
			Metallic structure testing equipment	1 set	Addition	

(cont'd)

	Output		Designation	Equipment		Remarks
	1st stage	2nd stage		1st stage	2nd stage (addition)	
Maintenance facilities			Machining shop	1 set	Addition	
			Machine repair shop	1 set	Addition	
			Steel-fabrication shop	1 set	Addition	
			Piping shop and foundry	1 set	Addition	
			Electric equipment and instrumentation repair shop	1 set	Addition	
			Vehicle maintenance shop	1 set	Addition	
Intraworks transportation facilities			Road transport facilities	1 set	Addition	
Product handling facilities	1,103,000 t/y	1,741,000 t/y	Product warehouse	Approx. 30,000 m ²	Approx. 18,000 m ²	
			Loader	10 t x 5	10 t x 3	
			Trailer	15 t x 10	15 t x 6	

CHAPTER 3

THE STEEL INDUSTRY AT PRESENT AND IN THE FUTURE



CHAPTER 3 THE STEEL INDUSTRY AT PRESENT AND IN THE FUTURE

3.1 Economic Situation	39
(1) Review and Outlook of National Economy	39
(2) Economic Structure	40
(3) Trends in Manufacturing Sector	47
(4) Direction of Economic Development Plan	49
(5) Energy and Electricity	55
3.2 Present Status of Thai Steel Industry	59
(1) Steel Production	59
(2) Importation of Steel	66
(3) Apparent Steel Consumption	70
(4) Steel Consumption by Demand Sectors	75
(5) Regional Demand for Steel	83
3.3 Steel Demand Forecast I (1985 and 1990)	87
(1) Methods of Forecast	87
(2) Economic Framework	89
(3) Results of Forecast by Macro Method	92
(4) Results of Forecast by Micro Method	96
(5) Final Figures of Demand Forecast	101
3.4 Steel Demand Forecast II (1995 and 2000)	107
(1) Methods of Forecast	107
(2) Forecast Based on Correlation with GDP	108
(3) Forecast Based on Steel Intensity	110
(4) Forecast Based on Historical Cross-sectional Approach	111
(5) Final Figures of Demand Forecast	116
3.5 Steel Prices and Price Performance in ASEAN Nations	117
(1) Pricing System and Distribution Channels in ASEAN Nations	117

(2) Steel Prices in Five ASEAN Nations	120
3.6 Possibility of Exporting Flat Products	128

CHAPTER 3 THE STEEL INDUSTRY AT PRESENT AND IN THE FUTURE

3.1 Economic Situation

(1) Review and Outlook of National Economy

Economic growth rate of Thailand in terms of gross domestic product (GDP) during the 1960's was 7.9 percent annually, and its scale was enlarged 2.14 times (during that period). The main factors contributing to the high economic growth in the 1960's were the promotion of industrialization by the positive introduction of foreign capital, success in agricultural policy stemming from diversified farming and the special procurement during the Vietnam War. "The promotion act for industrial investment" established in 1962 contributed to the development of the import substitution industry in the domestic market.

Towards the end of the late 1960's, the economy of Thailand went into contraction. During the first half of the 1970's, the Thai economy was stagnated by the slow-down of investments for equipment, the aggravation of the balance of payment due to sharp increase of imports of raw materials, and the adverse effects of an international monetary adjustment. Therefore, during the years 1970 to 1975, the real annual growth rate slowed down to 6.3 percent.

Due to the above economic situation, a direction of the economic policy was converted to industrialization. By the establishment of the "Investment Promotion Act" in 1972, which was in reality an economic policy change from

the development of the import substitution industry to the development of the export-oriented industry in the 1970's.

The third "Economic and Social Development Plan" (Oct. 1971 – Sept. 1976) aimed at an annual economic growth rate of 7 percent, but the result was 6.2 percent due to the effect of oil crisis, resultant worldwide stagnation and bad weather.

The fourth "Five-Year National Economic and Social Development Plan" (Oct. 1976 – Sept. 1981) was put into effect with its main target being the speedy restoration of the economy. Although the target of the annual economic growth rate was 7 percent, the result (1976 = 8.4%, 1977 = 6.9%, 1978^e = 8.7%) was more successful than the target due to the steady development of the industrial sector (1976 = 14.7%, 1977 = 14.0%, 1978^e = 11.7%).

The real growth rate of GDP in 1979 is expected to be 7.5 percent, with 6.4 percent in agricultural sector and 7.6 percent in industrial and service sectors.

One of the aims of the Thai economy for the 1980's is the conversion to heavy petro-chemical industrialization with the utilization of natural gas. For this to be accomplished, it is necessary to improve infrastructure (such as transportation, electricity, port and harbour etc.), to train skilled workers and technocrats, and to develop the domestic market, etc. on which the success of Thai economic development depends.

(2) Economic Structure

By the development of the import substitution industry in the 1960's, the Thai economy marked a remarkable change from the dominantly agricultural economy.

The structural shift as seen from the GDP trend (See Table 3.1.1 and 3.1.2) shows that the share of agriculture, forestry and fishery sector shrank

from 38.1 percent in 1960 to 30.0 percent in 1974, while the manufacturing sector expanded from 13.1 percent to 18.1 percent during the same period, which demonstrated the change in Thai economic policy toward industrialization. Needless to say, the manufacturing sector plays a major role in the industry.

This tendency has been growing in recent years and according to the estimated figures for 1978, the share of the manufacturing sector expanded to 21.3 percent and that of the industrial sector, to 36.2 percent. (See Table 3.1.2)

The annual GDP growth rate from 1970 to 1978^e was 7 percent (See Table 3.1.3), equal to the target of the 3rd and the 4th "Economic and Social Development Plans"; a fact which shows the attainment of the desired end.

Though agriculture was inactive because of droughts in 1972 and 1977, the influence of agriculture on the Thai economy was still large as the share of agriculture in GDP was around 30 percent. Marked development of the industrial sector (19.4 percent) also played an important role in the steady economic growth. (See Table 3.1.2)

Since 1974, that is to say after the oil crisis, the industrial sector has developed at an annual rate of 11.8 percent through the strong development of construction (16.1%), electricity and water work service (12.9%) and manufacturing (12.3%). (See Table 3.1.2)

Table 3.1.1 Share of GDP by Industrial Sectors (Unit: %)

	1960	1965	1970	1978 ^e	'78 - '60
Agriculture	38.1	34.0	32.2	27.1	▲ 11.0
Industry	27.0	30.7	30.3	36.2	9.2
Services	34.9	35.3	37.5	36.7	1.8
GDP	100	100	100	100	-

(Source: NESDB & Others)

^e = estimation

Table 3.1.2 Sectoral Composition of GDP at Constant 1972 Prices

(Unit: Million bahts)

	1974		1975		1976		1977		1978 ^a		Growth rate (%)						
	Amount	%	Amount	%	Amount	%	Amount	%	Amount	%	'74/73	'75/74	'76/75	'77/76	'78/77	Avg.	
Agriculture	56,962	30.0	62,080	30.4	64,735	29.3	63,633	26.9	69,045	27.1	9.0	4.3	4.7	4.1	9.4	5.2	
Industry	59,675	31.4	63,756	31.2	73,158	33.1	83,374	35.3	93,137	36.2	6.8	14.7	14.0	11.7	11.8		
Mining and quarrying	2,918	1.5	2,485	1.2	2,906	1.3	3,534	1.5	4,053	1.6	▲14.8	16.9	21.6	14.7	8.6		
Manufacturing	34,403	18.1	37,146	18.2	43,122	19.5	48,855	20.7	54,801	21.3	8.0	16.1	13.3	12.2	12.3		
Construction	7,459	3.9	8,514	4.2	10,022	4.5	11,947	5.1	13,560	5.3	14.1	17.7	19.2	13.5	16.1		
Electricity and water supply	2,706	1.5	3,167	1.6	3,627	1.6	4,134	1.7	4,518	1.8	13.7	14.5	14.0	9.3	12.9		
Transportation and Communication	12,109	6.4	12,444	6.0	14,904	6.2	14,904	6.3	16,205	6.2	2.8	8.3	10.6	8.7	7.6		
Services	73,313	38.6	78,220	38.4	83,404	37.6	89,483	37.8	94,345	36.7	6.7	6.6	7.3	5.4	6.5		
Wholesale and retail trade	34,249	18.0	36,142	17.7	38,658	17.5	40,586	17.2	41,589	16.2	5.5	7.0	5.0	2.5	5.0		
Banking, insurance and real estate	8,944	4.7	9,899	4.9	10,334	4.7	11,598	4.9	12,219	4.8	10.7	4.4	12.2	5.4	8.1		
Ownership of dwelling	3,453	1.8	3,555	1.7	3,666	1.7	3,821	1.6	4,017	1.6	3.0	3.1	4.2	5.1	3.9		
Public administration and defense	7,866	4.2	8,359	4.2	8,893	3.8	9,836	4.1	10,920	4.2	6.3	6.4	10.6	11.0	8.6		
Services	18,801	9.9	20,265	9.9	21,853	9.9	23,652	10.0	25,600	9.9	7.8	7.8	8.2	8.2	8.0		
Gross domestic product	189,950	100	204,056	100	221,297	100	236,500	100	257,127	100	7.4	8.4	6.9	8.7	7.9		

Remarks: ▲ indicates decline
(Source: NESDB - National Accounts of Thailand)

Table 3.1.3 GDP Growth Rate at Constant 1972 Prices

(Unit: %)

	G D P	Agriculture	Industry	Services
1970	6.5	2.6	6.1	10.2
1971	4.7	4.6	3.5	5.7
1972	4.8	▲ 1.2	7.8	7.5
1973	9.4	12.7	9.3	7.0
1974	5.4	1.3	7.8	7.0
1975	7.4	9.0	6.8	6.7
1976	8.4	4.3	14.7	6.6
1977	6.9	▲ 1.7	14.0	7.3
1978 ^e	8.7	9.4	11.7	5.4
'78/'70 Avr.	7.0	4.7	9.4	6.7

(Source: NESDB-ibid.)

^e'79 = Growth rate of GDP is estimated to be around 7.5%.

On the other hand, from the viewpoint of the GDP expenditure, the following facts could be inferred (See Table 3.1.4):

- a. The share of private consumption expenditure is steady at around 65 percent with a 7.1 percent annual growth rate.
- b. Gross domestic capital formation developed at 10.4 percent annually owing to the sharp growth of the public construction sector. At the time investments for private machinery and equipment were dull. The effective management of economic policy was demonstrated with an increase in public investment. Especially after 1975, the promotion of capital formation geared by public investment (annual average of 28.1%) was concentrated on the improvement of infrastructure.

Table 3.1.4 Gross Domestic Expenditure at Constant 1972 Prices

(Unit: Million bahts)

	1974		1975		1976		1977		1978 ^a					Avr.	
	Amount	%	Amount	%	Amount	%	Amount	%	Amount	%	'75/'74	'76/'75	'77/'76		'78/'77
Private consumption expenditure	126,207	66.4	133,584	65.5	143,947	65.0	154,467	65.3	165,871	64.5	5.8	7.8	7.3	7.4	7.1
General government consumption expenditure	19,818	10.4	21,908	10.7	25,325	11.4	29,947	12.7	34,341	13.4	10.6	15.6	18.3	14.7	14.7
Gross fixed capital formation ^b	42,140	22.2	42,411	20.8	44,779	20.2	55,494	23.5	62,645	24.4	0.6	5.6	23.9	12.9	10.4
1. Construction	14,717	7.8	16,875	8.3	20,171	9.1	24,425	10.3	27,816	10.8	14.7	19.5	21.1	13.9	17.3
(a) Private	10,419	5.5	10,592	5.2	10,720	4.8	13,185	5.6	15,067	5.9	1.7	1.2	23.0	14.3	9.7
(b) Public	4,298	2.3	6,283	3.1	9,451	4.3	11,240	4.7	12,749	4.9	46.2	50.4	18.9	13.3	31.2
2. Equipment	27,423	14.4	25,536	12.5	24,608	11.1	31,069	13.2	34,829	13.6	46.9	43.6	26.3	12.1	6.2
(a) Private	24,853	13.1	22,331	10.9	20,781	9.4	26,505	11.2	29,083	11.3	410.1	▲ 6.9	27.4	9.7	4.0
(b) Public	2,570	1.3	3,205	1.6	3,827	1.7	4,564	2.0	5,746	2.3	24.5	19.7	19.1	26.1	22.3
Change in inventories	5,616	3.0	7,828	3.8	4,889	2.2	2,343	1.0	8,859	3.4	39.3	▲ 37.5	▲ 52.1	278.1	12.1
Net export	▲ 3,831	▲ 2.0	▲ 1,675	▲ 0.8	2,357	1.2	▲ 5,751	▲ 2.5	▲ 14,589	▲ 5.7					
Statistical discrepancy															
Gross domestic expenditure	189,950	100	204,056	100	221,297	100	236,500	100	257,127	100	7.4	8.4	6.9	8.7	7.9
1. Private	35,272	18.6	32,923	16.1	31,501	14.2	39,690	16.8	44,150	17.2	46.7	44.3	26.0	11.2	5.8
(a) Construction	10,419	5.5	10,592	5.2	10,720	4.8	13,185	5.6	15,067	5.9	1.7	1.2	23.0	14.3	9.7
(b) Equipment	24,853	13.1	22,331	10.9	20,781	9.4	26,505	11.2	29,083	11.3	410.1	46.9	27.4	9.7	4.0
2. Public	6,868	3.6	9,488	4.7	13,278	6.0	15,804	6.7	18,495	7.2	38.1	39.9	19.0	17.1	28.1
(a) Construction	4,298	2.3	6,283	3.1	9,451	4.3	11,240	4.7	12,749	4.9	46.2	50.4	18.9	13.3	31.2
(b) Equipment	2,570	1.3	3,205	1.7	3,827	1.7	4,564	2.0	5,746	2.3	24.5	19.7	19.1	26.1	22.3

(Source: NESDB - ibid.)

- c. The elasticity of the growth rate of the fixed capital formation to that of the GDP during the past 5 years was high at 1.32.
- d. The share of domestic finance within the gross domestic fixed capital formation expanded from 62.3 percent in 1974, to 71.9 percent in 1978. (See Table 3.1.5) This means the gradual departure from "investment induces import" pattern has been in progress, although it prevailed until the first half of the 1970's. But from the viewpoint of heavy chemical industrialization in the 1980's in mind, such as the natural gas development project in the Gulf of Thailand and construction of an integrated steel plant, it is predictable that the "investment induces import" pattern will have to revive to a considerable extent and it will be that the share of domestic finance will have to level off. (See Table 3.1.6)

Table 3.1.5 Proportion of GFCF of Domestic and Imported Origin

(Unit: %)

	1974	1975	1976	1977	1978 ^e
* Imports of capital goods (c.i.f.)	37.7	34.4	29.1	29.5	28.1
Domestic fixed capital formation	62.3	65.6	70.9	70.5	71.9
(**Construction)	(34.6)	(38.3)	(42.3)	(42.0)	(42.4)
(Equipment)	(27.7)	(27.3)	(28.6)	(28.5)	(29.5)
Total gross fixed capital formation	100	100	100	100	100

* Including imported building materials

** Excluding imported building materials
(Source: NESDB-ibid.)

Table 3.1.6 The Investment Expenditure Target of Fourth Economic Development Plan at Current Prices

(Unit: Million bahts & %)

	1977	1978	1979	1980	1981	Total	'77-'81 Annual increase
Investment expenditure (A)	88,117	99,205	111,299	124,980	140,271	563,872	12.8
a. Public	24,772	28,562	31,470	34,842	36,373	156,019	14.6
b. Private	63,345	70,643	79,829	90,138	103,898	407,853	12.3
Capital transfer from foreign sector (B)	28,632	31,545	34,853	37,968	40,117	173,115	8.8
a. Public disbursement	4,172	5,407	6,779	7,750	7,496	31,604	18.6
b. Private	24,460	26,138	28,074	30,218	32,621	141,511	7.2
Direct investment	4,250	4,950	5,800	6,750	7,900	29,650	16.4
Loans & credits	7,100	7,750	8,500	9,350	10,250	42,950	9.5
Drawings	13,110	13,438	13,774	14,118	14,471	63,911	2.5
(B) / (A)	32.5	31.8	31.3	30.4	28.6	30.7	-

(Source: NEDSB - The Fourth Economic & Social Development Plan)

(3) Trends in Manufacturing Sector

The annual growth rate of manufacturing industry was 12.3 percent over the past 5 years in which the development of wearing apparel (18.5%), rubber (18.1%) and chemical products (17.6%) were especially remarkable. (See Table 3.1.7)

It is characteristic that the highest ranking five, i.e., foods, beverages, textiles, wearing apparel and transportation, accounts for 59.5 percent (1978^e) in the manufacturing sector. Emphasis is now shifted to the development of export-oriented industries from import substitution industries, and heavy/chemical industry is still in its infancy stage.

i. Food processing industry

Sugar refining is the leading industry in the manufacture of foods, producing 1.58 million tonnes in 1978 (2.21 million tonnes in 1977), and 75 percent of its production was exported in 1977. Now there are 42 sugar plants with modern facilities.

ii. Textile industry

Since 1971 the textile industry has been an export industry and through the textile boom in 1972 and 1973, an active investment for capacity expansion was pursued.

From the latter half of 1977, after 1974 – 1976's stagnation period, there has been some indication of restoration in domestic/foreign demand, and the textile industry is keeping up this trend for good business.

iii. Automobile industry

As for the development of the automobile industry, the government plans to raise the rate of domestic production (up to 50 percent in passenger cars by

1983) and is promoting the development of related industries such as parts and chassis. (See Table 3.2.12)

Table 3.1.7 Gross Domestic Products Originating from Manufacturing at 1972 Prices

(Unit: %)

	Composition					Growth rate (*78/'74 Avr.)
	1974	1975	1976	1977	1978 ^e	
Food	17.7	18.3	18.8	20.6	20.1	16.0
Beverages	10.8	9.0	9.4	10.1	11.0	12.7
Tobacco & snuff	8.9	9.3	8.6	7.3	7.1	6.0
Textiles	13.2	13.6	13.1	12.3	12.5	10.8
Wearing apparel except footwear	6.5	7.2	7.5	7.6	8.0	18.5
Leather, leather product & footwear	0.8	0.9	0.6	0.7	0.7	9.0
Wood & cork	2.6	2.5	2.3	2.0	1.6	▲ 0.1
Furniture & fixtures	0.7	0.7	0.7	0.7	0.8	13.7
Paper & paper products	1.2	0.9	1.1	1.2	1.2	11.2
Printing, publishing industries	2.8	2.8	3.0	2.6	2.4	8.2
Chemical & chemical products	4.5	5.0	5.0	5.1	5.5	17.6
Petroleum refining & petroleum products	7.2	7.5	7.1	6.5	5.6	5.5
Rubber & rubber products	2.2	2.4	2.4	2.5	2.6	18.1
Non-metallic mineral products	5.8	5.9	5.7	6.0	5.9	13.1
Basic metal industries	1.3	1.1	1.1	1.0	1.1	5.9
Metal products	1.7	1.4	1.3	1.0	1.0	▲ 2.9
Machinery	2.0	1.7	1.8	1.8	1.8	10.2
Electrical machinery & supplies	1.3	1.3	1.4	1.5	1.5	17.1
Transport equipment	7.0	6.4	6.9	7.6	7.9	15.8
Miscellaneous	1.8	2.1	2.2	1.9	1.7	12.2
Total value added	100	100	100	100	100	12.3

(Source: NESDB-ibid.)

(4) Direction of Economic Development Plan

(See Table 3.1.8)

i. Past development plan

- a. The economic development plan was introduced in Thailand in 1961 and the fourth "Five Year Economic and Social Development Plan" was put into effect in 1976. The first (1961-66) and the second (1966-71) plan concentrated on the arrangements of infrastructure of roads, irrigation facilities and electricity.
- b. During the first development plan, the manufacturing sector attained a high annual growth rate of 10.2 percent by production of import substitutional consumption goods. The GDP also recorded a high growth rate of 7.3 percent over the target of 5.5 percent.
- c. During the first half of the second development plan, the economy maintained a high growth rate by the expansion of agricultural and industrial production, combined with the increase in foreign private investment and special procurement demand related to the Vietnam War. But for the latter half of the plan period, the economic growth rate slowed down and the balance of payment changed for the worse. Consequently the GDP growth rate through this entire plan was 7.2 percent, but it left the problem of the aggravation of income differentials among regions and social classes.
- d. The main target of the third plan, which was carried into effect in 1971, was "control of population increase rate and appropriate distribution of economic and social service" in order to strive not only for "economic stability" and "restoration of economic structure" but also for the "improvement of income differentials". The GDP growth rate during this

plan was 6.2 percent, less than the target of 7.0 percent. This was due to the aggravation of the economic environment caused by the worldwide recession that stemmed from the turmoils in international monetary systems, the oil crisis and by the instability of the domestic political situation.

- e. The fourth plan from October 1976 took over the problem of the third plan as it was.

ii. The Fourth Five-Year National Economic and Social Development Plan
(Oct. 1976 – Sept. 1981)

- a. The idea of this plan aimed at the promotion of an equalization of economic and social orders, the elimination of poverty by means of stable national economic development and promotion of accumulation and desirable distribution of social capital among regions.
- b. The targets of the plan
 - Acceleration of business restoration
 - Lessening of income differentials
 - Attainment of lower population increase rate, exploitation of human capacity and an increase of employment opportunities.
 - Rigid control of basic resources and preservation of environment
 - Reinforcement of national security.
- c. Industrial development plan

This plan concentrates more on restructuring the economic fundamentals necessary for the development of heavy chemical industry during its term, receding from those targets posted in the third plan, i.e. to establish large scale industries such as the heavy-petrochemical industry, steel industry, food manufacturing industry and machinery

industry by private sectors.

Industrialization policies hereafter will focus on the promotion of the export-oriented industries, especially those related to agriculture.

More specifically, policies to be taken are as follows:

- Plan and execute plans for the regional dispersion of industrialization by establishing industrial development zones.
- Grant privileges which are based on the investment promotion act through the practical use of incentive provision systems such as a tax pay back system at the time of exporting goods made from the imported materials.
- Grant of credit.
- Abolishment of price regulations in principle.
- Promotion of industrialization by quasi-government enterprises.

d. Present and future regional differentials

(See Table 3.1.9)

This plan aims at the contraction of income differentials as one of the important policies and has resulted in various measures, such as the reallocation of economic and social services to underdeveloped regions and the dispersion of manufacturing industries. However, the present statistics shows that the income differentials among regions are widening. (See Table 3.1.10)

According to the regional GDP per capita in 1977 (See Table 3.1.11), the regions with the lowest figures were northeastern farming regions of severe production conditions. If GDP per capita in the metropolis (Bangkok and Tonburi) is set at 100, then that of the northeast area is only 15.3, and that of the north, 24.5. Following these, GDP per capita in the southern area of the main production region for rubber and tin is, 37.4, and that of the fertile central area, 54.3.

Table 3.1.8 Comparison between Actual Economic Performance and the Plan Targets by Industrial Origin

(Unit: %)

	The 1st plan ('61.1 - '66.9)		The 2nd plan ('66.10 - '71.9)		The 3rd plan ('71.10 - '76.9)		The 4th plan target ('76.10 - '81.9)
	Plan target	Actual achievement	Plan target	Actual achievement	Plan target	Actual achievement	
Agriculture	3.3	4.6	4.3	4.1	5.1	3.9	5.0
Industry							
Mining & quarrying	5.3	10.9	6.6	8.1	6.0	▲ 0.5	3.2
Manufacturing	9.3	10.2	10.9	9.2	8.0	8.6	9.6
Construction	3.9	12.3	11.4	8.4	6.5	4.0	3.0
Electricity & water supply	16.4	18.2	18.0	20.7	15.0	14.4	11.3
Transportation & communication	9.3	9.0	11.0	7.5	6.0	8.1	7.4
Services							
Wholesale & retail trade	5.5	8.0	8.4	7.7	7.0	4.8	6.3
Banking, insurance & real estate	5.5	16.6	17.0	14.4	15.0	5.1	8.1
Ownership of dwelling	5.5	3.7	5.0	4.1	2.5	3.6	4.4
Public administration & defense	5.5	7.2	12.0	10.0	6.0	6.0	6.5
Services	5.5	6.0	9.5	8.8	7.0	8.2	7.8
Gross domestic product	5.5	7.3	8.5	7.2	7.0	6.2	7.0

(Source: NESDB - The Fource Five-Year Plan & Others)

Table 3.1.9 Regional Shares of GDP in the 4th Economic Development Plan at Constat 1972 Prices

(Unit: %)

	Metropolitan		Central		North		Northeast		South		Whole Kingdom
	1977	1981	1977	1981	1977	1981	1977	1981	1977	1981	
	Agriculture	1.9	1.9	34.8	35.9	22.3	21.5	25.7	25.0	15.3	
Industry	38.6	40.0	34.9	33.9	9.3	9.8	8.3	8.1	8.3	8.3	100
Mining & quarrying	-	-	38.4	34.9	12.5	12.1	5.0	6.1	44.1	46.9	100
Manufacturing	41.4	44.1	43.1	41.5	5.5	5.4	5.5	4.8	4.6	4.2	100
Construction	41.9	42.0	16.4	15.8	11.6	10.9	19.4	20.0	10.7	11.3	100
Electricity & water supply	22.0	19.1	25.5	25.9	42.9	46.7	5.9	5.0	3.7	3.3	100
Transportation & communication	41.9	40.7	27.4	27.5	9.9	10.7	9.7	9.2	11.1	11.9	100
Services	41.8	40.4	22.2	21.8	11.2	11.4	13.3	13.1	11.5	13.2	100
Wholesale & retail trade											
Banking, insurance & real estate											
Ownership of dwellings											
Public administration & defense											
Services											
Gross domestic product	29.9	30.3	30.1	29.9	13.6	13.4	15.0	14.3	11.4	12.0	100

(Source: NESDB - Gross Regional Product)

Table 3.1.10 Trends in Income Distribution & Regional Shares of GDP at Constant 1962 Prices

(Unit: million bahts)

	North	Northeast	Central	South	Whole Kingdom
1971	18,653	19,935	74,117	16,912	129,617
1976	23,097	25,851	104,523	21,395	174,866
Average annual growth rate (percent)	4.5	5.4	7.1	4.8	6.2

Regional share of gross domestic product (percent)					
1971	14.4	15.4	57.2	13.0	100
1976	13.2	14.8	59.8	12.2	100

(Source: NESDB -- The Fourth Economic & Social Development Plan)

Table 3.1.11 Regional Classification of GDP at Current Prices in 1977

(at 1977 current prices)

	GDP (million bahts)		Per capita		
		%	bahts	US\$	%
Metropolitan	103,621	28.0	22,869	1,143	100
Central	113,433	30.6	12,416	621	54.3
South	46,562	12.6	8,553	428	37.4
North	52,309	14.1	5,592	280	24.5
Northeast	54,520	14.7	3,501	175	15.3
Whole Kingdom	370,445	100	8,412	421	36.8

(Source: NESDB - Gross Regional Product)

Looking at the regional distribution of industry, the industrial production is heavily concentrated in the metropolis (38.9%) and central area (35.1%), the share for both areas being 74 percent. On the other hand, the share of the northeast is 8.4 percent, that of the north 9.3 percent and that of the southern area 8.3 percent. This shows that the heavy concentration is toward the metropolis and the central area.

(5) Energy and Electricity

i. Energy

Energy consumption of Thailand was 112.3 billion kcal in 1976 and increased at 11.8 percent annually after 1970. Around 80 percent of the consumed energy came from petroleum and petroleum products, and 10 percent from hydroelectric power, and the rest from bagasse and coal, etc. This shows how highly Thai economy depends on petroleum and petroleum products. (See Table 3.1.12) All of petroleum and petroleum products consumed in Thailand comes

from abroad. Petroleum consumption in Thailand began to show sharp increase around 1954. It was 31,000 bbl/d in 1965 and reached 163,000 bbl/d in 1972, which was over 5 times as much as that of 1965. In 1980 it is expected to rise to 272,000 bbl/d.

From 1970 to 1973 in which the oil embargo took place, the proportion of petroleum and petroleum products in the total amount of import was 9 to 11 percent but after 1974 its share rose to 20 – 22 percent, reflecting the sudden hike of oil price, which aggravated the balance of payment. Therefore, the government raised gasoline prices in March 1978 as one of the consumption control measures. (See Table 3.1.13). And also it is estimated that consumer price index will go up more than 13 percent, primarily because of the crude oil price hike by OPEC effectuated at the end of June 1979.

The natural gas development project in the gulf of Thailand was initiated in order to depart from the high dependence on foreign energy resources and from the aggravation of the balance of payment, and also to change its economic direction to heavy-petrochemical industrialization. The project aims towards the production of natural gas to attain the level of 150 MMSCFD in mid-1981 and 500 MMSCFD in 1984. In 1986, the substitution rate for imported oil is expected to be 17 percent.

Table 3.1.12 Energy Consumption by Source of Energy
(Unit: Kilo calories x 10¹²)

	Petroleum products		Hydroelectric		Coal		Fuel wood		Charcoal		Paddy husk		Bagasse		Total	
		%		%		%		%		%		%		%		%
1967	29.8	77.6	4.5	11.7	1.2	3.2	0.7	1.8	0.7	1.8	0.5	1.3	1.0	2.6	38.4	100
1968	39.4	81.6	4.1	8.5	1.3	2.7	0.7	1.4	0.6	1.1	0.4	0.8	1.9	3.9	48.3	100
1969	42.6	84.2	3.1	6.1	1.4	2.8	0.4	0.8	0.5	1.0	0.3	0.6	2.2	4.3	50.6	100
1970	46.5	80.9	5.3	9.2	1.5	2.6	0.5	0.9	0.6	1.0	0.4	0.7	2.7	4.7	57.5	100
1971	58.4	83.0	6.1	8.6	1.7	2.4	0.6	0.9	0.6	0.9	0.4	0.6	2.6	3.6	70.4	100
1972	68.3	85.8	5.6	7.0	1.4	1.8	0.5	0.6	0.4	0.5	0.3	0.4	3.1	3.9	79.6	100
1973	77.8	85.7	6.1	6.7	1.4	1.5	0.5	0.5	0.4	0.4	0.4	0.4	4.2	4.6	90.8	100
1974	75.4	82.0	7.8	8.5	2.2	2.4	0.4	0.4	0.2	0.2	0.4	0.4	5.6	6.1	91.9	100
1975	79.1	80.2	10.6	10.7	2.2	2.2	0.4	0.4	0.1	0.1	0.4	0.4	5.9	6.0	98.6	100
1976	89.1	80.2	11.3	10.1	2.5	2.2	0.4	0.4	0.2	0.2	0.4	0.4	8.4	7.5	112.3	100
'76/'67 Avr.	12.9	-	10.8	-	-	-	-	-	-	-	-	-	-	-	11.8	-

(Source: National Energy Authority)

Table 3.1.13 Imports of Petroleum Products
(Unit: million bahts)

	(A)						Imports total (B)	A/B
	Crude oil	Gasoline	Kerosene	Diesel oil	Lubricants	Total		
1970	1,198	119	38	561	402	2,318	26,407	8.8
1971	1,941	34	18	457	250	2,700	26,606	10.1
1972	2,432	12	14	347	290	2,095	30,635	10.1
1973	3,572	48	12	677	324	4,633	42,055	11.0
1974	10,382	44	13	1,532	529	12,500	63,304	19.7
1975	12,076	158	14	1,478	428	14,154	64,526	21.9
1976	13,857	120	5	2,116	508	16,606	71,446	23.2
1977 p.	16,448	162	22	3,398	658	20,688	96,013	21.5
1978 e.	17,248	320	28	3,748	1,308	22,652	101,688	22.3

(78.4 ~ 6 x 4)

(Source: Bank of Thailand Monthly Bulletin; July '78)

ii. Electric power

Intense electric power development started in 1961. Demand for electric power has rapidly increased by the progress of industrialization and the higher level of income. In 1976, generation of electric power was 9,414 million kWh and its generation peak was 1,652 MW.

The present national electrification rate is 24.9 percent and by region, the capital area is 88.7 percent, central area 29.6 percent, northern area 15.5 percent, southern area 15.2 percent and northeast area 11.2 percent. According to the demand forecast in 1990 made by NEA, the generation of electric power is expected to be 33,000 million kWh and its peak generation, 5,500 MW. It is urgent to facilitate a power distribution network for the above mentioned demand increase.

3.2 Present Status of Thai Steel Industry

(1) Steel Production

i. Forming up of steel industry in Thailand

Full-fledged steel production was begun in Thailand after the "Industrial Investment Promotion Act" being legislated in 1960. The first national steel productions were galvanized sheets and tin plates. Galvanized sheets have been produced since January 1960 by "Thailand Iron Works Co., Ltd." which was established in December 1958. The Company was a joint venture between Japan and Thailand companies; shares of capital were 60 percent for Thailand and 40 percent for Japan (Mitsui & Co., Ltd. 36.16%, Azuma Kogyo Co., Ltd. 3.84%). "Thai Tinsplate Mfg. Co., Ltd." established by local capital in December 1958, started its production of hot dip products in April 1960. Later Japanese companies invested capital to this company in May 1972, and the company started to produce modernized ETL in July 1973. The share of Japanese capital was 45 percent (Mitsui & Co., Ltd. 15.75%, Kawasho Corporation 13.50%, Kawasaki Steel Corp. 9.00% and C. Itoh & Co., Ltd. 6.75%).

"Thai Steel Pipe Ind. Co., Ltd.", a joint venture between Japan & Thailand companies, was established in December 1963 and commenced its production of welded steel pipes in April 1965. The share of Japanese capital is 73.4 percent (Sumitomo Metal Industries, Ltd. 36.7%, Nomura Trading Co., Ltd. 36.7%) and that of Thailand capital is 26.6 percent.

The production of bars using electric arc furnace began during the period from 1966 to 1967 and that of light gauges, in 1969, thus roughly establishing the frame of the steel industry that prevails today. (See Table 3.2.1)

Table 3.2.1 Main Existing Steel Plants & Their Productions in Thailand (As of June 1977)

Company and location	Facilities and annual capacity	Products and others
(1) The Bangkok Iron & Steel Works Co., Ltd. [42 Suksawadi Road, Phrapradaeng]	6 electric arc furnaces Rolled steel	Deformed bars 10 to 28 mm Round bars 6 to 28 mm billets & sections
(2) Bangkok Steel Industries Ltd. [27 Poochao Samingprai Road, Phrapradaeng, Samutprakarn]	2 electric arc furnaces Rolled steel	Deformed/round bars 9 to 25 mm
(3) G.S. Steel Co., Ltd. [98 Poochao Samingprai Road, Phrapradaeng, Samutprakarn]	3 electric arc furnaces Rolled steel	Deformed/round bars 6 to 28 mm Wire rods 5.5 mm (coil weight 100 to 130 kg)
(4) The Siam Iron & Steel Co., Ltd. [Taluang, Saraburi]	2 electric arc furnaces Rolled steel	Deformed/round bars Wire rods/p.c. wire Steel casting
(5) Thai India Steel Co., Ltd. [40 Poochao Samingprai Road, Phrapradaeng, Samutprakarn]	2 electric arc furnaces Rolled steel	Deformed/round bars Mild steel ingots
(6) Bangna Steel Co., Ltd. [529 Soi Mit-Udom 1, Sukhumvit Road, Samrong-nua Samutprakarn]	1 Re-rolling line	Round bars 6 to 12 mm
(7) Chonvitya Steel Co., Ltd. [22 Soi Salakpan, Moo 15, Poochao Samingprai Road, Samutprakarn]	1 Re-rolling line	Round bars 6 to 9 mm

Steelmaking

Re-rolling

Table 3.2.1 (cont'd)

Company and location	Facilities and annual capacity	Products and others
Re-rolling	(8) Meyer (Thailand) Co., Ltd. [33 Soi Bangna, Sukhumvit Road, BKK]	1 Re-rolling line (12,000 t) Round bars 6 to 15 mm
	(9) Sahaviriya Steel Works Co., Ltd. [Sukunwadi Road, Phrapradaeng, Samutprakarn]	4 Re-rolling lines (48,000 t) Round/flat bars Shapes
	(10) Siam Steel Industry Co., Ltd. [109 Moo 2 Soi Khamuterom Bangplakod, Samutprakarn]	3 Re-rolling line (60,000 t) Deformed bars 10 to 35 mm Round bars 9 to 28 mm
	(11) Union Metal Co., Ltd. [79 Poochao Samingprai Road, Phrapradaeng, Samutprakarn]	3 Re-rolling lines (30,000 t) Round bars 6 to 33 mm
	(12) High Pressure Steel Pipe Industry Co., Ltd. [36 Moo 4 Soi Wat Mahawongse, Poochao Samingprai Road, Samrongtai, Samutprakarn]	1 ERW line (36,000 t) 1 Galvanizing line (12,000 t) ERW gas/water pipe
Pipe and tube	(13) Hong Seng Huat Factory [273/70 Soi Sakhareon, Jarunsanitwong Road, BKK]	1 Furniture tube line (12,000 t) 1 ERW line (18,000 t) Furniture tube (4") ERW gas/water pipe (4")
	(14) Saha Thai Steel Pipe Co., Ltd. [109 Poochao Samingprai Road, Samrongtai, Samutprakarn]	2 ERW lines (36,000 t) 1 Galvanizing line (18,000 t) 2 Furniture tube line (12,000 t) ERW gas/water pipe (6") Furniture tube (6") Shapes
	(15) Sathask Driam (Thailand) Co., Ltd. [33 Km Pabolyothin Road, Rangsit, Paruntani]	2 Spiral welding lines (35,000 t) Spiral pipe (6" - 60")

Table 3.2.1 (cont'd)

Company and location	Facilities and annual capacity	Products and others	
Pipe and tube	(16) Thai Asia Steel Pipe Co., Ltd. [Poochao Samingprai Road, Phrapradaeng, Samutprakarn]	2 ERW lines (48,000 t) 2 Galvanizing line (24,000 t)	ERW gas/water pipe (8")
	(17) Thai Stainless Pipe Industry (2516) Co., Ltd. [36 Moo 4 Soi Wat Mahawongse, Poochao Samingprai Road, Samrongrai, Samutprakarn]	4 Stainless welding lines (1,200 t) 1 ERW line (6,000 t)	Stainless pipe ERW gas/water pipe
	(18) Thai Steel Pipe Industry Co., Ltd. [36 Poochao Samingprai Road, Bangyapraek Phrapradaeng, Samutprakarn]	3 ERW lines (24,000 t) 1 Galvanizing line (24,000 t)	ERW gas/water pipe (4") Furniture tube
	(19) Thai Union Steel Co., Ltd. [56 Poochao Samingprai Road, Phrapradaeng, Samutprakarn]	3 ERW lines (42,000 t) 1 Furniture tube line (12,000 t)	ERW gas/water pipe (6") Furniture tube (6")
	(20) Far East Iron Works Co., Ltd. [No. 5 Group 4, Tambol Banghoyaeng, Amphur Muang, Patumthani]	5 Galvanizing lines (60,000 t)	Galvanized sheet
Galvanized sheet	(21) The Sangkasi Thai Co., Ltd. [Amphur Muang, Samutprakarn]	7 Galvanizing lines (84,000 t) 1 colour line (3,000 t)	Galvanized & colour galvanized sheets (USG35 - 14)
	(22) Thailand Iron Works Co., Ltd. [2552/2 Tanon, BKK]	5 Galvanizing lines (60,000 t)	Galvanized sheets
Tinplate	(23) Thai Tinplate Mfg. Co., Ltd. [33 Moo 13 Soi Salakbandh, Poochao Samingprai Road, Phrapradaeng, Samutprakarn]	1 Electrolytic tinning line (60,000 t) Nail making units	Tin plate (0.20 to 0.50 mm) Nail (12 mm BWG17-150 mm BWG 4)

Table 3.2.1 (cont'd)

Company and location	Facilities and annual capacity	products and others
(24) Cosmopolitan Steel Works Ltd., Part. [739/9 Soi Phramae Mari, Chant Road Yannawa, BKK]	4 L.G.S. forming line (10,000 t) 1 Peeling machine	Light gauge Bright round bars
(25) Sahaviriya Light Gauge Steel Co., Ltd. [222 Soi Highland, Suktawat Road, Samutprakarn]	2 L.G.S. forming lines (20,000 t) 1 Shearing line (9,000 t) 1 Slitting line (36,000 t)	Light gauge Cold cut sheet Slit coil

(Source: Japanese Chamber of Commerce Bangkok "Hand book of Steel Industry in Thailand" & Interview Survey by Study Mission)

ii. Current production in Thailand

Although the statistics of the steel production in Thailand is currently still incomplete, steel mill production in 1977 (See Table 3.2.2) was around 890,000 tonnes according to our fact-finding survey. The production of bars and wire rods was 568,000 tonnes, which accounts for 64 percent, or nearly two-thirds of the total production. Other steel mill productions were as follows: Galvanized sheets: 129,000 tonnes (share: 14.5%), Welded pipes: 130,000 tonnes (14.6%), Tin plates: 36,000 tons (4.1%) and Light gauges: 25,000 tonnes (2.8%). Therefore, the share of bars and pipes was 81 percent and that of flat steel products was 19 percent.

The apparent steel consumption (as mentioned hereafter) in 1977 (See Table 3.2.7) was 1,544,000 tonnes, which means that the rate of local production (local production by total consumption) was 57.5 percent. However, deducting the materials for galvanized sheets, tin plates, welded pipes and light gauges, which depend on import, the rate of local production drops down to 36.8 percent.

iii. Co-existence of 3 supply routes in Thailand

Thus, three types of steel supply co-exist in Thailand. They are:

- a. domestic production (bars and wire rods produced by electric arc furnace and re-rolling makers)
- b. production processed domestically (GI sheets, tin plates, welded pipes and light gauges, using the imported materials) and
- c. import of completed steel mill products, 53 percent of imported hot rolled products and 62 percent of imported cold rolled products are consumed as materials for local processing.

(See Table 3.2.2 & 8)

Table 3.2.2 Steel Mill Capacity & Steel Mill Products of Thailand (As of June 1977)

(Unit: 1,000 tonnes & %)

	Nos. of manufacturers *	Annual capacity of production	Achievements of production **				
			1974	1975	1976	1977 ^c	
Steelmaking by electric arc furnaces	5	480	351	258	300	300	-
Rolling mill products:							
Bar & wire rod	43	1,125	440	430	530	65.8	568
- produced by steelmaking mills	7	589	313	297	316	39.3	N.A.
- produced by re-rolling makers	36	536	127	133	214	26.5	
Galvanized sheet	3	204	87	101	120	14.9	129
Tin plate	1	60	27	21	26	3.2	36
Welded pipe	10	372	82	85	107	13.3	130
Light gauge	6	68	17	18	22	2.8	25
Total			653	655	805	100	888
Cut sheet	6	162	58	77	91	-	N.A.
Shearing		78					
Slitting							

* These figures do not contain the whole capacities & production in Thailand.
 (Source: Japanese Chamber of Commerce Bangkok "Handbook of Steel Industry in Thailand" & Interview Survey by Study Mission)

iv. Location of major existing steel works

Majority of main steel makers are located at the estuary of Chao Phraya river as if it were the steel industry complex. This is because of;

- a. governmental guidances,
- b. having steel consuming industries such as automotive in adjacent areas,
- c. only 25 kilometers to Bangkok, a large steel consuming area, and
- d. convenience of shipment. (See Fig. 3.2.1)

(2) Importation of Steel (See Table 3.2.3)

The total steel imports in 1977 was 1,069,000 tonnes. Flat steel products imported was 770,000 tonnes, accounting for 72 percent of the total. 330,000 tonnes (31% of the total) was consumed as materials of galvanized sheets, tin plates, welded pipes and light gauges.

After the oil crisis, however, the tendency showed a gradual decrease of imports along with the dwindling demand. That is, 710,000 tonnes in 1973, 690,000 tonnes in 1974 and 580,000 tonnes in 1975. But steel imports increased to 920,000 tonnes in 1976 and reached 1,069,000 tonnes in 1977, the highest record in the past.

The share of imported steel products in 1977 were as follows:

Flat steel products 71.9 percent, bars 25.5 percent and tubes 1.3 percent. Import of cold coil products and sheets were 272,000 tonnes with the highest share of 27.4 percent. It should be noted that hot coil products abruptly increased from 99,000 tonnes in 1974 to 217,000 tonnes in 1977.

A breakdown of imports by country of origin (See Table 3.2.4), shows that Japan had the highest share of 80 ~ 90 percent. But Japan's share has been gradually decreasing since 1976 (80%) and as of 1978, appears to have leveled-out at about 65 percent.

No.	Names of the steel works
1	Thai Tinplate Mfg. Co., Ltd.
2	Thai Special Steel Co., Ltd.
3	G.S. Steel Co., Ltd.
4	Chonviriya Steel Co., Ltd.
5	Thai Steel Pipe Ind. Co., Ltd.
6	Thai Stainless Pipe Ind. (2516) Co., Ltd.
7	High Pressure Steel Pipe Ind. Co., Ltd.
8	Bangkok Steel Ind. Ltd.
9	Sahaviriya Metal Ind. Co., Ltd.
10	Sintani Ind. Co., Ltd.
11	Boriboon Steel Co., Ltd.
12	Kang Yong Mfg. Co., Ltd.
13	Union Metal Co., Ltd.
14	Saha Thai Steel Pipe Co., Ltd.
15	Thai Union Steel Co., Ltd.
16	Thai Asia Steel Pipe Co., Ltd.
17	Boriboon Steel Ind. Co., Ltd.
18	Thai India Steel Co., Ltd.
19	The Sangkasi Thai Co., Ltd.
20	Bangna Steel Co., Ltd.
21	Thai Kobo Welding Co., Ltd.
22	Thailand Steel Works Co., Ltd.
23	Sahaviriya Plate & Sheet Co., Ltd.
24	Sahaviriya Light Gauge Steel Co., Ltd.
25	The Bangkok Iron & Steel Works Co., Ltd.
26	Thai Nail Works Co., Ltd.
27	Siam Steel Ind. Co., Ltd.
28	Sahaviriya Steel Works Co., Ltd.

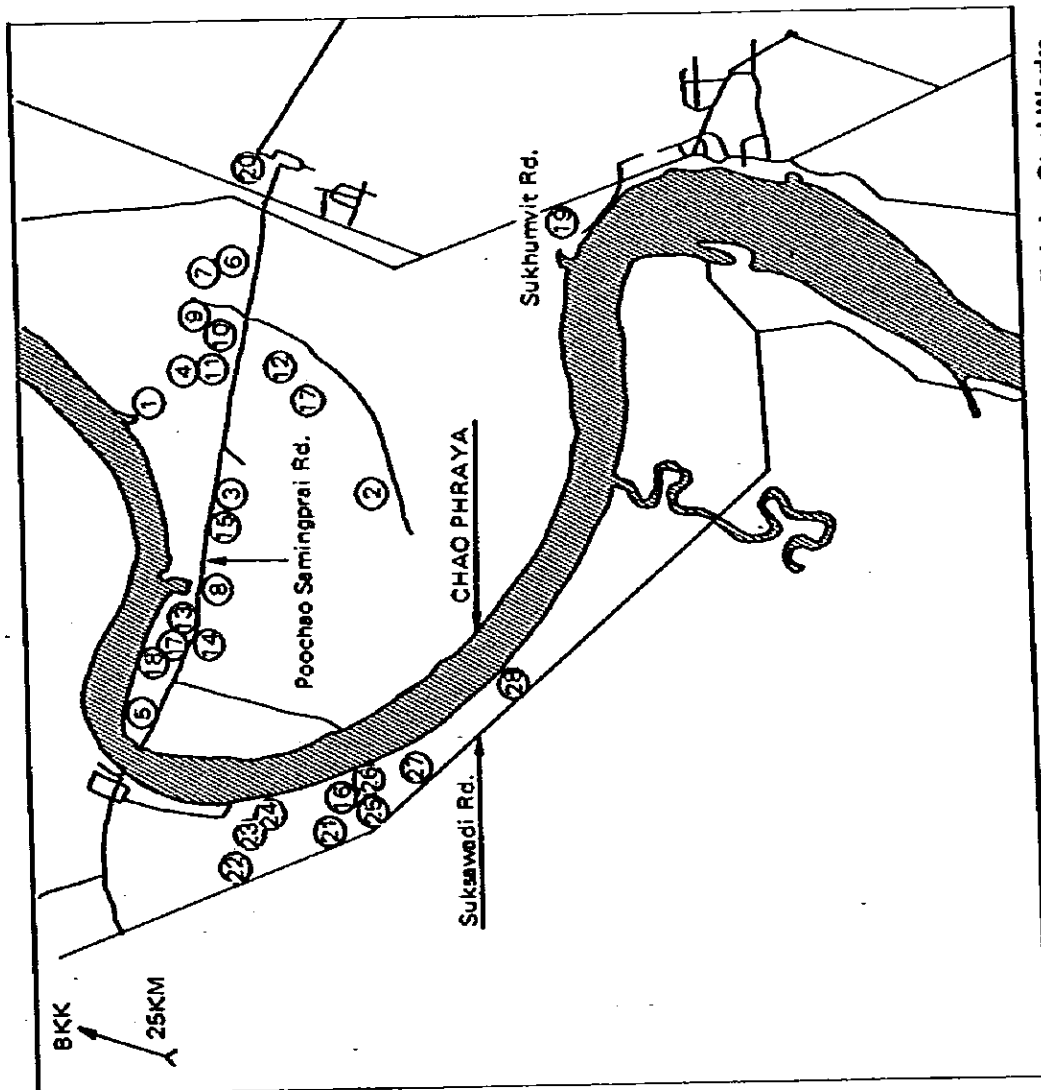


Fig. 3.2.1 Location of the Main Existing Steel Works

Table 3.2.3 Past Trend of Steel Imports

(Unit: 1,000 tonnes, %)

	1970	1971	1972	1973	1974	1975	1976	1977	
Steel mill productions	Bars & sections	23 2 39 57 48	3 1 22 40 48	10 6 10 39 54	- 2 10 35 68	- 2 20 56 64	- 1 18 34 56	- 5 30 46 63	- 3 46 63 101
	Sub-total	169	114	119	115	142	109	144	213
	Heavy & medium plates	73	52	72	96	85	122	110	122
	Rolled sheets	74	89	218	217	193	124	321	302
	Coils for re-rolling	2	-	52	95	99	102	181	217
	Hoop	18	11	19	15	14	9	16	25
	Galvanized sheets	1	1	1	1	1	9	15	30
	Tin plates	38	38	38	47	31	25	45	50
	Other coated sheets	78	39	19	19	22	12	10	23
	Sub-total	(50) 284	(47) 230	(67) 419	(69) 490	(65) 445	(69) 403	(76) 698	(72) 769
	Pipes & Tubes	14	14	12	11	8	3	3	5
Welded pipes	47	40	35	39	30	9	12	9	
Sub-total	61	54	47	50	38	12	15	14	
Total	514	398	585	655	625	524	857	996	
Others	Ingot & semis	7	35	6	2	19	12	9	
	Cast iron pipes	1	3	2	3	1	-	-	
	Wire products	39	49	26	38	36	31	39	
	Others	9	7	8	9	8	12	7	
Total	56	94	42	52	64	59	58	73	
Grand total	(100) 570	(100) 492	(100) 627	(100) 707	(100) 689	(100) 583	(100) 915	(100) 1,069	

(Source: Dep't of Customs BKK, Annual Statement of Foreign Trade of Thailand)

Table 3.2.4 Country Classification of Steel Export to Thailand in 1977

(Unit: thousand tonnes & %)

	Plates & sheets		Others		Total		Remarks
Japan	590	54.0	242	22.1	832	76.1	
Korea	35 ¹⁾	3.2	1	0.1	36	3.3	1) Hot coils for re-rolling (23)
Taiwan	3	0.3	8	0.7	11	1.0	
India	6	0.5	44 ²⁾	4.1	50	4.6	2) Pig iron (20), bars (13)
Australia	18 ³⁾	1.6	1	0.1	19	1.7	3) Hot coils for re-rolling (18)
West Germany	26 ⁴⁾	2.4	4	0.3	30	2.7	4) Hot coils for re-rolling (5)
United Kingdom	13 ⁵⁾	1.2	5	0.4	18	1.6	5) Hot coils for re-rolling (11)
Italy	17	1.6	-	-	17	1.6	
South Africa	14 ⁶⁾	1.3	7	0.6	21	1.9	6) Tin plates (14)
U.S.A.	32 ⁷⁾	2.9	3	0.3	35	3.2	7) Tin plates (18)
Others	15	1.4	9	0.9	24	2.3	
Grand total	769	70.4	324 [*]	29.6	1,093 [*]	100	[*] Pig iron & ferro alloys are included.

(Source: *ibid.*)

As seen in the Table 3.2.5, the import of steel products was primarily increased by flat steel products after 1970. That is, the import of steel increased at 9.4 percent per annum in total and that of flat steel products increased at 15.3 percent annum.

Table 3.2.5 Change in Imported Steel Products

(Unit: 1,000 tonnes)

	1970		1977		(B) - (A)	
	(A)	%	(B)	%		%
Bars & sections (including wire products)	208	36.5	273	25.5	65	13.0
Sheets & plates	284	49.8	769	71.9	485	97.2
Tubes & pipes	61	10.7	14	1.3	▲ 47	▲ 9.4
Others	17	3.0	13	1.3	▲ 4	▲ 0.8
Grand total	570	100	1,069	100	499	100

(Source: Annual Statement of Foreign Trade of Thailand)

(3) Apparent Steel Consumption

Apparent steel consumption (local production + imports - exports) increased from 790,000 tonnes in 1970 to 1,540,000 tonnes in 1977 with a 10 percent annual increase. (See Table 3.2.6) The annual increase of non-flat steel products (bars & sections, seamless tubes) was low at 7.8 percent compared to 12.7 percent of flat steel products (sheets, plates, light gauge and welded pipes).

Table 3.2.6 GDP Growth Rate and Apparent Steel Consumption

(final products base)

(Unit: 1,000 tonnes. %)

		1970	1971	1972	1973	1974	1975	1976	1977	'77/'70
Real GDP growth		6.5	4.7	4.8	9.4	5.4	7.4	8.4	6.9	6.7
Apparent steel consumption		792	754	936	1,160	1,025	919	1,346	1,544	10.0
Break down	*Flat products	327	276	413	525	462	400	694	757	12.7
	Non-flat products	465	478	523	635	563	519	652	787	7.8

* Flat products = Sheets & plates + Light gauge + Welded pipes

The comparative shares of steel mill products has changed as follows:

(See Table 3.2.7 & 8)

Bars 58.8% (1970) —→ 52.3% (1977)

Pipes 18% (1970) —→ 8.6% (1977)

Sheets and plates 23.3% (1970) —→ 39.1% (1977)

This shows the drastic increase in sheets and plates; the comparative proportion of flat steel products also expanded from 41.3 percent in 1970 to 49.2 percent in 1977.

The weight of commerce and trading sector in the private capital stock in Thailand has been dominantly large, as is well known. Thus the stock of steel products fluctuates widely because of strong inclination for speculation. Therefore, in predicting the demand for steel in 1985, the average apparent steel consumption for three years (1975 to 1977) was used as the starting basis.

Apparent crude steel consumption per capita (See Table 3.2.9) increased from 29kg in 1970 to 48kg in 1977 with a 7 percent annual increase.

Table 3.2.7 Apparent Consumption of Steel Mill Products

(Unit: thousand tonnes)

		1970	1971	1972	1973	1974	1975	1976	1977
Bars & sections	Railway rails	23	3	10	-	-	-	-	-
	Sheet piles	2	1	6	2	2	1	5	3
	Sections	57	59	67	85	81	74	85	127
	Bars	285	338	372	485	396	361	471	541
	Wire rods	99	82	80	80	100	98	110	136
Total		466	483	535	652	579	534	671	807
Sheets & plates	Heavy & medium plates	73	52	72	96	85	122	110	122
	Hot rolled sheets & coils	▲ 70	▲ 59	▲ 14	72	39	24	121	117
	Cold rolled sheets & coils	▲ 45	▲ 52	29	41	50	▲ 17	118	97
	Others	78	39	19	19	22	12	8	23
	(Sub-total)	(36)	(▲20)	(106)	(228)	(196)	(141)	(357)	(359)
Galvanized sheets		100	113	121	99	88	110	135	159
Tin plates		48	50	53	69	57	46	71	85
Total		184	143	280	396	341	297	563	603
Pipes & tubes	Seamless tubes	8	6	1	-	1	3	3	5
	Welded pipes	134	122	120	112	104	85	109	129
Total		142	128	121	112	105	88	112	134
Grand total (= Apparent steel consumption)		792	754	936	1,160	1,025	919	1,346	1,544
Breakdown of ASC	Flat products	327	276	413	525	462	400	694	757
	Non-flat products	465	478	523	635	563	519	652	787

Note: ▲ indicates that the figure of materials for secondary products was bigger than that of imports for the year.
(Source: Provided by Study Mission)

Table 3.2.8 Classification of ASC by Final Products (1/2)

(Unit: thousand tonnes)

		1970	1971	1972	1973	1974	1975	1976	1977	Remarks	
Bars & sections	Rail	23	3	10		
	Steel sheet piles	2	1	6	2	2	1	5	3		
	Sections	local prod.	9	11	13	17	17	18	22	25	
		imp.	48	48	54	68	64	56	63	102	
	Bars	local prod.	228	299	342	457	340	327	425	478	
		imp. exp.	57	40	39	35	56	34	46	63	
	Wire rods (incl. BIC)	local prod.	60	60	70	70	80	80	80	90	
		imp.	39	22	10	10	20	18	30	46	
	Sub-total		297	370	425	544	437	425	527	593	
	Sheets & coils	Heavy, medium plates	imp.	169	114	119	115	142	109	144	214
exp.			-	1	9	7	-	-	-	-	
HR sheets, coils		imp.	73	52	72	96	85	122	110	122	
		imp.	▲70	▲59	▲14	72	39	24	121	117	
CR sheets, coils		imp.	▲45	▲52	29	41	50	▲17	118	97	
		local prod.	99	112	120	99	87	101	120	129	
Galvanized sheets		imp.	1	1	1	1	1	9	15	30	
		exp.	1	...	-	...	-	
Tin plates		local prod.	11	12	15	23	27	21	26	36	
		imp. exp.	38	38	38	47	31	25	45	49	
		1	1	...	1	1	-	-	-		

Table 3.2.8 (cont'd)

(Unit: thousand tonnes)

		1970	1971	1972	1973	1974	1975	1976	1977	Remarks	
Sheets & coils	Other coated sheets		78	39	19	22	12	10	23		
	Sub-total	local prod. imp. exp.	110 75 1	124 19 ...	135 145 ...	122 276 2	114 228 1	122 175 -	146 419 2	165 438 -	
Pipes & tubes	Seamless tubes	imp. exp.	14 6	14 8	12 11	11 11	8 7	3 -	5 -		
	Welded pipes	local prod. imp. exp.	88 47 1	82 40 ...	86 35 1	73 39 -	82 30 8	85 9 9	107 12 10	130 9 10	
	Sub-total	local prod. imp. exp.	88 61 7	82 54 8	86 47 12	73 50 11	82 38 15	85 12 9	107 15 10	130 14 10	
	Grand total	local prod. imp. (+) exp. (-)	495 305 8	576 187 9	647 311 22	739 441 20	633 408 16	632 296 9	780 578 12	888 666 10	
ASC		792	754	936	1,160	1,025	919	1,346	1,544		

Note: ...: negligible small, imp.: import, exp.: export, prod.: production
(Source: Provided by Study Mission)

Table 3.2.9 Apparent Crude Steel Consumption Per Capita

(Unit: kg)

1970	1971	1972	1973	1974	1975	1976	1977
29	27	33	40	34	30	43	48

(Source: Provided by Study Mission)

(See Table 3.3.11)

(4) Steel Consumption by Demand Sectors (See Table 3.2.10)

According to the statistics of steel consumption by sectors, the construction industry (civil and construction) accounts for about 60 percent of the total consumption.

Construction sector in 1977 consumed 75 percent of bars, 37 percent of sheets and plates, and 69 percent of pipes.

Other than the construction sector, the main sectors are the light industry, having agricultural processing as the main constituents, and personal consumption. Since heavy-petrochemical industry is still in its infancy stage, the steel consumption in this sector is small.

i. Construction sector

a. Building

According to the construction activities by "Greater Bangkok Metropolitan Region," approved building floor space in 1977 was 4,329,000 m² with a 26.3 percent increase from the previous year. Its breakdown is as follows: dwelling-commercial concurrent use accounts for 65.2 percent, dwelling use for 28.1 percent and others, 6.7 percent. (See Table 3.2.11) In Thailand, buildings for dwellings and commercial uses are

mainly built by reinforced concrete (RC) structure, and since it is not necessary to be earthquake-proof in Thailand, the primary materials employed are round bars. Reinforced bars for concrete are not used in Thailand as much as in Japan. At present, buildings of structural reinforced concrete (SRC) structure are under construction in Bangkok for the first time in Thailand. The outline of the building is as follows:

Floor space: 122,600 m²

Height: thirty-two stories

Building below eight stories:

SRC structure for pillars,

RC structure for beams

Building above nine stories:

SRC structure for both pillars and beams

Main materials: Concrete 61,000 m³

**reinforced bars 10,500 tonnes (including
770 tonnes of D51)**

steel frames: 1,000 tonnes

Building for dwelling-commercial concurrent use are generally three or four stories high. They have stores on the first floor with one or two-folded shutters (lifting or sliding type). Hot rolled products of 140 kg are used for double folded shutters of 4 m width. In the country-side, galvanized sheets are widely used as roof materials, No. 35 being the main thickness of the sheets. The use of pipes for scaffold is still low except for Japanese construction companies.

Table 3.2.10 Steel Consumption Analysis (1975, 76, 77 Avr.) by Major Industrial Sectors

(Unit: 1,000 tonnes)

Steel products	Sectors																		
	ASC	Ship-building	Automobile & motorcycles				Industrial machinery	Electric machinery (Household)	Household & office equipment	Container			Construction			Bicycle	Secondary products	Others for shearing	
			Passenger cars	Commercial cars	Motor cycles	Sub-total				Food cans	Others	Sub-total	Civil	Building	Sub-total				
Bars & sections	Sheet piles	3											3		3				
	Sections	95	1		1	1	2						11	80	91				
	Wide flange beams	6											6		6				
	Light gauges	22												22	22				
	Others	67	1		1	1	2						5	58	63				
	Bars	458	4		8		8	4						62	348	410		32	
	Small bars	410												62	348	410			
	Others	48	4		8		8	4											32
	Wire rods (incl. BIC)	115																	115
	Total	671	5		9		9	6						76	428	504			147
Sheets & plates	Plates	118	12				62						36	8	44				
	Heavy	88	9				44						28	7	35				
	Medium	30	3				18						8	1	9				
	Sheets	167			13	4	17	25	5	15		6	6	13	12	25	4		70
	HR	87			11	1	12	25				2	2	13	12	25	1		22
	CR	66			2	3	5		5	15		4	4				3		34
	CR (Others)	14																	14
Tin plates	67									42	25	67							
Galvanized sheets	135						6	1	6				13	109	122				
Total	487	12		13	4	17	93	6	21	42	31	73	62	129	191	4		70	
Pipes & tubes	Seamless tubes	4					4												
	Welded pipes	108	2	1	2	1	4	10		13			61	16	77	2			
	Total	112	2	1	2	1	4	14		13			61	16	77				
Grand total (%)	(100) 1,270	(1.5) 19	(0.1) 1	(1.9) 24	(0.4) 5	(2.4) 30	(8.9) 113	(0.4) 6	(2.7) 34	(3.3) 42	(2.4) 31	(5.7) 73	(15.6) 199	(44.9) 573	(60.5) 772	(0.5) 6	(11.5) 147	(5.9) 70	

(Source: Provided by Study Mission)

**Table 3.2.11 Bangkok Metropolitan Area (BMA) Permitted
for Construction**

(Unit: 1,000 m²)

	1973	1974	1975	1976	1977	1978 1st halfx2
BMA total	2,490	3,236	3,757	3,428	4,329	6,665

(Unit: 1,000 m²)

	1977. Jan. – Jun.		1977. Jul. – Dec.		1978. Jan. – Jun.	
		%		%		%
Residential	657.8	35.2	558.0	22.7	805.7	24.2
Commercial	1,098.9	58.7	1,723.9	70.1	2,372.9	71.2
Factories	28.6	1.5	32.7	1.3	68.0	2.0
Services & transport	34.0	1.8	60.1	2.4	51.2	1.5
Others	51.4	2.8	83.6	3.5	34.9	1.1
Grand total	1,870.7	100	2,458.3	100	3,332.7	100

(Source: Study Mission Hearing)

b. Civil

The main public investment are those of electricity, bridges, railway bridges, roads and water works and others, with cement being the main material consumed. Even for large bridges, the use of steel is limited to round concrete bars and prestressed concrete (PC) steel wires at the most, and therefore unit steel consumption in the civil construction sector is quite small.

ii. Shipbuilding

Over 100 domestic shipyards exists in Thailand, but over 90 percent of them are engaged in the construction of wooden barges, and only 4 or 5 are

engaged in constructing steel vessels. The main shipbuilding companies of steel vessels are as follows:

- a. **Bangkok Ship Building and Engineering Corp.**
Capacity: 300 ~ 10,000 DWT of tankers and barges
300 ~ 3,000 DWT of bulk carriers
Normal lead time: about 7 months for 5,000 DWT tanker
Unit steel consumption of a tanker: 300 kg/DWT
Standard size of flat steel: 4.5 ~ 10 mm x 5' x 20'
- b. **Bangkok Dock Co., Ltd.**
Main shipbuildings are small boats such as fisher/patrol boats
Capacity: about 3 boats in a year
- c. **Captain Co.**
4 Steel vessels and 3 ferry boats were built in 1976
- d. **Oriental Marine & Aminates Co.**
Shipbuilding of steel vessels began in 1977
- e. **Bang Thai Shipping**
(Repairing firm)

iii. Automobiles

At present there are 20 automotive assembly plants including 7 plants with Japanese capital participation. There were 61,700 units of motor vehicle assembled in 1977, of which 17,300 units were passenger cars and 44,400 units were commercial vehicles. The regulations on domestic automobiles production specifies that passenger cars should have at least 25 percent domestic components while for commercial vehicles it should be at least 20 percent. The Ministry of Industry decided in August 1978 to uplift the domestic component ratio of passenger cars to 50 percent by 1983. (Commercial vehicles are said to be given the same considerations). It seems difficult to raise the domestic com-

ponent level of passenger cars because of its small demand market and the excessive variety of cars. (See Table 3.2.12) It is estimated that the local contents level of commercial vehicles will increase rapidly because of its limited variations, its interchangeability of the parts, and its potential demand. At present cars are far too expensive in view of the consumers' income, a stage to be called pre-motorization. However, we predicted 58,500 units of passenger cars and 203,800 units of commercial vehicles to be assembled in 1985. Steel consumption will rapidly increase by the mixed effects of demand increase itself and an expansion of local contents hereafter.

iv. Motorcycles

Motorcycles are more popular than cars, as firmly rooted demand in the rural area. The government bars the import of motorcycles (CBU) as it does with cars. Presently four Japanese companies manufacture motorcycles in Thailand. Two types of motorcycles are mainly in production: 80 cc mopet type and 125 cc sports type. They have equal shares and, as of 1977, have manufactured about 210,000 units in all. The Government legislated to raise the rate of domestic component to 70 percent by July, 1979. Some companies even exceeded their rates in the end of 1978. Local companies predict that at least 360,000 units of motorcycles will be produced by 1985.

v. Bicycles

Bicycles are the indispensables in the rural areas together with motorcycles as the only means of transportation. The rate of popularization is one bicycle per household. Production was 250,000 units in 1977, and it will be possible to produce about 520,000 units in 1985 as the demand potential is great. Demand for the transportation equipment tends to depend on the level of agricultural production (that is, the level of agricultural income.) The consump-

tion of steel, especially flat steel products, will increase constantly by the increase in demand and by the rise of local component ratio.

vi. Light electrical appliances

The production of electric appliances like TV sets, refrigerators and fans increased sharply during the past few years. The annual growth rate (1974–1978) of these appliances is as follows: refrigerators 25 percent, TV sets (B/W) 15 percent and fans 20 percent. Their productions in 1977 are as follows: refrigerators 150,000 units, TV sets (B/W) 150,000 units and fans 350,000 units. Future income growth, the higher electrification rate (the present rate of national electrification: 25%, Bangkok 89%, central: 30%, north: 16%, south: 15%, northeast: 11%) and the enormous population all blend together to make the potential demand for this market a brighter prospect. Therefore, it is predicted that consumption of flat steel products (mainly cold-rolled sheets) will expand substantially in the near future.

vii. Metal furniture and enamel ware

Metal furniture and furniture tubes have enjoyed sudden popularity in recent years due to the rise of timber price and the difficulty in obtaining them, coupled with income increase. Use of enamel ware also expanded. The consumption of flat steel products is expected to increase steadily in this field as living standards and conditions of office equipment equipment being improved.

viii. Cans and containers

Canned milk, pineapple and fruits account for more than half of the cans used for food. Cans for milk are supplied to the domestic market and are increasing at about the same rate as the population. Demand for pineapple cans has increased rapidly in recent years. Thai pineapples have been expanding its share

and supplies 15 percent of the world demand, owing to low material costs and relatively cheap labour cost. There is a high possibility that Thai pineapple will obtain 25 percent of the share in the world in 1985. In light of this demand increase, demand for tin plates is expected to increase also at an annual rate of 8 percent. Containers for LP gas are expected to draw close attention in the future. In 1978, the demand for gas was about 180,000 tonnes. When the natural gas project at the Gulf of Thailand is completed, the demand for welded containers will rapidly increase as civil utilization of gas is also expected to expand. At present there is one welded container manufacturer in Thailand and it produces 50 ~ 60,000 units monthly and exports about 70 percent of its production.

(5) Regional Demand for Steel (See Table 3.2.13 & 14)

The central area including the metropolis accounts for 73.7 percent in steel consumption, of which the metropolis alone accounts for 45 percent. In regard to flat steel, its consumption is concentrated in Bangkok and the central area with a share of 81 percent. Steel-related industry, except the construction sector (60%), is concentrated in Bangkok and its outskirts. The two exceptions are the sugar plants at Kanchanaburi and Phetchaburi, and the pineapple plants at Phetchaburi-Prachuap Khiri Khan. The tendency to concentrate in the central area shall continue in the first half of the 1980's unless a systematic dispersion of industry is pushed forward as can be seen in the five year plan.

Table 3.2.12 Local Production of Parts for Commercial Vehicles

	Light (1-2 t) trucks			Medium, heavy (4-10 t) trucks		
	Present stage	Future stage	Remarks	Present stage	Future stage	Remarks
Cabin	Roof			○		
	Back panel		material: CR	○		material: CR
	Bonnet					
	Quarter pillar					
	Floor	☆	} will be localized in a near future		☆	} will be localized in 2-3 years
	Door	☆			☆	
	Fender	☆				
Deck	Side panel		material: CR			
	Skirt panel					
	Wheel house					
	Side panel end					
	Side panel front					
	Tailgate panel					
Frame	Cross member			○		material: HR
	Side rail	☆	material: HR		☆	
Wheel	Rim		} material: HR		☆	} large dia. wheels require large capa. press
	Disk				☆	
	Cap		material: CR			

○ : Localized parts at present stage
 (Source: Study Mission Survey)

Table 3.2.12 (Cont'd) Assembled Units of Passenger Cars & Commercial Vehicles in Thailand

(Unit: units)

	Passenger cars		Commercial vehicles		Total	
		%		%		%
1971	9,017	—	5,997	—	15,014	—
1972	11,630	29.0	7,755	29.3	19,385	29.1
1973	17,935	54.2	9,499	22.5	27,434	41.5
1974	17,572	▲ 2.0	14,891	56.8	32,473	18.4
1975	15,524	▲ 11.7	15,467	3.9	30,991	▲ 4.6
1976	15,333	▲ 1.2	25,729	66.3	41,062	32.5
1977	17,334	13.1	44,346	72.4	61,680	50.2

(Source: Provided by Study Mission)

Table 3.2.13 Main Economic Indicators of Regional Distribution (1977) and ASC

(Unit: 1,000 tonnes. %)

	GDP total	Manufacturing	Construction	ASC (1975-77 Avr.)	
Metropolitan	29.9	41.4	41.9	571.5	45.0
Central	30.1	43.1	16.4	364.5	28.7
North	13.6	5.5	11.6	95.3	7.5
Northeast	15.0	5.4	19.4	152.1	12.0
South	11.4	4.6	10.7	86.6	6.8
Whole Kingdom	100	100	100	1,270.0	100

(Source: NESDB & Study Mission Survey)

Table 3.2.14 Geographical Distribution of Steel Consumption (1975-1977 Analysis)

(Unit: thousand tonnes)

	ASC	Metropolitan	Central	North	Northeast	South	Remarks
Sheet piles	3	2.5	0.5	-	-	-	
Sections	95	42.3	16.7	10.1	16.7	9.2	
Wide flange beams	6	5.0	1.0	-	-	-	
Light gauges	22	9.2	3.6	2.6	4.3	2.3	
Others	67	28.1	12.1	7.5	12.4	6.9	
Bars	458	199.1	87.9	47.6	79.5	43.9	
Small bars	410	171.8	67.2	47.6	79.5	43.9	
Others	48	27.3	20.7	-	-	-	
Wire rods (incl. BIC)	115	65.4	49.6	-	-	-	
Total	(100)	(46)	(23)	(9)	(14)	(8)	
Plates	118	59.1	51.9	2.2	2.9	1.9	
Heavy	88	46.6	41.4	-	-	-	
Medium	30	12.5	10.5	2.2	2.9	1.9	
Sheets & coils	167	71.5	65.3	9.9	11.9	8.4	
HR	87	36.2	30.8	6.3	8.3	5.4	
CR	80	35.3	34.5	3.6	3.6	3.0	
Tin plates	67	27.7	39.3	-	-	-	
Galvanized sheets	135	56.5	25.6	14.9	24.4	13.6	
Total	(100)	(44)	(37)	(6)	(8)	(5)	
Pipes & tubes	112	47.4	27.7	10.6	16.7	9.6	
Seamless tubes	4	2.3	1.7	-	-	-	
Welded pipes	108	45.1	26.0	10.6	16.7	9.6	
Grand total (%)	(100)	(45.0)	(28.7)	(7.5)	(12.0)	(6.8)	
	1,270	571.5	364.5	95.3	152.1	86.6	

(Source: Provided by Study Minton)

3.3 Steel Demand Forecast I (1985 and 1990)

It is a conventionally accepted approach, in forecasting a future steel demand, to calculate the demand figures using various methods and techniques available, based upon the growth rates of GDP, IIP, etc. or target production levels of major industries as usually prescribed in the long range economic plans of the respective country. As for the Kingdom of Thailand, the current 4th Five Year Economic and Social Development Plan specifies those target figures up to September 1981, but not any further ahead. Since no official target figures are available for those years whereby the steel demand had to be predicted, such basic figures as GDP growth rates, activity levels of major industrial sectors and so on had to be generated and used as hypothetical premises in order to proceed with this forecasting task.

It is, therefore, to be kept clearly in mind by the parties concerned that this forecast values should be reviewed and corrected accordingly, as the premises have to change, when the 5th Five Year Plan is set forth by the Royal Thai Government whereby the specific economic policies, the target economic indexes and activity levels of major industries are depicted as official figures.

(1) Methods of Forecast

Two different techniques are commonly used in predicting demand, that is, the macro method approach and the micro method approach. (In addition, the semi macro method approach is also available as a conciliatory method of the above two methods.) The macro method approach is based on forecasting from the past trend of co-relations between steel demand and basic economic activities (such as GDP, IIP, GDCF, etc., as exogenous variables.). The micro method approach is based on the sectoral demand accumulation approach: demand is projected for major industrial sectors based on the prevailing con-

sumption patterns. (Steel consumption of a certain sector = activity of the sector x steel consumption unit per activity unit.) The semi macro method approach is also the sectoral accumulation approach: demand is projected as follows:

That is, steel consumption of a GDP expenditure item = value of the GDP expenditure item x steel consumption unit per unit of GDP expenditure item.

In this study, we employed the micro method for predicting the 1985 demand and the macro method for the 1990 demand. The reasons why we employed the above approach are as follows:

- a. It was required to forecast the demand for major steel product items and it is predicted that steel consumption fluctuates widely sector by sector. (In the case of automobiles, for example, multiple acceleration effect is expected in the flat steel product by the increase of assembled vehicles and the promotion of local component ratio).
- b. It is more accurate for the short-term forecasting than the macro method because steel consumption is surveyed sector by sector.
- c. However, we had to employ the macro method for the 1990 prediction because of the following reasons: In the case of a long-range demand forecast after 1985, it will naturally include many unknown and subjective factors in predicting the level of activities for each demand sector, and furthermore, there are excessive difficulties involved to forecast the updowns of specific industries.
- d. The figures of the demand forecast for 1990 generated by the macro method were modified by the ratio obtained in the process of adjusting the demand figures for 1985 generated by both micro and macro methods:

(2) Economic Framework

Future steel consumption will be determined by the growth rate and the developmental pattern of Thai economy. Economic policies for the 1980's is expected to promote the conversion of economy to heavy chemical industries based on the promotion of industrialization and the development of natural gas. In this study (See Table 3.3.1 and 2) we employed 7 percent annual economic growth rate in terms of real GDP growth rate.

The reasons are as follows:

- a. The average annual economic growth rate was 7.0 percent from 1970 to 1978. (6.7 percent from 1970 to 1977). But during this period, it varied from 4.7 percent to 9.4 percent primarily due to the fluctuations in the agricultural production. The average annual economic growth rate was 7.6 percent for three years from 1975 to 1977.
- b. The target economic growth rate is set at 7 percent in the 4th "Economic and Social Development Plan" (1976 – 1981).
- c. Results from interview surveys of economists and entrepreneurs in Thailand were also in line with the 7 percent growth rate.

Table 3.3.1 Economic Frame through 1990

	Gross domestic product at 1972 prices														GDP per capita			
	Millions of bahts	Millions of USD	G.R.%	Composed of			Growth rate (%)			Population (thousands)	1972 Prices		Current prices					
				Industry	Agriculture	Service	%	Ind.	Agr.		Ser.	GDP	bahts	USD	baht	USD		
																	%	%
1970	150,092	7,172	6.5	45,413	30.3	48,332	32.2	56,347	37.5	6.1	2.6	10.2	36,370	4,127	197	3,297	158	
1971	157,088	7,506	4.7	46,999	29.9	50,537	32.2	59,552	37.9	3.5	4.6	5.7	37,490	4,190	200	3,857	184	
1972	164,626	7,866	4.8	50,683	30.8	49,919	30.3	64,024	38.9	7.8	4.2	7.5	38,590	4,260	204	4,266	204	
1973	180,146	8,723	9.4	55,373	30.7	56,237	31.2	68,536	38.0	9.3	12.7	7.0	39,690	4,539	220	5,456	264	
1974	189,950	9,223	5.4	59,675	31.4	56,962	30.0	75,313	38.6	7.8	1.3	7.0	40,780	4,675	229	6,613	325	
1975	204,056	10,013	7.4	63,756	31.2	62,080	30.4	78,220	38.3	6.8	9.0	6.7	41,870	4,869	239	7,077	347	
1976	221,297	10,848	8.4	73,158	33.1	64,735	29.3	83,404	37.7	14.7	4.3	6.6	42,960	5,128	251	7,732	379	
1977	236,500	11,593	6.9	83,374	35.3	63,633	26.9	89,493	37.8	14.0	4.7	7.3	44,160	5,334	261	8,389	411	
1978 ^a	257,127	12,644	8.7	93,137	36.2	69,645	27.1	94,345	36.7	11.7	9.4	5.4	45,400	5,664	279	9,784	489	
77/70			6.7							9.1	4.1	6.8	2.8			4.1		14.6
78/70			7.0							9.4	4.7	6.7	2.8			4.4		15.2
1985	412,890	20,303		174,240	42.2	96,616	23.4	142,034	34.4				53,710	7,687	378			
1990	579,099	28,477		272,177	47.0	121,611	21.0	185,312	32.0				59,800	9,683	476			
85/78			7.0							9.4	4.8	6.0	2.4			4.4		
90/78			7.0							9.3	4.8	5.8	2.3			4.6		

(Source: NESDB, WB Report & Study Mission Survey)

Note: USD: US dollar

Table 3.3.2 Gross Fixed Capital Formation at Constant 1972 Prices

(Unit: million bahts & %)

	Gross fixed capital formation										G F C F type of capital goods						
	Million bahts					Supplied by		Per cent of GDP	Construction			Machinery & equipment					
	Construction	Machinery & equipment	Total	Millions of USD	G.R. (%)	Import	Domestic		Private	Public	Total	Transport equipment	Machinery	Total			
									%	%	%	%	%	%			
1970	17,524	22,427	39,951	1,909	0.4	33.8	66.2	26.6	9,545	7,979	20.0	17,524	6,477	16.2	15,950	39.9	56.1
1971	17,222	22,113	39,335	1,880	▲ 1.5	32.7	67.3	25.0	9,185	8,037	20.4	17,222	7,487	19.0	14,626	37.2	56.2
1972	16,638	17,969	34,607	1,654	▲ 12.0	32.9	67.1	21.0	8,623	8,015	23.2	16,638	5,332	15.4	12,637	36.5	51.9
1973	15,683	22,221	37,904	1,835	9.5	34.8	65.2	21.0	9,240	6,443	17.0	15,683	7,601	20.0	14,620	38.6	58.6
1974	14,717	27,423	42,140	2,068	11.2	36.9	63.1	22.2	10,419	4,298	10.2	14,717	8,808	20.9	18,615	44.2	65.1
1975	16,875	25,536	42,411	2,081	0.6	33.6	66.4	20.8	10,392	6,283	14.8	16,875	8,128	19.2	17,408	41.0	60.2
1976	20,171	24,608	44,779	2,195	5.6	27.8	72.2	20.2	10,720	9,451	21.1	20,171	8,380	18.8	16,228	36.2	55.0
1977	24,423	31,069	55,494	2,720	23.9	27.5	72.5	23.5	13,185	11,240	20.9	24,423	11,152	20.0	19,917	35.9	55.9
1978*	27,816	34,829	62,645	3,080	12.9	27.5	72.5	24.4	15,067	12,749	20.4	27,816	13,574	21.6	21,235	33.9	55.5
77/70	4.9	4.8	4.8		4.8				4.7	5.0		4.9	8.1		3.2		
78/70	5.9	5.7	5.8		5.8				5.9	6.0		5.9	9.7		3.7		
1985	52,685	67,053	119,738	5,888		24.2	75.8	29.0	28,737	23,948	20.0	52,685	28,833	24.1	38,220	31.9	56.0
1990	85,614	108,963	194,577	9,568		20.3	79.7	33.6	46,699	38,915	20.0	85,614	49,033	25.2	59,930	30.8	56.0
85/78	9.6	9.8	9.7		9.7				9.7	9.4		9.6	11.4		8.7		
90/78	9.8	10.0	9.9		9.9				9.9	9.7		9.8	11.3		9.0		

(Source: NESDB & Study Mission Survey)

(3) Results of Forecast by Macro Method

Demand for steel in 1985 and 1990 was calculated as follows by the correlation between demand for steel and GDP (See Table 3.3.3 and 4):

i. Total demand for steel

1985: 2,737,000 tonnes

1990: 3,972,000 tonnes

$$Y = 0.007431X - 331.67$$

(X: GDP, Y: Apparent steel consumption)

Correlation coefficient (γ) = 0.94136

Term: 1966 – 1977 (12 years)

ii. Demand for non-flat steel products

1985: 1,360,000 tonnes

1990: 1,919,000 tonnes

$$Y = 0.003364X - 28.83$$

(X: GDP, Y: Non-flat steel products)

Correlation coefficient (γ) = 0.91194

Term: 1966 – 1977 (12 years)

iii. Demand (*) for flat steel products [(a) – (b)]

1985: 1,377,000 tonnes

1990: 2,053,000 tonnes

(*) For demand forecast of flat steel products, we employed the method of subtracting the demand of non-flat steel products from the total demand of steel, since we predicted that non-flat steel products more accurately reflected the consumption conditions than flat steel products (the stock change of flat steel products in Thailand is significantly influenced by speculation, because of the importation of flat steel products.).

(Unit: Thousand tonnes)

Table 3.3.3 Comparison of Demand Forecast by Various Methods

Case	Method	Demand forecast						Remarks
		1985			1990			
		Flat	Non-flat	Total	Flat	Non-flat	Total	
Case I	Demand accumulation	1,201	1,249	<100> 2,450				
Case II. Aa	Correlation regression (Finished products base)			<112> 2,737			<112> 3,972	Correlation with GDP
Ab	Correlation regression (Finished products base)		1,360			1,919		Correlation with GDP
Ac		1,377			2,053			Ac = Aa - Ab
Case III	Correlation regression (Crude steel base)			<118> (2,882) 3,842			<119> [4,213] 5,616	[] = finished product conversion Correlation with GDP
Case IV	Case I, II modified				1,758	1,795	<100> 3,553	$3,972 \cdot 10^3 \cdot 2,450 / 2,737 = (0.9) \cdot 3,553 \cdot 10^3$
Case V	Correlation regression (Finished products base)	1,511			2,259			Correlation with GDP
Case VI. Aa	Steel intensity SI: Avr. '75, '76, '77			<96> 2,363			<93> 3,314	SI = 116.37/USD.10°
Ab	Steel intensity SI: '77			<110> 2,704			<107> 3,792	SI = 133.18/USD.10°

(Source: Provided by Study Mission)

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Table 3.3.4 Trend of Steel Intensity through 1990

	GDP USD '72 10 ⁶	ASC t 10 ³	SI Actual t/USD. 10 ⁶	GDP/CAP USD '72
1970	7,172	792	110.43	197
1971	7,506	754	110.45	200
1972	7,866	936	118.99	204
1973	8,723	1,160	132.98	220
1974	9,323	1,025	109.94	229
1975	10,013	919	91.78	239
1976	10,848	1,346	124.08	251
1977	11,593	1,544	133.18	261
1985	20,303	2,450	120.67	378
1990	28,477	3,553	124.77	476

(A)

ASC = Finished products base

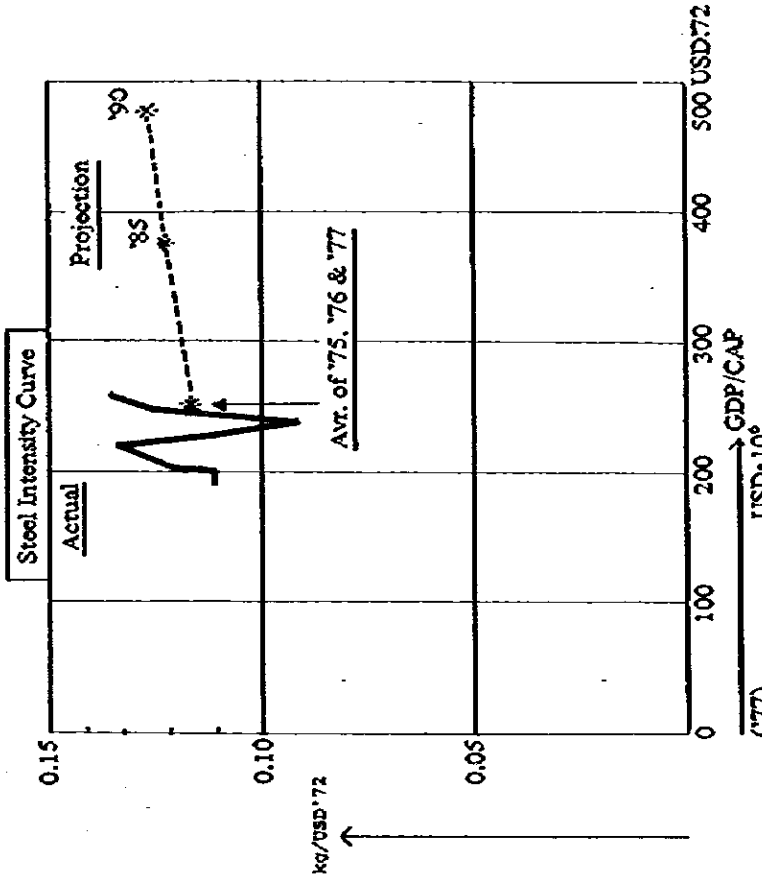
* Avr. SI Actual from '70 through '77: 116.48 t/10⁶ USD

** Avr. SI Actual from '75 through '77: 116.37 t/10⁶ USD

USD-10⁶

$$(B) \quad 116.37 \text{ t/USD} \cdot 10^6 \times (85) \ 20,303 = 2,363 \text{ t} \cdot 10^3$$

$$\times (90) \ 28,477 = 3,314$$



$$(C) \quad 133.18 \text{ t/USD} \cdot 10^6 \times (85) \ 20,303 = 2,704 \text{ t} \cdot 10^3$$

$$\times (90) \ 28,477 = 3,792$$

(D) Comparison (10³ · t)

	'85	'90
(A)	2,450 (100)	3,553 (100)
(B)	2,363 (96.4)	3,314 (93.3)
(C)	2,704 (110.4)	3,792 (106.7)

(USD: US dollar)

(Source: Provided by Study Minton)

(4) Results of Forecast by Micro Method

Demand for steel in 1985 (See Table 3.3.5) was estimated at 2,450,000 tonnes by the micro method. The average growth rate was 7.6 percent against the average apparent consumption for the three years from 1975 to 1977 (1,270,000 tonnes). The construction sector (See Table 3.3.6) still has a high share of 60 percent. It is also remarkable that the annual growth rate of automobiles and motorcycles is high at 23.5 percent, and the annual growth rate of the container manufacturing sector such as food cans is still good at 9.6 percent. Consumption in heavy industries, such as shipbuilding, electric and industrial machinery is not expected to show a full-fledged-growth as of yet. The proportion of imported machinery and equipment in gross domestic capital formation (See Table 3.3.2) went down from 37 percent in 1974, to 27.5 percent in 1977, and is expected to go further down to 24 percent in 1985. But since machinery and equipment still depend largely on imports, time will be needed to arrive at the economic structure whereby equipment investment of heavy-petrochemical industry will induce the domestic steel demand related to investments.

With regard to the demand by type of steel products, the annual growth rate of flat steel product is obtained at 7.8 percent.

The annual growth rate of hot rolled steel is especially high at 11.3 percent and that of tin plates is high at 9.8 percent (See Table 3.3.7). Bars and sections have the majority share of 52.6 percent. Though the demand for flat steel products (especially HR and CR) will increase until 1985, no basic change in this pattern is expected to take place.

Table 3.3.5 Steel Demand Forecast (1985) by Major Industrial Sectors

(Unit: 1,000 tonnes)

Steel products	Sectors	ASC	Ship-building	Automobile & motorcycles				Industrial machinery	Electric machinery (Household)	Household & office equipment	Container		Construction			Bicycle	Secondary products	Others for shearing	
				Passenger cars	Commercial cars	Motor cycles	Sub-total				Food cans	Others	Sub-total	Civil	Building				Sub-total
Bars & sections	Sheet piles	5											5						
	Sections	195	2		4		4	3					18	168	186				
	Wide flange beams	10											10	46	46				
	Light gauges	46											8	122	130				
	Others	139	2		4		4	3					102	696	798	53			
	Bars	898	7		1	32		33	7					102	696	798			
	Small bars	798															53		
	Others	100	7		1	32		33	7								190		
	Wire rods (incl. BIC)	190															190		
	Total	1,288	9		1	36		37	10					125	864	989	243		
Sheets & plates	Plates	199	20					103					59	17	76				
	Heavy	149	15					73					46	15	61				
	Medium	50	5					30					13	2	15				
	Sheets	372			4	125	11	140	41	25	22		11	21	25	46	11		
	HR	228												21	25	46	3		
	CR	121			4	95	3	98	41				4				8		
	CR (Others)	23				30	8	42		12	22		7				30		
	Tin plates	155										101	54	155			10		
Galvanized sheets	235			7			7	10	2	9			21	186	207				
Total	961	20		11	125	11	147	154	27	31	101	65	166	101	228	329	11		
Pipe & tubes	Seamless tubes	7						7											
	Welded pipes	194	3		7	8	2	17	17				19	101	34	135	3		
	Total	201	3		7	8	2	17	24				19	101	34	135	3		
Grand total (%)	(100)	(1.3)		(0.8)	(6.9)	(0.5)	(8.2)	(7.7)	(1.1)	(2.0)	(4.1)	(2.7)	(6.8)	(13.3)	(46.0)	(59.3)	(0.6)	(9.9)	(3.1)
	2,450	32		19	169	13	201	188	27	50	101	65	166	327	1,126	1,453	14	243	76

(Source: Provided by Study Mission)

Table 3.3.6 Industrial Classification of Steel Demand (1985)

(Unit: thousand tonnes & %)

	Demand		Composition		Growth rate
	Base *	1985	Base	1985	
Ship building	19	32	1.5	1.3	6.0
Automobile & motorcycle	30	201	2.4	8.2	23.5
{ Passenger cars	1	19	0.1	0.8	38.7
{ Commercial vehicles	24	169	1.9	6.9	24.2
{ Motor cycles	5	13	0.4	0.5	11.2
Industrial machinery	113	188	8.9	7.7	5.8
Electric machinery	6	27	0.5	1.1	18.2
Household & office equipment	34	50	2.7	2.0	4.4
Container	73	166	5.7	6.8	9.6
{ Food cans	42	101	3.3	4.1	10.2
{ Others	31	65	2.4	2.7	8.6
Construction	772	1,453	60.8	59.3	7.3
{ Civil	199	327	15.7	13.3	5.7
{ Building	573	1,126	45.1	46.0	7.8
Bicycle	6	14	0.5	0.6	9.9
Secondary products	147	243	11.5	9.9	5.7
Others for shearing	70	76	5.5	3.1	0.9
Steel demand total (ASC)	1,270	2,450	100	100	7.6

(Source: Provided by Study Mission)

* Base = Average of 1975, '76 & '77

Table 3.3.7 Production Classified by Steel Product through 1990

(Unit: thousand tonnes & %)

	Base		Projection		Growth rate		Remarks			
	1975, '76 & '77		1990		'85/Base	'90/'85				
	Avr.	%	1985	%	%	%				
Bars & sections	Steel sheet piles	3	0.1	5	0.2	7	0.2	5.8	5.8	
	Wide flange beams	6	0.5	10	0.4	13	0.4	5.8	5.8	
	Light gauges	22	1.7	46	1.9	69	1.9	8.5	8.5	
	Others	67	5.3	139	5.7	208	5.9	8.4	8.4	
	Sub-total	95	7.5	195	8.0	290	8.2	8.3	8.3	
	Small bars	410	32.3	798	32.6	1,156	32.5	7.7	7.7	
	Others	48	3.8	100	4.1	150	4.3	8.5	8.5	
	Sub-total	458	36.1	898	36.7	1,306	36.8	7.8	7.8	
	Wire rods (incl. BIC)	115	9.1	190	7.7	251	7.0	5.7	5.7	
	Total	671	52.8	1,288	52.6	1,854	52.2	7.5	7.6	
Plates	Heavy	88	6.9	149	6.1	199	5.6	6.0	6.0	
	Medium	30	2.4	50	2.0	66	1.9	5.8	5.8	
	Sub-total	118	9.3	199	8.1	265	7.5	6.0	6.0	
Sheets & plates	HR	87	6.9	228	9.3	389	10.9	11.3	11.3	
	CR	66	5.2	121	4.9	170	4.8	7.0	7.0	
	CR (Others)	14	1.0	23	1.0	30	0.9	5.7	5.7	
	Sub-total	167	13.1	372	15.2	589	16.6	9.3	9.3	
	Tin plates	67	5.3	155	6.3	247	7.0	9.8	9.8	
Galvanized sheets		135	10.7	235	9.6	320	8.9	6.4	6.4	
	Total	487	38.4	961	39.2	1,421	40.0	7.8	8.1	
Pipes & tubes	Seamless tubes	4	0.3	7	0.3	10	0.3	6.4	6.4	
	Welded pipes	108	8.5	194	7.9	268	7.5	6.7	6.7	
	Total	112	8.8	201	8.2	278	7.8	6.7	6.7	
Grand total (ASC)	1,270	100	2,450	100	3,553	100	7.6	7.7		

(Source: Provided by Study Mission)

(5) Final Figures of Demand Forecast

From the above evaluations, demand for steel in 1985 and 1990 are predicted as follows:

- a. The figures obtained by the micro method is employed for the year 1985 (2,450,000 tonnes).
- b. The demand for 1990 is based on the figures obtained by macro method. The original figures are multiplied by the adjustment factor of 0.9, which was the differential factor between the two figures arrived at in calculating the 1985 figure by both micro and macro analytic methods.

Base figures by macro method: 3,972,000 tonnes

(GDP base year: 1978, the annual growth rate: 7% in real terms)

Final demand for 1990 = 3,972,000

× 0.9 (adjustment factor)

= 3,553,000 tonnes

- c. The 1990 demand by type of steel products is obtained by calculations based on the demand pattern and respective growth rate used in predicting 1985 figures. According to this estimation, the total annual growth rate from 1985 to 1990 is 7.7 percent. It is 7.9 percent for flat steel products and 7.5 percent for non-flat steel products. In 1990 the proportion of flat steel products is expected to increase up to 40 percent. (See Table 3.3.8)
- d. The breakdown of supply and demand by products is as described in Table 3.3.8.
The flat steel product can be classified by rolling mills as follows. (Table 3.3.9)

Cold rolling mill:	580,000 tonnes in 1985
	830,000 tonnes in 1990
Hot rolling mill:	1,260,000 tonnes in 1985
	1,850,000 tonnes in 1990

But the flat steel product to be rolled by heavy plate mill is still low as in the following.

Heavy Plate mill:	20,000 tonnes in 1985
	30,000 tonnes in 1990

- e. Steel demand by regions in 1985 (See Table 3.3.10) will be similar to that of present situation (See Table 3.2.14), concentrating heavily in Bangkok and the central area. And apparent crude steel consumption per capita will increase to 61 kg in 1985 and 79 kg in 1990. (See Table 3.3.11)

Table 3.3.8 Balance of Supply & Demand (1977, 1985 & 1990)

(Unit: thousand tonnes)

	Present situation ('77)			Projection ('85 & '90)			Remarks
	Annual capacity (A)	Local production	Total demand	'85: Total demand (B)	'90: Total demand (C)		
					(A) - (B)	(A) - (C)	
Bars & sections							
Steel sheet piles	0	0	3	5	(-) 5	7	(-) 7
Wide flange beams	0	0	9	10	(-) 10	13	(-) 13
Light gauges	68	25	25	46	22	69	(-) 1
Others	0	0	93	139	(-) 139	208	(-) 208
Sub-total	68	25	127	195	(-) 127	290	(-) 222
Small bars		478	478	798		1,156	
Others	(563)*	0	63	100	((-) 525)	150	((-) 994)
Sub-total	1,125+α	478	541	898	37	1,306	(-) 432
Wire rods (incl. BIC)		90	136	190		251	
Total	1,193+α	593	807	1,288	(-) 95	1,854	(-) 661
Plates							
Heavy	0	0	87	149	(-) 149	199	(-) 199
Medium	0	0	35	50	(-) 50	66	(-) 66
Sub-total	0	0	122	199	(-) 199	265	(-) 265
HR	0	0	117	228	(-) 228	389	(-) 389
CR (ordinary)	0	0	97	121	(-) 121	170	(-) 170
CR (special)	0	0	23	23	(-) 23	30	(-) 30
Sub-total	0	0	237	372	(-) 372	589	(-) 589
Tin plates	60	36	85	155	(-) 95	247	(-) 187
Galvanized sheets	204	129	159	235	(-) 31	320	(-) 116
Total	264	165	603	961	(-) 697	1,421	(-) 1,157
Pipes & tubes							
Seamless tubes	0	0	5	7	(-) 7	10	(-) 10
Welded pipes	372+α	130	129	194	178+α	268	104+α
Total	372+α	130	134	201	171+α	278	94+α
Grand total	1,829	(58)	(100)	2,450	(-) 621	3,553	(-) 1,724
		888	1,544				

* () indicates case of 50% operation factor.

(Source: Provided by Study Mission)

Table 3.3.9 Demand for Flat Steel Products by Rolling Mills (1985 & 1990)

(Unit: thousand tonnes)

Rolling mill	1985			1990			Remarks
	Cold	Hot	Plate	Cold	Hot	Plate	
Steel sheet piles							
Wide flange beams							
Light gauges							
Others							
Sub-total		48			72		
Small bars							
Others							
Sub-total							
Wire rods (incl. BIC)							
Total		48			72		
Heavy							Heavy plates { 85%: Hot strip mill 15%: Heavy plate mill
Medium		127	22		169	30	
Sub-total		177	22		235	30	
HR							Welded pipes { 75%: Hot strip mill 25%: Cold strip mill
CR		228			359		
CR (Others)		136			190		
Sub-total		390			613		
Tin plates		160	179		255	286	
Galvanized sheets		224	251		305	342	
Total		528	997	22	760	1,476	30
Seamless tubes							
Welded pipes		53	215		72	297	
Total		53	215		72	297	
Grand total		581	1,260	22	832	1,845	30

(Source: Provided by Study Minton)

Table 3.3.10 Geographical Distribution of Steel Demand (1985)

(Unit: thousand tonnes & %)

	ASC	Metropolitan	Central	North	Northeast	South	Remarks
Sheet piles	5	4.2	0.8	-	-	-	
Sections	195	86.3	33.1	19.7	35.6	20.3	
Wide flange beams	10	8.4	1.6	-	-	-	
Light gauges	46	19.3	7.3	5.0	9.2	5.2	
Others	139	58.6	24.2	14.7	26.4	15.1	
Bars	898	393.7	167.6	87.0	159.6	90.1	
Small bars	798	335.2	126.1	87.0	159.6	90.1	
Others	100	58.5	41.5	-	-	-	
Wire rods (incl. BIC)	190	111.1	78.9	-	-	-	
Total	(100)	(46)	(22)	(8)	(15)	(9)	
	1,288	595.3	280.4	106.7	195.2	110.4	
Plates	199	114.6	73.0	3.5	4.7	3.2	
Heavy	149	92.9	56.1	-	-	-	
Medium	50	21.7	16.9	3.5	4.7	3.2	
Sheets & coils	372	163.1	142.6	22.6	24.8	18.9	
HR	228	99.6	82.8	14.8	17.9	12.9	
CR	144	63.5	59.8	7.8	6.9	6.0	
Tin plates	155	68.4	64.3	8.4	7.4	6.5	
Galvanized sheets	235	99.2	44.3	24.1	42.7	24.7	
Total	(100)	(46)	(34)	(6)	(8)	(6)	
	961	445.3	324.2	58.6	79.6	53.3	
Seamless tubes	7	4.1	2.9	-	-	-	
Welded pipes	194	82.7	45.8	17.9	29.8	17.8	
Total	(100)	(43)	(24)	(9)	(15)	(9)	
	201	86.8	48.7	17.9	29.8	17.8	
Grand total (%)	(100)	(46.0)	(26.7)	(7.5)	(12.4)	(7.4)	
	2,450	1,127.4	653.3	183.2	304.6	181.5	

(Source: Provided by Study Mission)