REPORT ON
THE DEVELOPMENT AND EXPANSION OF THE IRON AND STEEL INDUSTRY IN THE SIX SOUTH-EAST ASIAN COUNTRIES

JANUARY 1969

GOVERNMENT OF JAPAN

FOREWORD

The Government of Japan, in response to the request of ECAFE, decided to conduct a survey on the possibilities of regional cooperation for the development of steel industry in the six Southeast Asian countries (Taiwan, Philippines, Indonesia, Singapore, Malaysia and Thailand), and entrusted the execution of the survey with The Overseas Technical Cooperation Agency.

The survey mission was organized in two groups, each comprising eight team members, participated by one (executive) secretary from ECAFE. The first group was headed by Mr. Torao Okumura, Managing Director of The Japan Iron and Steel Federation and the second group, by Mr. Shintaro Tabata, Executive Director of The Iron and Steel Institute of Japan. The survey in the three countries, namely, Taiwan, the Philippines and Indonesia, was carried out by the First Group during a period of 23 days from June 19, 1968 to July 11, 1968 and another in the three countries, namely, Singapore, Malaysia and Thailand, was conducted by the Second Group during a 24 day period from July 22, 1968 to August 14, 1968, in which prevailing situation of steel industries in these countries were observed and necessary data was gathered.

Thanks to the assistance and cooperation of ECAFE and the governments concerned, the survey activities in these countries were smoothly carried out, and the report on the findings of the survey is now ready for submission.

We shall be more than happy if the report submitted contributes to the development of steel industries in the six Southeast Asian countries and at the same time further friendship between these countries and Japan.

Finally, I express my grateful appreciation to the ECAFE and the governments of the six countries for their generous assistance and cooperation rendered to the team during this survey.

January 1969

Shinichi Shibusawa
Director General
Overseas Technical Cooperation Agency

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PART I

(GENERAL REVIEW)

1. INTRODUCTION

(1) During its second session held at Bangkok in March 1967, the Asian Industrial Development Council (AIDC) recommended the organization of the first survey mission to study possibilities of regional cooperation for the development of the iron and steel industry in the establishment of large technologically and economically viable integrated steel plants.

The mission consisted of eleven steel experts and two member-secretaries from the Secretariat. It conducted on-the spot-surveys in the six Southeast Asian countries (Taiwan, the Philippines, Indonesia, Singapore, Malaysia, and Thailand) during the period from July 30 through September 9.

(2) The report of the first survey mission was discussed in the third session of AIDC held at Bangkok from February 12 to 19, 1968 with the participation of 18 countries and other international organizations. The summary of its findings, among others, was as follows:

(a) The six countries indicated their unanimous approval of the recommendations made by the First Survey Mission and their willingness for a united effort in the promotion and development of the iron and steel industry.

(b) The urgent need for cooperation of development plans among the six countries to ensure the most effective utilization of the mineral and other natural resources for iron and steel production.

(c) The potential market and resources in Southeast Asia is sufficient to justify the establishment of a few integrated steel projects in this subregion.

(d) It was also estimated that approximately US$2,200 million will be required for the plant investment in steel plants. It was considered necessary to make a careful pre-investment feasibility studies for such an enormous investment before undertaking the construction of possible steel projects Pre-investment feasibility studies would be helpful to these countries in making decisions on the investment required, facilitate the consultations and formulation of policies among the governments concerned, and provide basis for the possible consideration of the assistance from financial institutions and the interest of the private sector for the possible establishment of these projects. The estimate of steel consumption of about 12 million tons of crude steel in 1985 in these countries was considered moderate.

(e) It was considered necessary for the AIDC to rely upon to a great extent the assistance of advanced countries and international organizations for undertaking these studies.

(f) Apart from these studies, the establishment of a steel institute was also recommended. However, it was the opinion that the establishment of such an institute would be necessary for the secretariat and the interested governments to make a preliminary survey on the purpose and scope of responsibility of the proposed institute.

(3) The Council expressed its appreciation to the Japanese Government for its generous offer to make these studies without cost to the AIDC and the countries concerned. As a result of consultations between the Japanese Government and the secretariat, the survey mission was organized with the following primary objectives:

(a) To undertake pre-investment studies on four specific projects, paragraph 145, (Report of the Iron and Steel Survey Mission) Document AIDC (3)/5.

(b) To hold consultations with the governments and business circles concerned; discuss ways and means to harmonize and coordinate plans for the development of the iron and steel industry; particularly in respect of specialization in products mix to maximize productivity and efficiency.

(c) In this context, the mission investigated steel demands and markets. It studied types and sizes of plants, equipment and processes; estimated capital investments and production costs. It suggested the location of plants in some of these countries.

(4) This report consists of two parts: Part I contains (1) a general survey of the present structure in plants for the expansion of steel industry in these countries, (2) the problem facing to the development, and (3) conclusions and recommendations of the Mission. Part II contains the detailed feasibility studies of steel projects in China (Taiwan), Indonesia, Singapore and Thailand. It also contains miscellaneous informations on the steel plants in the Philippines and Malaysia.

(5) The Mission consisted of two groups and one member from the secretariat. It was fielded from June to August. The First group was headed by Mr. Torao Okumura and visited Taiwan, the Philippines and Indonesia from June 19 to July 11, 1968. The second group was headed by Mr. Shintaro Tabata and visited Thailand, Malaysia and Singapore from July 22 to August 14, 1968.

MEMBER LIST OF

THE SURVEY TEAM FOR THE DEVELOPMENT PROJECT OF IRON AND STEEL INDUSTRY IN SOUTH-EAST ASIAN SIX COUNTRIES

(as of August 1968)

– First Group –

Mr. Torao Okumura
Leader, Managing Director
The Japan Iron & Steel Federation

Mr. B. P. Abrera
Technical Engineering Adviser
Industry and Natural Resources Division
Ecafe, Un

Mr. Tadashi Yasukawa
Member (Market)
Staff Member
Market Research Dept. Marketing Div.
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Mr. Bunzo Iwamura
Member (Market)
Market Analyst
Economic Research Department
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Mr. Tatsuo Shimizu
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Executive Director
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Mr. Yoshio Fujimoto
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Chief, Equipment Planning Section
Technical Department
Kawasaki Steel Corporation

Mr. Tadashi Tsuchiya
Member (Fund and Cost)
Assistant Chief
Budget & Cost Control Section
Controlling Department
Sumitomo Metal Industries Co., Ltd.

— Itineary of Survey Mission —

First Group

June 19,	Wed.	Left Tokyo and arrived in Taipei.
" 20,	Thu.	In the morning; courtesy call to Government of Republic China and had meeting with the officials. In the afternoon; courtesy call to Taiwan Steel & Iron Industries Association and had meeting with the officials.
" 21,	Fri.	Left Taipei and arrived in Kaohsiung. In the morning; courtesy call to Kaohsiung Harbor Bureau and observation of the facilities. In the afternoon; Observation of Tang Eng Iron Works Ltd. and Dah-yung Steel Mfg. Company Ltd.
" 22,	Sat.	In the morning; Observation of Taiwan Machinery Manufacturing Corporation. Left Kaohsiung and arrived at Taipei.
" 23,	Sun.	Arrangement of data and materials.
" 24,	Mon.	In the morning; Observation of Taiwan Ship-building Ltd. and courtesy call to Keelung Harbor Bureau and observation of the facilities. In the afternoon; Observation of Taiwan Iron Manufacturing Corporation and Ming Fong Iron & Steel Works Ltd.
" 25,	Tue.	In the morning; courtesy call to Japanese Embassy Left Taipei and arrived in Manila.
" 26,	Wed.	In the morning; courtesy call to Japanese Embassy and ADB. In the afternoon; courtesy call to Board of Investment and had meeting with the officials and courtesy call to UNDP.
" 27,	Thu.	Left Manila and arrived in Iligan. In the afternoon; Visited Iligan Integrated Steel Mills.
" 28,	Fri.	In the morning; had meeting with Iligan Integrated Steel Mill's officials. Left Iligan and arrived in Manila.
" 29,	Sat.	In the morning; Observation of Elizalde Iron and Steel Co., Ltd.
" 30,	Sun.	In the morning; Arrangement of data and materials. Left Manila and arrived in Djakarta.
July 1,	Mon.	In the morning; courtesy call to Japanese Embassy. In the afternoon; Observation of Air Trading Coy's Steel Factory.
" 2,	Tue.	In the morning; courtesy call to Ministry of Industry and had meeting with the officials. In the afternoon; Observation of Tumbak Mas GI Steel Factory and Bakrie Brothers Pipe Factory.

July 3,	Wed.	Observation of Tjilegon Steel Mills and Merak Harbor facilities
" 4,	Thur.	In the morning; courtesy call to Tandjung Priok Harbor and observation of the facilities. In the afternoon; Observation of PAKIN Ship Building Dock-Yards and PN Sabang Merake Machinery Repair Work Shop.
" 5,	Fri.	Left Djakarta and arrived in Surabaja.
" 6,	Sat.	In the morning; Observation of BARATA work shop and BISMA work shop. In the afternoon; courtesy call to Surabaja Harbor and observation of the facilities.
" 7,	Sun.	Left Surabaja and arrived in Djakarta.
" 8,	Mon.	In the morning; Arrangement of data and materials. Left Djakarta and arrived in Bangkok.
" 9,	Tue.	In the morning; courtesy call to Japanese Embassy and visited ECAFE for the reporting of survey.
" 10,	Wed.	Arrangement of data and materials.
" 11,	Thu.	Left Bangkok and arrived in Tokyo.

Second Group

July 22,	Mon.	Left Tokyo and arrived in Bangkok.
" 23,	Tue.	In the morning; courtesy call to ECAFE and had meeting. In the afternoon; courtesy call to Japanese Embassy and had meeting.
" 24,	Wed.	Arrangement of data and materials.
" 25,	Thu.	Left Bangkok and arrived in Singapore.
" 26,	Fri.	In the morning; courtesy call to EDB and had meeting with officials. In the afternoon; Observation of Shimalpan Steel Industries Ltd.
" 27,	Sat.	In the morning; observation of the Malaysia Steel Pipe MFG., Co., Ltd. and National Iron & Steel Mills Ltd. In the afternoon; observation of Jurong Shipyard Ltd., Eastern Wire MFG., Co., Ltd. and Jurong Industry Estate.
" 28,	Sun.	In the morning; Arrangement of data and materials. In the afternoon; discussion meeting with officials of EDB.
" 29,	Mon.	In the morning; meeting with officials of the Jurong Town Cooperation and EDB. In the afternoon; observation of Singapore Galvanizing Industries Ltd.
" 30,	Tue.	Left Singapore and arrived in Kuala Lumpur. Courtesy call to Japanese Embassy and had meeting with the officials.

July	31,	Wed.	In the morning; courtesy call to UNDP and had meeting with officials.
			In the afternoon; courtesy call to FIDA and had meeting with officials.
August	1,	Thu.	In the morning; observation of United Malaysian Steel Mill.
			Visited Selangor State Development Cooperation.
"	2,	Fri.	Left Kuala Lumpur and arrived in Penang.
			Observation of Malayawata Steel Mill and Malayawata Charcoal Industry.
"	3,	Sat.	Arrangement of data and materials.
"	4,	Sun.	Left Penang and arrived in Kuala Lumpur.
"	5,	Mon.	Arrangement of data and materials.
"	6,	Tue.	Left Kuala Lumpur and arrived in Bangkok.
"	7,	Wed.	In the morning; courtesy call to the Department of the Mineral Resources and had meeting with the officials of the Dept.
			Courtesy call to the Ministry of Industry and had meeting with the officials.
			In the afternoon; courtesy call to Board of Investment had meeting with officials.
"	8,	Thu.	In the morning; visited State Railway of Thailand and had meeting with the officials.
			Observation of G.S. Steel Co., Ltd.
			In the afternoon; observation of the Sangkasi Thai Co., Ltd., Thai Tin Plate MFG., Co., Ltd. and Thai Steel Pipe Industry Co., Ltd.
"	9,	Fri.	In the morning; visited Makkasan Workshop and had meeting with the officials of State Railway of Thailand and Port Authority of Thailand.
			In the afternoon; courtesy call to Yanhee Electricity Authority.
"	10,	Sat.	In the morning; observation of Bangkok Steel Industry Co., Ltd. and Sinthani Industry Co., Ltd.
			In the afternoon; observation of Thailand Iron Works Co., Ltd. and Sathask Driam Co., Ltd.
"	11,	Sun.	Inspected Sri-Racha (the proposed plant-site).
"	12,	Mon.	Observation of Siam Iron and Steel Co.
"	13,	Tue.	In the morning; visited ECAFE and Japanese Embassy for the last meeting and for leaving greeting.
"	14,	Wed.	Left Bangkok and arrived in Tokyo.

2. PRINCIPAL THEME OF THE SURVEY

The principal work of the recent Japanese AIDC Survey Mission was confined only to the specific projects recommended by the first survey mission in their report, paragraph 145, Document AIDC (3)/5. These feasibility studies in this report are mainly directed towards the coordination of steel projects at the rolling section that precedes integration. These are the projects that required urgent investigations. For further clarification, the summary of the conclusions and recommendations made by the first Survey Mission are described below.

137. The total steel consumption in the sub-region, in terms of crude steel equivalent, is estimated as follows:

year	1000 tons
1966	3,050
1970	4,400
1975	6,400
1980	9,000
1985	12,100

138. An investigation of present known deposits of domestic raw materials shows that, for an expanded steel consumption of these dimensions, neither iron or nor coal of necessary quality and quantity are available within the sub-region, nor is domestic scrap available in sufficient quantities. Therefore, in the short term, the dominant portion of iron ore and coal (possible coke) will have to be obtained by import, largely from Australia and India.

This constitute, however, no disadvantage, as the imported high grade raw materials will most likely permit production of iron and steel at a lower cost than would be possible when using the domestic raw materials normally of lower grade. Considering the short transport distances from the above suppliers, the imported iron ore and coal should be available to the sub-region at reasonable costs. Consequently, the raw material situation would appear reassuring.

139. As the best and cheapest transport of iron ore and coal is nowadays performed in large bulk carriers of over 50,000 tons, it is essential that modern large steel plants be located alongside deep-sea harbours with efficient unloading facilities. This is particularly desirable for any sub-regional steel plants that are designed for the future and it will permit high production at the lowest possible production cost over a long period of time.

140. Nowadays, ideal site for a large steel plant is along-side a deep-sea harbour and if possible, near the consumption area also. This important criterion limits the number of places in which a regional steel plant should be located. In the sub-region, good harbours exist at Kaohsiung (Taiwan) and Jurong

(Singapore); Iligan (Philippines) and possibly Merak (Indonesia) are satisfactory with further development. In Malaysia, the development of Prai as an all-weather deep sea harbour should be considered. Shiracha (Thailand) is said to be a potential good deep-sea harbour site.

141. For reliable large-scale iron and steel production only well introduced and proven processes can be recommended by the mission. For instance, blast furnaces are best in most cases and electric pig iron when power price is particularly favourable compared with coke. Furthermore, for steel making, basic oxygen converters and continuous as well as conventional casting practices are recommended. Electric melting may also be envisaged. However, this does not prejudice the missions' recommendation to study and consider new processes.

142. There is a tendency for steel plant capacities to increase partly owing to increasing consumption within the natural market area of the plant. Although rather small plant may under certain circumstances be very economical and the first start for several reasons may have to envisage a moderate annual capacity of 100-300 thousand tons, it is recommended that the possibilities for quick expansion to something like 500,000 tons and then a gradual expansion up to 1 million tons be foreseen. If the possibilities can be kept open for a still later expansion up to 2-3 million tons, this may be considered a reasonable expansion potential in the foreseeable future.

143. Besides the production of ordinary steel, attention should be given to the production of some special products viz. alloyed and special steel as well as foundry pig iron. These constitute a necessary part of normal iron and steel consumption.

144. The possibilities for regional as well as economical development of steel production in the region through optimum development strategy including erection of regional steel plants and specialization of product mix must be carefully scrutinized with regard to economic background and consequences. The time available has not permited the mission to do so. Such studies are most suitable for joint ventures.

145. The following suggestions for joint ventures are well worth investigating at an early date in close co-operation with the countries and the intending parties concerned:

(a) That Taiwan should establish a mill or mills to produce hot rolled coils and plates for the eastern sub-region, China (Taiwan) and Philippines, bearing in mind that the Philippines has already taken steps to establish a cold rolling mill;

(b) That Thailand should establish a cold rolling mill, preferably one which could meet the entire market demand from the western sub-region (Malaysia, Singapore, Indonesia and Thailand), bearing in mind the feasibility of Indonesia's participation in the manufacture of cold rolled products;

(c) That a mill for the production of billets to cover the whole sub-region should be established in Singapore;

(d) That Indonesia should continue its efforts to establish production of its entire requirements of merchant bars.

146. Apart from the above proposals, the following should be studied at a later date, in particular as regards economics:

(a) In view of the estimated future demand in the sub-region, another hot strip mill will be required in 1970–75.
As the site of the hot strip mill Malaysia is suggested because the next logical development of Malayawata at Prai could well be flat products;

(b) In view of the increasing tin plate requirements in this region, another electrolytic tinning line, in addition to the two lines planned in the Philippines and Taiwan, will be needed. Thailand is suggested, because the tinning line should be located near the cold rolling mill in order to secure efficiency. However, transport costs of tin plates from Thailand to Malaysia, Singapore and Indonesia must be taken into account before the proposal can be implemented;

(c) As a hot strip mill is to be established in Taiwan and another possibly in Malaysia, a slab producing plant will be needed. The Philippines is suggested as the possible site.

147. Possible sub-region co-operation in other subjects than making steel is recommended for investigation, including:

(a) Co-operation in mineral over the region, jointly using existing facilities. The present knowledge of mineral reserves is very limited and in a number of countries only a very minor part of the area has been investigated;

(b) Joint research on utilization of domestic minerals, in order to find ways of using non-coking coal for metallurgical purposes as well as of exploring methods and the possible economy of using laterite and titanium containing iron sand for iron and steel production. All these minerals are abundant in the sub-region, and a successful solution of these techno-economical problems would be very fruitful;

(c) The lack of trained and skilled man power is perhaps the most serious problem involved in the accelerated development of iron and steel production. The urgent need both for internal training programmes in each country and for a regional training programme within the sub-region is obvious. It is recommended that the measures necessary to accelerate and harmonize the training programmes should be investigated and implemented by a joint organization for the sub-region.

148. To complete, supplement and follow up all the work necessary for facilitating and increasing the efficiency and sound development of the iron and steel industry in the region, the mission recommends strongly the creation of a permanent joint organization, which may be called the South-east Asian iron and steel institute. For this reason, the Mission recommends further that a representative meeting with the parties concerned in the sub-region should be convened at an early date under the aegis of ECAFE/AIDC to implement this recommendation.

3. REVIEW OF IRON AND STEEL INDUSTRY IN THE SIX COUNTRIES OF THE REGION

The details of the current situation of the iron and steel industry, the future prospect of supply and demand, and the description of plant expansion projects in the six countries of the region are described in Part II of this report. The following summary is presented as a precondition to the study of feasibility of the four projects mentioned above.

3.1 Republic of China (Taiwan)

(1) Economic growth in Taiwan has been remarkable in recent years. GNP in 1967 attained a growth rate of 8.9%. Further industrialization and higher industrial level are anticipated. The demand for steel products is rapidly increasing. The average growth rate of steel demand in the last several years was 14% and the elasticity against the growth of GNP was about 1.7, which would mean further increase in the demand for steel products in the future. Forecast of demand for steel products is shown below.

Table 1. Forecast of Demand for Steel Products

(Unit: 1,000 ton)

Year	1966	1967	1970	1975	1980	1985
Flat products	238		345	545	870	1330
Others	352		517	722	1062	1612
Total steel products	590		862	1267	1932	2942

The table shows that the demand for steel products, particularly for flats will increase considerably as a consequence of probable changes in the industrial structure in such as the expansion of ship-building, food processing, rolling stock and electric equipment and machinery manufacturing industries.

(2) At present there are over 100 steel manufacturers in Taiwan. Out of them, two plants are equipped with iron and steel making facilities, although they are small in scale.
The majority of these plants are engaged in the production of only small shapes and bars of various types from small ingots which are produced by electric arc furnaces or from rerolling steel scrap.
Summary of annual production capacity of the existing facilities are as follows.

Table 2. Annual Production Capacity of the Existing Facilities

Iron making	120,000 T/Y
Steel making	500,000 "
Shapes and bar rolling	600,000 "
Flat products rolling	60,000 "
Galvanizing	60,000 "
Hot dip tinning	20,000 "
Steel pipe making	65,000 "
Wire drawing and rope making	120,000 "

(3) The steel production by electric arc furnaces has made a rapid development in the post-war period. This was partly due to the relatively low cost of electricity. However, the small capacity and inefficiency of the existing facilities, production is not enough to meet demand for steel products in Taiwan at present. Furthermore, the lack of adequate rolling facilities for flat products to meet the increasing demand for flats has necessitated the expenditure of foreign currency totalling about US$40 million annually for the import of these products. This situation causes a serious foreign exchange problem in the balance of payments in this country and focuses the importance of the expansion of steel industry.

(4) The Taiwan Government is, therefore, now pushing forward a drive for the rationalization and modernization of the existing steel industry. It is also contemplating the establishment of an integrated steel plant with an ultimate production capacity of about two million tons of crude steel, which will be located at the Kaohsiung Harbor. This is an excellent site for this plant in Taiwan.

A preparatory office was established as early as January of 1966 as a subordinate agency of the Ministry of Economy of the Taiwan Government. The office is now drafting a detailed working plan for the period up to Phase II and the new company after obtaining a government approval is expected to function by the end of 1968.

The construction work is expected to be started in 1969.

Facilities for the proposed plant will be built in stages.

Phase I	(1969–1971)	Electrolytic tinning line	80,000 T/Y
		Cold tandem mill	500,000 "
Phase II	(1971–1973)	Hot strip mill	1,000,000 "
		Expansion of tinning line	160,000 "
Phase III	(1973–1975)	Iron and steel making	1,000,000 " (crude steel)

Phase IV (1979–1981) Expansion of the above facilities 2,000,000 T/Y (crude steel)

3.2 The Philippines

The economy of the Philippines had made a rapid recovery in the post-war period. The production in the country has already reached its pre-war level in 1949. The government is presently working out a new 4 Year Economic Program (1967–1870) with the aim of promoting further industrialization and also of the balanced development of both the industry and the agriculture sectors. Real growth rate of economy in 1950's was over 6% but the growth rate in the past several years dropped to around 4%. Average growth rate recorded during the period from 1962 to 1966 was 4.6%.

It is expected that with the further accumulation of social overhead capital and industrialization, the rate of steel products in demand will increase accordingly.
Forecast of demand for steel products is shown below.

Table 3. Forecast of Demand for Steel Products

(Unit: 1,000 ton)

Years	1966	1967	1970	1975	1980	1985
Flat products	283	417	481	671	882	1,134
Others	280	317	484	707	955	1,236
Total steel products	563	734	965	1,378	1,837	2,376

The table shows that the steel consumption of flat product has accounted for nearly 50% of the total steel consumption. Cold rolled sheets, particularly, was the major product. This was due to a high demand for galvanized sheets for roofing and a large consumption of tin plates for containers and cans for processed foods. Although this tendency may continue, the relative proportion of flat products will decrease to some extent because of the increase in the demand for other types of steel products.

(1) At present, there are five major steel manufactures in the Philippines. All of these plants are now producing only small ingot by melting scrap in electric arc furnaces. These ingots are used to produce reinforced bars and wire rods. There are also 23 small rerolling plants which manufacture round bars from imported billets. In addition, there are five galvanizing plants which are operating only about 50 to 60% of their capacity because of shortage of base plate supply. Summary of the capacity of the existing facilities is as follows.

Table 4. Capacity of the Existing Facilities

Steel making	184,500 T/Y
Shapes & bar rolling	380,200 "
.	(also equipped with steel making facilities 286,200 T/Y)
Cold rolling	120,000 "
Galvanizing	211,000 "
Electrolytic tinning line	72,000 "
Steel pipe making	94,000 "
Electric pig iron making	12,000 "

(2) The steel industries are managed and operated by private enterprises. The Congress of the Philippines enacted the Investment Incentives Act (RA. No. 5186) in September, 1967. This act created the Board of Investment to encourage foreign investments, to provide protection and favorable treatment to new enterprises.

(3) Some of the steel plants being expanded and or under construction include: The Iligan Integrated Steel Mill Inc. (IISMI) and Elizalde Iron and Steel Corporation (ELISCO). ELISCO, presently equipped with electrolytic tinning line having a capacity of 72,000 tons annually is now adding to its facilities a cold reversing mill with a capacity of 140,000 tons annually. It is expected that the plant will operate in 1969 to produce tin base plates and black sheets from imported hot coils.

The IISMI, a newly organized private enterprise, took over the construction of the integrated steel plant in Iligan from the National Shipyards and Steel Corporation (NASSCO) government-owned. The steel project was financed partly with a loan of US$62.3 million from the Export and Import Bank of Washington, D.C.

The new company also took over the merchant bar facilities of NASSCO located at Iligan. The construction work there is being done with the assistance of the Koppers Co., Inc. of Pittsburgh, Pa., U.S.A. The integrated steel plant will be built in stages.

Phase I	(1964–1968)	Cold tandem mill rolling	400,000 T/Y (estimated)
		Electrolytic tinning line	70,000 " (estimated)
Phase II	(1968–1970)	Blooming mill (combination mill)	1,000,000 T/Y (estimated)
		Hot rolling mill (steckel mill)	300,000 T/Y (estimated)

Phase III (1971–1974) Iron & steel making 1,200,000 T/Y (estimated)

(4) In the Phase III by the installation of iron and steel making facilities consisting of blast furnaces and LD converters, the plant will be fully integrated. The first step of a continuous casting facilities for the production of billets also is being planned for 1975. The location of the plant in Iligan is more favorable over other sites in the country, except for its distance from market centers in Luzon and restricted area for further expansion. This location is favored by abundant cheap power supply generated from the hydro electric plant of Maria Christina Falls and the availability of a deep weather port which has an average depth of (–) 10 meters.

3.3 Indonesia

(1) A great effort is now being made in the emerging Indonesia towards the stabilization of its economy. The Government is now working on a 5 year economic rehabilitation program, with emphasis on (1) increased production of food and clothing, (2) housing construction, (3) increase of employment, (4) establishment of import substitution industries (5) and promotion of export.

(2) In view of these problems, it is extremely difficult under present conditions to make a prediction on the future of steel consumption in Indonesia. The survey mission attempted to forecast the steel demand in the country as follows:

Table 5. Forecast of Demand for Steel Products

(Unit: 1,000 ton)

Year	1966	1970	1975	1980	1985
Flat products	31	112	139	181	244
Others	121	202	240	303	374
Total steel products	152	314	379	484	618

Note. (1) 1966 – 1969 Transitional period
(2) 1970 – 1975 Stabilization and rehabilitation period
(3) After 1976 Expansion period

Table 6. Demand for Cold Rolled Sheet & Billet

(Unit: 1,000 ton)

Year	1966	1970	1975	1980	1985
Cold rolled sheets	4	32	87	121	166
Galv. base sheet	–	20	70	96	131
Others	4	12	17	25	35
Billet	–	–	160	210	273

Note: Ibid.

Demand for cold rolled steel sheets is expected to increase rapidly after 1967, because of the increasing use of base plate in the domestic production of galvanized sheets and plans for the establishment of other steel consuming industries in the immediate future.

(3) The forecast for the demand for billets is based only on the quantity of billets required for the Tjilegon merchant mill, and that billets would not be imported by the Air Trading Co., the only existing rolling steel plant in the country, which was established in the suburbs of Djakarta in 1954 and placed in its commercial operation in the 1956 – 57. This company in addition to its future expansion plan, is now engaged in the rerolling of scraps with its three 8"/10" cross country mills. It is producing merchant bars ranging from 5.5 mm to 12 mm of about 20,000 to 30,000 tons annually.

The Tumbak mas is currently operating a galvanizing plant and the additional line is under construction. Production capacity of this plant after the completion of the additional line is estimated at 21,000 tons annually working on 2 shifts.

The Bakrie Brothers Co., is producing 25,000 to 30,000 meters per day of the furniture tubes and conduit pipes along with about 150 tons per month of nails.

(4) The Government had been continuously studying the possibility of establishing a primary steel industry in the country.

Since 1955, several contracts with foreign consultants were made to undertake feasibility studies on three projects.

These are:

(1) Establishment of an iron and steel plant with an annual production capacity of 35,000 T at Lampung, Sumatra.

(2) Establishment of a steel plant with an annual production capacity of 100,000 T at Tjilegon, Central Java.

(3) Implementation of the Kalimantan Survey Project for the establishment of an integrated iron and steel plant having an annual production capacity of 250,000 tons of crude steel.

In April, 1962 the Tjilegon and Kalimantan projects were carried out with technical and financial assistance of the USSR.
These were suspended in 1965.

(5) The Tjilegon (Trikora) project as originally planned consists of the following projects:

Open hearth facilities:	Open hearth	
	50 T/ch x 3	
	(Steel ingot)	100,000 T/Y
Rolling facilities:	Products; concrete bar	51,000 "
	Light section	18,000 "
	Wire	15,000 "
Related facilities:	Thermal power plant;	$12,000^{KW}$ x 3
	Water supply and sewage system;	Reservoir, 40^{km} pipe line
	Port facilities at Merak, maintenance shop, and other related facilities.	

Before its suspension in 1965, the project was partially completed and the delivery of materials was as follows:

(1) Preparation of the land for the plant site covering an area of 50 hectares out of the total project area of 400 hectares, (2) completion of all the engineering drawings, (3) the construction of about 50% of the main building and partial installation of thermal electric substation and building, and (4) the delivery to plant site of about 75% of machinery and equipment and material furnished by the USSR.

The percentage of machinery delivered are as follows:

Table 7.

(Unit: T)

Plant facilities	Total weight	Delivered	Not delivered	Delivered & installed
Open hearth	3,366.4	917.4	2,449.0	–
Rolling facilities	6,068.3	5,398.9	669.4	–
Related facilities	1,719.7	1,641.3	78.4	474.7
Sub total	11,154.4	7,957.6	3,196.8	–
Thermal power plant	4,082.6	3,481.0	601.6	226.0
Total	15,237.0	11,438.6	3,798.4	700.7
%	(100)	(75)	(25)	(4.6)

The followings are the position of the project before its suspension:

Open hearth furnace:	Foundation work alone is 100% complete.
Rolling plant:	Building is 30% complete. Part of the building with completed roofs are being used for the storage of machinery and equipment.
Oxygen plant:	Facilities including air compressor room are 100% complete and are in operation. 200 bottle/day sale is being accomplished.
Repair and maintenance shop:	Nearly 100% complete. The shop is being operated by a private sector on lease basis.
Vehicle maintenance shop:	Building is 80% complete.
Refractory warehouse:	100% complete. Assortment and storage of refractory are now in progress.
Water supply facilities:	Approximately 60% complete.
Plant railroad:	Almost complete. Three diesel locomotives available.
Thermal power plant:	Facilities including buildings are approximately 80% complete.
Reservoir:	Civil work alone is 60% complete.
Pipe line:	Laying of pipe in the length of 2km out of the total 40km is complete.
Employees housing:	Out of the total 1,500 units under the housing project, 200 units mainly for officials have been completed and are now in use.

Power source for construction work:	Four diesel generators each having a capacity of 400 KVA are now in smooth operation and generated power is being supplied to the oxygen plant.

During the peak period of the work before its suspension, 2,000 workers were employed for the construction work. Russian engineers in the supervision of the work totalled 70. Currently, 90 operators in the oxygen plant, 70 in the repair shop, 140 maintenance men and 150 others, a total of 450 is the strength at the plant site.

The Indonesian Government provided an appropriation of 1,000,000 Rupias during the period of 1967 through 1968 for the maintenance of these equipment, provided a security measure by installing a plant fence, and at the same time has taken necessary measures such as inventory check and maintenance of machinery and equipment.

In addition, another main project under consideration calls for other projects which were suspended; (1) the construction of the reservoir at the Rava Danau Lake, which was to serve as the source of water supply to the plant. This is located about 40 KM from the site; (2) the construction of handling facilities and warf at Merak Harbor located about 9 km from the plant site. The cost of equipment which would be supplied by the USSR was about US$36 million. The amount already spent in this work amounted about US$5 million from 1962 to 1965.

3.4 Thailand

(1) The economy of Thailand in recent years has been growing at a high pace. The average annual growth rate of economy in this country from 1958 to 1968 was 7.8%. Ratio of manufacturing industry and construction industry in the GDP is also on increase. The foreign currency reserve reached the level which is equivalent to the approximate amount of annual imports. Capital formation in the GNP, which is most closely related to the steel consumption, increased from 1960 to 1967 at the average annual growth rate of 13.4% and is expected to show a sharp increase in the future. The elasticity against the growth of GNP for the period of 1962 through 1966 is 1.85.

Forecast of demand for steel products and cold rolled sheets is shown below:

Table 8. Forecast of Demand for Steel Products

(Unit: 1,000 ton)

Year	1966	1970	1975	1980	1985
Flat products	190	261	388	588	786
Others	325	514	897	1,345	1,875
Total steel products	515	775	1,285	1,893	2,661

Table 9. Forecast of Demand for Cold Rolled Sheets

(Unit: 1,000 ton)

Year	1966	1970	1975	1980	1985
For GI Sheet	103	124	173	219	273
For TIN plate	8	12	12	18	22
Others	49	65	111	176	268
Total	160	201	296	413	563

(2) There are two iron and steel making plants in Thailand presently, namely; (1) the Siam Iron and Steel (Steel Division of the old Siam Cement) located 120 km north of Bangkok, and (2) the G.S. Steel, located in the suburbs 27 km from Bangkok.
Beside these two major plants, there are two pipe mills, three galvanizing sheet mills and one tin plate mill, along with some wire drawing mills and re-rolling mills.

(3) The Thai Government for more than 15 years has encouraged the development of iron and steel industry in the country.
The position of the government was that this development was to be initiated by the government on a pilot scale.
The present policy of the government is to provide the infrastructures, leaving the responsibility of development of the industry to the private sector.
The government has promoted the development of the industry by granting incentives to encourage the private sector in setting up steel indudtries.
The plan to set up an integrated steel plant in Thailand is presently under a serious consideration by the government.
The decisions for its establishment have been left to the Board of Investment in respect of the approval for several applications for setting up this plant by the private sector.

3.5 Singapore

(1) The Government of Singapore has been making serious efforts for the development of its economy by positively implementing progressive industrialization policies. For example, the Government has established Jurong Industrial Estate for the site of commercial and industrial enterprises under the liberal payment for its use.

The anticipated withdrawal of British forces in Singapore and its effect on employment has compelled the government to take urgent measures to reduce the impact of this withdrawal and the effect on its economy.

The progress of industrialization in Singapore is reflected on the growth of economy during the last few years.

The growth rate in the demand for steel, particularly, for 1967 was 14.2% over 1962 and the elasticity against the growth of GNP was 1.94.

The Government of Singapore is seriously considering the establishment of large steel plants in the country.

Forecast of demand is as follows:

Table 10. Forecast of Demand for Steel Products

(Unit: 1,000 ton)

Year	1970	1975	1980	1985
Total steel products	272	373	499	636
Flat products	141	195	274	366
Others	131	178	225	270

It is anticipated that the demand for flat products will increase because of the expansion of ship-building industry in the Jurong Shipyard as well as the steel transforming industry, such as galvanizing mills, pipe mills and manufacturers of household appliances.

(2) There are six iron and steel works in Singapore, among which the National Iron and Steel Mills is the largest. All the mills except the Malayan Iron and Steel are established at Jurong Industrial Estate under special privileges granted by the Pioneer Industrial Ordinance. Total production capacity of these mills is as follows:

Steel making	144,000 T/Y
Shapes & bars	128,900 "
Steel pipe	39,000 "

Most of these mills use scrap generated from ship breaking and or from imported scrap. The pipe and galvanizing mills use imported materials.

The National Iron and Steel Mills was established with a joint capital financed by the Economic Development Board (E.D.B.) and private groups.

It produces crude steel at low cost by melting scraps in electric arc furnaces. It also produces small shapes and bars to meet the target demand in Singapore, and the small quantity for exports.

The other rolling mills are also operating satisfactorily with the use of scrap.

Other mills such as galvanizing and pipe mills are mainly engaged in the secondary processes.

All of these mills with their small capital investment and short period after their inception maintain a high working ratio and are operating successfully. The successful operation of these mills even with a small market clearly indicates the skill of the workers and the successful management of these enterprises by the private sector as well as the sound judgement of the government in assisting these enterprises.

3.6 Malaysia

Malaysia comprises three regions, namely, Sabah, Sarawak and West Malaysia, in which 85% of the total population is in West Malaysia.

The demand for steel products also centers around this area.

The "First Malaysia Plan 1966 – 1970" is being carried into effect.

According to this plan, the annual growth rate of GNP is estimated at 4.8%. The elasticity of demand was 2.7 for steel products against the growth of GNP for 1962 – 1967. And significant growth of demand is expected.

This estimate of steel demands is further supported by the increased proportion of construction and manufacturing sector, in the five year plan. Apparent steel consumption and forecast of demand are as follows:

Table 11. Apparent Steel Consumption and Forecast of Demand

(Unit: 1,000 ton)

	1966	1970	1975	1980	1985
Total steel products	284	438	726	910	1195
Flat products	115	188	348	438	576
Others	169	250	378	472	619

Although the growth of demand for flat products is mainly for the base plate for GI sheets, the demand for cold rolled sheets will further increase with the production of tin plates. Demand for shapes and bars will increase in the construction field. This will require the expansion of the Malayawata Steel Mill., Ltd. The demand for billets in Malaysia will also increase, but the expansion of Malayawata and the restrictive government policy will reduce the importation of billets in the country.

(1) There are two steel mills in the country producing crude steel and merchant bars. These are Malayawata Steel Mill and United Malaysian Steel Mill.
The Malayawata Steel Mill at Pari is the only integrated plant and began its operation in 1967. It has the following equipment installed: (1) sinter machine, (2) charcoal blast furnace, (3) LD vessels, (4) roughing mill, continuous mill, cross-country type finishing

mill, (5) pig casting machine, (6) limestone burning shaft kilns, and (7) oxygen plant.

A second similar sized blast furnace may be installed within two years, and if so, the crude steel output will increase to 120,000 tons per year.

United Malaysian Steel Mills in Kuala Lumpur is the only other steel roller in the country. It has an old mill comprising 6–8" cross country stands and is producing 700 tons per month of flats, rounds and reinforcing bars. The plant will be expanded by the installation of 2 – 14" and 8" roughing stands; 2 high 10" finishing stands.

Table 12 Current Production and the Capacity of Malayawata and United Malaysia

	Capacity	Current production
Malayawata Steel Mill	84,000 (M.T)	72,000 (M.T)
United Malaysian Steel Mill	9,600 (On the assumption that two electric furnaces with a total capacity of 36,000 tons are used)	9,600 Scheduled to be in operation at the end of 1968. Imported billet is to be used in portion.
Total	93,600 (129,600)	81,600

Present Capacity and Production and Future Capacity of G.I. Sheet Mills are shown below:

Table 13 Present Capacity and Production, and Future Capacity of GI Sheet Mills

	As of August 1968		1971	
	Capacity	Production (1967)	Future capacity	Production
Federal Iron Work (FIW)	24,000 ton	16,000 ton	24,000 ton	18,000 ton
Southern Iron & Steel Works (SIW)	12,000 ton	7,200 ton	12,000 ton	10,000 ton
Malaysia Galvanized Iron Works (MGIW)	14,000 ton	8,000 ton	24,000 ton	15,000 ton
Total	50,000 ton	31,200 ton	60,000 ton	43,000 ton
Demand for base plate		30,000 ton		41,000 ton

Table 14 Capacity and Production of Steel Pipe Mill

Name of Mills	Annual Production Capacity (M.T)	Remarks
Malaysia Galvanized Iron Pipes Ltd.	36,000	1/2"-4" electric welded steel pipe
K.C. Boon & Sheen Steel Pipes Ltd.	12,000	Electric welded steel pipe
The Steel Pipe Industries of Malaysia	14,000	Electric welded steel pipe under construction

4. REGIONAL COOPERATION AND TREND OF STEEL DEMAND

Present demand for steel products and the future prospect for the six countries covered by this survey mission in detail is in Part II of this report. Followings are the summaries of steel consumption in these countries.

Table 15 Total Steel Products

(Unit: 1,000 ton)

Year	1966	1970	1975	1980	1985
Taiwan	590	862	1,267	1,932	2,942
Philippines	563	965	1,378	1,837	2,370
Indonesia	152	314	379	487	618
Thailand	515	775	1,285	1,892	2,661
Singapore	178	272	373	499	636
Malaysia	285	438	726	910	1,195
Total	2,283	3,626	5,408	7,554	10,422

Table 16 Shapes & Bars

(Unit: 1,000 ton)

Year	1966	1970	1975	1980	1985
Taiwan	352	517	722	1,062	1,612
Philippines	280	484	707	955	1,236
Indonesia	121	202	240	303	374
Thailand	325	514	877	1,334	1,876
Singapore	87	131	178	225	270
Malaysia	170	250	377	472	619
Total	1,335	2,098	3,121	4,351	5,987

Table 17 Flat Products

(Unit: 1,000 ton)

Year	1966	1970	1975	1980	1985
Taiwan	238	345	545	870	1,330
Philippines	283	481	671	882	1,134
Indonesia	31	112	139	181	244
Thailand	190	261	388	558	785
Singapore	91	141	195	274	366
Malaysia	115	188	349	438	576
Total	948	1,528	2,287	3,203	4,435

Summary of the above in crude steel equivalent is as follows:

Table 18

(Unit: 1,000 ton)

Year	This Survey	First Survey)
1966	2,903	3,050
1970	4,601	4,400
1975	6,877	6,400
1980	9,607	9,000
1985	13,263	12,100

The findings of this survey mission show that the trend on the future demand for steel products in this region is a little over than that made by the First Survey Mission. The demand for 1985 on crude steel base is estimated at 13,263,000 tons annually.
The total capacity, however, of existing steel making plant in the six countries is only about 1,000,000 tons which is primarily produced by electric arc furnaces from scrap.
If the demand in the wake of economic recovery in Laos, Cambodia, and the Vietnam, which are also member countries in the region but were not included in this survey, is taken into consideration, the total demand for steel products is also expected to increase correspondingly.

Therefore, as far as supplying the total demand for steel in the sub region is concerned, a joint establishment of a few integrated iron & steel plants would be possible an justifiable from a long range view.

In this connection, however, the following two points must be given emphasis.

(1) This survey shows that the ratio of flat products and shapes & bars to the total demand of steel products is about 43% and 57% respectively. Accordingly, the required production of flat products for the target year of 1985 will be approximately 6,000,000 tons of crude steel.

On the assumption that an annual production capacity of 2,000,000 tons crude steel for the manufacture of flat products is the minimum economic unit for one integrated steel plant, it will require the establishment of three plants of this size to meet the target production of 6,000,000 tons in 1985.

It should also be noted that the construction of an integrated iron and steel plant of this type is now under construction and or being planned in both the Philippines and Taiwan. It would, therefore require the establishment of one more integrated steel plant of this type in one or another country in the subregion to meet the estimated target demand of flat products in 1985.

The Mission has recommended in this report the installation of such plant in Thailand.

The production of shapes and bars (i.e., billet center) is discussed in detail in the Singapore section, of this report. The mission is of the opinion that as long as the production of billet is aimed at satisfying the immediate demand within the region, the most economical way to meet this demand initially would be the electric steel making method instead of a fully integrated steel plant with a blast furnace.

(2) Most of the advanced steel making countries have large scale plants equipped with modern and high productive machinery and equipment and advanced techniques The international competitive position of these countries should be taken into account in working out future steel projects for the development of these six countries.

In this context, steady economic and technical cooperative relationship which has already been fostered between the advanced steel making and these six countries through the supply of semi-finished products may be considered as a practical and reasonable approach. The supply of these materials would be advantageous in the progressive development of steel industry in these countries, until such time as the demand for flat products shall have increased considerably which will justify the domestic production.

Estimate of the trend of future steel consumption in the six countries as described in the preceding paragraph represents prospective quantities by various forecasting methods based on the present conditions in each country.

There is a great potential for a large market for steel in these countries. The development of steel industry in these countries will accelerate the industrial growth.

Governmental policy to promote the industry would be necessary.
Development of economy and the promotion of living standards are indispensable to these developing countries.
Followings may be considered generally as the reasons for the urgent desire of each developing country to promote its steel industry.

(1) The establishment of steel plants to supply basic materials for the development of its industrial growth and to achieve some measure of economic independence.

(2) The realization of self-supply of steel products first of all for the purpose of improving the balance of international payments and the promotion of import substitution industries to attain this objective.

(3) The effective utilization of domestic resources and upgrading the degree of processing for export products.

(4) The increase of employment opportunities for the labor force as a result of the establishment of a steel industry as well as its linkages on other industries. Such employment will raise the standards of living of the people in these countries.

The steel industry by its nature requires a large amount of capital investment and high technical standards of wide range in its various phases of operation. This is particularly true in the establishment of integrated steel plants. For example, in Japan which had started modern steel making techniques over 60 years ago; established highly developed related industries; developed high technical standards and high skill of steel workers; and adopted recent technological advances in iron and steel production. These developments and progress required many years before Japan reached its high rank in steel production.

In addition, Japan has spent an enormous amount of investments in establishing steel plants. Such investments, however, were carefully planned to avoid wasting of resources, such as, i.e., by careful study in respect of type of plants, cost of production, cost of construction and installation, etc.
Generally, the main reasons for the slow progress towards establishing a large steel industry in these countries are: (1) difficulty in the procurement of enormous funds required for capital goods and construction; (2) lack of high standards of technical skills and management required for the construction and operation of steel plants; (3) the smallness of domestic market which will not justify the establishment of a steel plant in economies of scale. This last factor is one of the most serious deterrents in the establishment of integrated steel plants.

The development of steel industry in these countries is given an importance in their drive towards industrialization to meet domestic demand. Protective tariffs and favorable treatments are granted by the governments in the promotion of the steel industry.

Except for the construction of a plant that produces products peculiar to the environment of the country, the scope of production and type and size of equipment for the integrated steel plant envisaged, in principle, should generally be limited to match only the domestic demand of these countries.

The importation of semi-finished products at relatively low cost and the installation of high efficiency mills even of a small size suited to prevailing conditions to produce only for demand is justified.

It may be safe to conclude that unless the country has several outstanding favorable conditions (such as abundant raw materials available at competitive cost, large efficient labor force and huge amount of funds available at reasonable rates of interest, etc.), the establishment of an integrated steel plant to survive international competition would be extremely difficult.

It would be necessary to establish such integrated plants progressively on a step-by-step procedure, (1) the finishing section should be established first and (2) the integration of the process should be planned when the demand reaches the level of economical operations.

This does not mean that these countries will never be able to own integrated steel mills of a certain scale. On the premise that a country provides a tariff barrier and further long range protective measures, the industry will eventually be able to stand on its own feet. The establishment of these plants should be carefully examined and planned in relation to other industries.

The demand for steel has the aspect in that its production generates also consumption. Constant leveling up of industrial standards and up-grading of the standards of living with the development of overall economy are the fundamental requirements for the steady expansion of steel consumption.

It would seem difficult for any one of these countries, under present conditions, to establish independently in one attempt a large scale integrated steel mill which would produce products that would be competitive in the international market.

The solution, therefore, would be for these countries to cooperate in forming joint venture schemes, such as the market sharing, pooling of resources, etc.

Furthermore, this mission believes that it would be necessary to create and foster an atmosphere of cooperation in each of these countries.

One possible way would be that several countries under similar situations having common objectives should plan a joint steel development project as a part of national economic programs. Each country might extend its cooperation to the industry of another country in various forms such as the participation in the equity and joint management of new enterprises.

It is the considered opinion of the mission that the attempt to promote regional cooperation in establishing only finishing steel mill operations in these countries which will precede subsequent establishing of integrated steel plants is not adequate. Such regional cooperation should include the overall economic development in which the promotion and development of steel industry could play an important role. Furthermore, it would be most useful to promote the regional cooperation if government authorities concerned could initiate measures and policies to promote such regional development.

5. PROPOSED SPECIFIC STEEL PROJECTS AND POSSIBILITIES OF REGIONAL COOPERATION

The findings of this Mission in respect of the four projects recommended by the First Survey Mission are described below.

5.1 Hot Coil and Plate Mill (Products supplied to Taiwan and the Philippines)

(1) Completion of the hot strip combination mill of the proposed integrated steel mill in Kaohsiung, Taiwan, is expected in 1973, assuming that the construction work is to proceed as scheduled. The production of hot coils and plates will not be possible before 1974.

(2) Cold strip mills of IISMI and ELISCO of the Philippines are scheduled to be completed at the end of 1968 and in 1969 respectively. The construction works are under way in both sites so that the operations can be started as scheduled. Moreover, a hot strip mill of IISMI is also under construction and the completion is due by the end of 1969 – 1970.

(3) The operation of the cold strip mill of IISMI in the Philippines will be five years ahead of the proposed hot combination mill in Taiwan.

(4) The IISMI will produce hot coils beginning in 1970. This is a steckel mill which will initially produce about 300,000 tons. According to the estimation of this mission, the supply of hot coil would fall behind the domestic demand from about 200,000 to 400,000 tons yearly, in spite of the future expansion as shown in Table (B).

(5) On the other hand, the hot strip mill in Taiwan is expected to start its first operation in 1974. For the immediate two years, however, the production is planned on the basis of imported slabs, which would result in high manufacturing cost.
The difficulty in importing large quantity of slabs on long term would be a serious problem. Therefore, the export of hot coil rolled from these slabs can hardly be feasible.

(6) The Mission made the feasibility study of the proposed mill.
This study shows that:
Taiwan will establish an integrated steel mill having an annual production capacity of one million tons by 1976:

(1) The production of the hot strip mill will be limited by its steel making capacity as shown in the following Table (A),

(2) Export of hot coils considering the increasing domestic demand, may be expected only for the first three years. No exports could be made thereafter to other countries in the region.

The Mission suggests that in order to meet the increasing domestic demand in the country and to provide surplus for exports, the proposed capacity of the mills (Phase III) for 1976 should be increased from 1 million tons to 1.5 million tons annually. It also suggests that the capacity of the proposed plant in Phase IV should also be increased from 2 to 3 million tons annually. This proposal will enable Taiwan to meet its increasing domestic demand for steel and also create surplus for exports.

It would appear from the feasibility study of the Mission that:

(1) Taiwan will produce hot coils from imported slabs in 1974. A surplus for exports will be difficult to create for this year because the product will not be competitive.

(2) Taiwan will be able to create a surplus for exports from 1976 to 1978.

(3) After 1976 onward, under Taiwan's present plan of expansion, there will be no surplus for exports because of increasing domestic demand. Surplus for exports could only be manufactured if the capacity of the mill in Phase IV is increased to 3 million tons.

Table A. Comparison between Demand-Domestic capacity-Estimated Import & Export of Flat Products in Taiwan

(Unit: 1,000 ton)

Year	Demand			Required Hot Coil for (b) x (c) (as roll)	Production capacity		Import				Remarks
	Plate	HR Sheet Strip Hoop	CR Sheet Strip, Hoop GI Sheet, Tin plate		Hot Coil (as roll)	Plate (a-f)	Slab (e)	Plate (b)	Hot Coil (as roll)	Hot Coil (as roll)	
	(a)	(b)	(c)	(d)	(d)'	(a)'	d d-d' or 0.97 0.97	a – 20 or ax 0.23	d–d'	d'–d	
1970	76	96	173	318	–	20	–	56	318	–	
1971	93	109	203	369	–	20	–	73	369	–	
1972	101	119	220	400	–	20	–	81	400	–	Cold mill completed
1973	105	132	238	436	–	20	–	85	436	–	
1974	117	138	255	463	(1,180) 768 463	90	478	27	–	–	Hot mill completed
1975	125	147	273	495	(1,170) 762 495	96	510	29	–	–	
1976	157	158	315	570	(1,140) 733	121	–	36	–	163	Completion of integration (1 million ton)
1977	173	172	345	608	(1,130) 720	133	–	40	–	112	
1978	188	187	375	662	(1,110) 706	145	–	43	–	44	
1979	203	202	405	715	(1,100) 693	156	23	47	–	–	
1980	218	217	435	767	(1,090) 677	168	93	50	–	–	
1985	333	332	665	1,168	(990) 578	256		77			Completion of integration (2 million ton)

Note:
1. After 1974, 23% – 30% of demand for plate, special products, are to be imported.
2. With the existing production capacity of 60,000 T/Y for plate, actual production is estimated at 20,000 T/Y.
3. The productioncapacity of the hot strip mill to be completed in 1973 is estimated as follow:

Plate 200 T/H x 0.85 (yield-slab) = 170 T/H
Coil 200 T/H x 0.97 (yield-slab) = 194 T/H
Annual operating hours = 8,765 H/year x 76% = 6,500 H/year

Figures not paranthesized in the column (d') show production on the basis of 1 million T/year in ingot supply.
Figures in paranthesis show production when the slab is available freely.
Figures in the brackets show the quantity corresponding to domestic demand.

Table B. Comparison between demand-IISMI capacity-estimated import of flat products in the Philippines

(Unit: 1,000 ton)

Year	Plate	Demands			Required hot coil for (b) & (c) (as roll)	Production capacity (IISMI)						Remarks
		Medium plate & HR sheet	CR sheet GI sheet & tin plate	Other cold roll-ed sheet		Hot coil (as roll)	Plate	Slab	Plate	Other cold rolled sheet	Hot coil (as roll)	
	(a)	(b)	(c)	(d)	(e)	(e)'	(a)'	e'/0.97	(a)	(d)	e – e'	
1970	60	87	329	5	496	303	–	313	60	5	193	
1971	66	95	350	6	531	303	–	613	66	6	228	
1972	72	104	372	7	567	303	–	313	72	7	264	
1973	78	113	394	8	605	303	–	313	78	8	302	
1974	84	122	416	9	641	303	–	313	84	9	338	
1975	92	132	437	10	677	428	–	–	92	10	249	Completion of integration expansion of hot strip mill.
1976	99	143	459	11	716	428	–	–	99	11	288	
1977	109	153	481	12	754	428	–	–	107	12	326	
1978	114	164	503	13	793	428	–	–	114	13	365	
1979	121	175	525	14	831	428	–	–	121	14	403	
1980	130	187	550	15	875	428	–	–	130	15	447	
1985	176	254	684	20	1,109							

Note: "Other cold rolled sheets" include specially surface-treated sheets, stainless sheets, etc.

Comparison between Demand-Domestic capacity-Estimated Import & Export of Flat Products in Taiwan
at 1.5 million tons capacity of steel ingot

(Unit: 1,000 ton)

Year	Domestic Demand			Required Hot Coil for (b) & (c) (as roll)	Production capacity		Import			Export	Remarks
	Plate	HR Sheet Strip Hoop	CR Sheet Strip, Hoop, GI Sheet Tin plate		Hot Coil (as roll)	Plate (a-f)	Slab (e)	Plate (f)	Hot Coil (as roll)	Hot Coil (as roll)	
	(a)	(b)	(c)	(d)	(d)'	(a)'	d/0.97 or d-d'/0.97	a-20 or ax0.23	d=d'	d'-d	
1970	76	96	173	318	–	20	–	56	318	–	
1971	93	109	203	369	–	20	–	73	369	–	
1972	101	119	220	400	–	20	–	81	400	–	Cold mill completed
1973	105	132	238	438	–	20	–	85	436	–	
1974	117	138	255	463	(1,180) 463	90	478	27	–	–	Hot mill completed
1975	125	147	273	495	(1,170) 495	96	510	29	–	–	
1976	157	158	315	570	(1,140) 1078	121	–	36	–	508	Completion of integration (1.5 million tons)
1977	173	172	345	608	(1,130) 1075	133	–	40	–	467	
1978	188	187	375	662	(1,110) 1072	145	–	43	–	410	
1979	203	202	405	715	(1,100) 1070	156	–	47	–	355	
1980	218	217	435	767	(1,090) 1069	168	–	50	–	302	
1985	333	332	665	1,168	(990) 1045	256		77			Completion of integration (3 million tons)

Note. 1. Figures not parenthesized in the column (d') show production on the basis of 1.5 million T/Year ingot supply.

5.2 Merchant Mill in Indonesia (Products supplied to Indonesia)

(1) The demand for bars & sections in Indonesia was discussed in the earlier pages. This demand is further classified by year and by product as follows:

Table 19.

(Unit: 1,000 ton)

Year	1966	1970	1971	1972	1973	1974	1975	1976	1980	1985
Steel bar	67	94	99	102	107	111	114	120	145	185
Section	8	16	17	17	17	18	19	20	24	30
Wire, wire products	20	31	32	33	34	36	38	40	48	62
Others	26	61	63	66	68	68	69	72	86	97
Total	121	202	210	218	226	233	240	252	303	374

In view of the estimated actual demand for bars & sections amounting to 121,000 tons in 1966 and the anticipated steady increase in the demand following the progress of the rehabilitation plan in the future, early completion and reactivation of the Tjilegon facilities appears necessary. The establishment of this plant will also contribute to savings in foreign exchange.

(2) The reactivation of Tjilegon covers various local development projects such as thermal power plant, water supply, and port improvements. The implementation of these projects should be detached from the Tjilegon project and might be undertaken by the government.

(3) The Tjilegon project appears to have some difficult problems; (1) the estimated construction cost of about US$12,370 million is comparatively higher than the usual standard cost of similar size project in other countries (this could cost US$7 to 8 million); (2) the plant apparently has been sited as a social project in the depressed area in the country. It is situated away from the market centers.

	Demand percentage (%)
West Java	40
Central Java	23
East Java	30
Sumatra	5
Others	2
Total	100

(4) However, in view of the fact that the majority of imported machinery and equipment have been already delivered and that the construction work was suspended after the completion of 25% of the total work, and also that the Rupia funds equivalent to US$5 million was already spent for this project including related facilities, the reactivation of these facilities should be considered as a matter of course.

(5) Details of construction and operation plans for the reactivation and utilization of the Tjilegon project, i.e. for the installation of merchant mill and wire rod mill are discussed in Part II of this report. It is estimated that additional funds required for the construction of this project will be US$2.4 million. The project will be completed by 1973.

(6) This undertaking would be an joint venture between the government and the private enterprises. The construction, operation and management of this plant in persuance of government policies would be in the hands of the private sector. Foreign capital has been invited to participate, too.

In order to make the enterprise a success commercially, protective measures should be taken by the government to support this industry.

(7) Details of profitability study are discussed in Part II for Indonesia. Financial recommendations and anticipated problems as the result of this objective study are as follows.

1) Part of the project, such as water supply, power generation and port facilities should be separated from the merchant mill project and should be completed as an independent project under the sole responsibility of the government. Arrangements should be made by the government for the supply of power and water to the mill at a reasonable unit price.

2) The details of the terms of credit made by the U.S.S.R. are not available. The new company which will operate and manage the steel plant should not be responsible for the early repayment of obligations with the U.S.S.R. Repayments, if any, should be on a long term basis, after the successful operation of the plant.

3) It might be appropriate for the government to make a contribution in the form of property other than money, i.e., the merchant mill, including related auxiliary facilities, and possibly entrust the entire management of the company with a private sector.

It is also necessary to give due consideration for the smooth operation of the project on commercial base by reducing the capital cost of equipment.

Likewise the real estate should be leased to the company free of charge or at very low cost.

The Mission suggests that any expansion of steel industry in the immediate future, or an establishment of an integrated steel mill, in relation to the regional cooperation with the objectives, should be located in more favorable sites.

The Indonesian Government has already taken a measure for the encouragement of new enterprises by enforcing the Law No. 1 – Foreign Capital Investment – in 1967.

The encouragement given to private enterprises and assistances of the government in setting up steel industry in the country is a step in the right direction.

5.3 Cold Strip Mill in Thailand (Products supplied to: Thailand, Malaysia, Singapore and Indonesia)

(1) The demand for cold rolled sheet in Thailand is very strong and is expected to show steady growth in the future.

On top of this, if the demand in Malaysia, Singapore and Indonesia is taken into account on the basis of a common market, this total demand would reach the level which will justify the establishment of one unit of cold tandem mill by around 1970. It is the opinion of the Mission that as far as the demand is concerned, early construction of one unit of cold tandem mill for cold rolling in Thailand where there is a large domestic demand is considered justifiable.

Forecast of demand for cold rolled sheets is as follows:

Table 20 Forecast of Demand for Cold Rolled Sheet in Western Subregion of South East Asia

(Unit: 1,000 M/T)

	Thailand	Singapore	Malaysia	Indonesia	Total
1967	162	37	45	15	259
1970	201	45	60	32	338
1971	217	50	63	43	378
1972	232	56	72	54	414
1973	251	61	82	65	459
1974	273	66	93	76	508
1975	296	69	105	87	557
1976	316	73	110	99	598
1977	338	77	115	106	636
1978	361	82	120	111	674
1979	386	87	126	116	715
1980	413	92	132	121	758
1985	563	119	173	166	1,021

(2) The manufacture of cold rolled sheets, however, requires high technical standards. Therefore, it will be necessary that the steel industry in Thailand, which has no experience in this field, should aquire the necessary techniques and familiarize itself with cold rolling mill operations. This would require a long period, if the cold rolled products are to be manufactured at low cost but with high quality corresponding to that of the imported. However, in the manufacture of cold rolled sheets, the thinner it is, the more difficult would be the production. Nearly 90% of cold rolled sheets consumed in Thailand are the thinner gauges. It will be extremely difficult to manufacture such thin gauged sheets in a tandem mill by inexperienced personnel in the early stages of operation.

(3) In this respect the most important need for the cold rolling mill project would be the acquisition of techniques and the familiarization in its operation on the part of the engineers and workers. To implement these requirements, it will be necessary to send a large number of personnel to advanced countries for the on-the-job training at cold rolling mills for a prolonged period. In the first stage the erection of a cold reversing mill is suggested. This mill is relatively easier to operate than a tandem mill. Its erection in this first instance would enable the engineers and workers to gain experiences and techniques and familiarize themselves in cold mill operations. It is important that the above project is planned on the step-by-step basis. It is only by such a method that economic losses would be minimized.

(4) If and when the aforementioned well worked out plan is implemented steadily, the working ratio of the reversing mill would go up gradually to the planned level without difficulty. From the economic point of view, however, it will be difficult to bring production cost to international levels even with a smooth production schedule because of the inherent low productivity of the reversing mill. It is also obvious that this mill will not be able to produce and supply the domestic demand in this stage. Therefore, the construction of a tandem mill, as a next step, should be expedited as soon as technically possible.

(5) The machinery of a cold reversing mill and a tandem mill would be imported. The total construction cost would be considerably higher compared to that of similar mills of the same size in an advanced country which manufactures capital goods.

(6) A cold rolling plant constructed in Thailand will depend its initial supply of hot coils on imports. Thus the cold rolled sheets produced in Thailand might cost comparatively higher than those produced in the advanced countries wherethey are turned out in large quantities in integrated steel plants.

(7) These disadvantages described in (5) and (6) would appear as big handicaps for the establishment of this cold rolling plant in Thailand for the production of sheets at internationally competitive prices. This might result as a possible difficulty in the proposed joint scheme of market sharing

among these countries. Production, however, to meet domestic demand will be advantageous in view of the fact that the import of cold rolled products is restricted by import duties. Production to meet domestic demand would be advantageous since it assures immediate availability of these products and also will conserve foreign exchange in these countries.

The disadvantages described in item (5) is of the nature which cannot be avoided in developing countries. The disadvantages described in item (6), however, can be eliminated with the establishment of flat products steel plant in the subregion to supply raw material at internationally competitive cost.

It is evidently advantageous to proceed with the training of personnel at its earliest stage of the construction of a new mill in Thailand.

(8) Judging from the estimated demand for flat products in the four countries, Thailand, Malaysia, Singapore and Indonesia, the demand is expected to grow to the extent which corresponds to the capacity of one hot strip mill in the early 1980's. It would appear therefore, that the possibility exists for the construction of a hot strip mill in Thailand in or about 1980. Meanwhile, however, Thailand shall import hot coils from foreign sources.

(9) The construction of a steel plant requires a long period for detailed soil survey followed by the construction of port facilities, development of land and other infra-structures as well as an enormous investment; which cannot be borne generally by private enterprises. It would seem necessary therefore that for the construction of a steel project the government might have to take certain initiatives and assistances in the implementation of such a project.

(10) After having undertaken the necessary detailed survey of the plant site and the provision of infra-structures, such as power, port facilities, etc., the installation of a cold reversing mill could be started immediately. The installation of the tandem mill could be completed thereafter. The Mission also made a study of possible site of the plant. It would appear that Raem Chabang, 15 km to the south of Sirah Cha could be favorable location. Further investigation would be necessary to finalize this plant location. The detailed study in connection with the establishment of these plants are discussed in Part II of this report.

According to the above schedule, the new mill would be in full production in 1979, with an annual production of about 432,000 tons, of which about 10% or more are to be exported to other countries.

It is recognized that the establishment of a steel plant requires an intensive high capital cost and low return on investment.

Measures, therefore, should be taken in the initial stages of operation to exempt imported hot coil from duties. If this is done, about one U.S. dollar profit per ton of production may be anticipated from the total sale.

The export of products at international market price in itself will not even cover the direct cost of production.

It will be necessary for the government to promote export as a national policy and it might be necessary to take certain measures to subsidize private enterprises temporarily until the export of products becomes profitable.

It will require a period of 10 years from the start of operation, if the plant is successfully managed, to realize 10% return on the investment.

5.4 Billet Center in Singapore (To supply six countries; Indonesia, Malaysia, Thailand, Philippines, China (Taiwan), and Singapore).

The proposal of the First Survey Mission for the establishment of a billet center in Singapore is of great significance in relation to the current theme of fostering regional cooperation among these six countries, particularly in the united effort in the construction and development of the iron and steel industry in the subregion.

The billet center was envisaged to supply the requirements of billets in the six countries under the aegis of the common market to supplement the present low production of small steel ingots and billets in some of these countries and to replace, as it were, those currently being imported by them from outside sources.

The choice of Singapore as the site for the billet center was made because of: (1) its central location in respect of the distance to each of the six countries; (2) availability of an existing deep harbor weather port equipped with modern handling facilities, and its future expansion which can accommodate large cargo ships and bulk carrier ships; (3) availability of skilled personnel and existence of training facilities; (4) a national economy geared and oriented toward the promotion of exports; (5) the government has expressed the view that it is not possible to support, if it will not be in Singapore.

The Mission has surveyed and considered various factors relevant to the possibility of establishing a billet center in Singapore.

The detailed feasibility study of this project is included in Part II of this report. Its highlights are summarized below.

The estimated potential demand for billet import in the region is shown in the table below.

Table 21

(Unit: 1,000 M/T)

Countries \ Year	1970	1975	1980	1985
Singapore	28	67	90	100
Malaysia	60	100	140	140
Thailand	110	180	240	250
Taiwan	100	100	100	100
Philippines	150	150	150	150
Indonesia	–	160	210	273
Total	448	757	930	1,013

1) Estimation of the probable demand for billets in the region, particularly for imports, is difficult due to the restriction of imports because of the shortage of foreign exchange. Thus, while the demand actually exists, the quantities imported do not reflect this demand.

2) The estimated probable demand for Singapore billet in each of these countries were those derived from the production of bars, shapes and wire rods, of which 30% of the total will be imported, under the common market plan, from Singapore. The Singapore supply of billets to each of these countries is based on the above assumption.

The major important point which was considered in the proposed Singapore billet center was the feasibility and possibility, under the prevalent conditions in Singapore to manufacture billets at the lowest possible cost and at a price equal to, if not less than, international market prices.

The establishment, justification and the commercial success of the Singapore project, in the opinion of the Mission, will depend entirely on the attainment of this objective – that the product will be competitive in the international market.

The Mission made a comparative case studies of four commercial types of steel making plants to determine which type would produce the lowest minimum manufacturing cost, at a given capacity, but at the same time with international market prices.

The types of steel making plants considered with a capacity of 250,000 tons yearly were:

(1) blast furnace with LD converters,

(2) electric smelters with LD converters,

(3) electric arc furnaces,

and (4) blast furnace with LD converters for a one million ton capacity of billets.

The following factors were considered in the estimated plant production cost:

(1) capital, construction and operational cost and other charges.

(2) availability of raw materials, iron ore, coal/coke, scrap, etc.,

(3) power supply and cost,

(4) technical skills required,

(5) possibilities of expansion.

The result of these studies show that the electric arc furnaces using imported scrap as the initial raw material would be the most suitable type of plant for the billet center in Singapore in its initial stage.

The unit plant production cost of small ingots or billets based on a plant capacity of 250,000 tons per year would be US$69.56 per ton of an electric arc furnace against US$79.30 of a blast furnace LD converter with a billet mill.

On the other hand, a plant capacity of 1,000,000 tons annually, the plant production cost/ for per ton of billet is: with a blast furnace – LD converters with billet mill, US$72.70. Such a plant would require further careful investigation as to its feasibility and viability.

In its decision to recommend the establishment of the billet center by the electric arc furnace, the Mission recognizes the need for the constant supply of scrap at a competitive price of some US$40 per ton delivered at the works.

The supply of about 320,000 tons of scrap from domestic and imported sources could be sufficient without too much deficiency for the following reasons:

(1) With the increasing use of the LD converters in the highly industrialized countries, for examples, the U.S. and Japan, the relative quantities of purchased scrap has decreased correspondingly in these countries.

(2) Scrap generation in these industrialized countries have created a surplus for exports. This source may be availed of by the Singapore plant.

For example, in Japan, the importation of scrap has reduced considerably per unit of steel production, than it was several years before the introduction of the LD converters in each steel industry.

There are other decisive factors which favor the use of the electric steel making in the Singapore plant, viz.:

(1) The cost of electric arc furnace installation is considerably lower than that of an equivalent capacity blast furnace and LD converters.

(2) In case of expansion from a small production capacity, additional units of suitable size may be installed. The blast furnace with LD converters will not have this flexibility.

(3) The construction of an electric arc furnace does not require the high skills which are required in a blast furnace-LD converter plant. Singapore has the nucleus of personnel for electric steel making operations from the National Iron and Steel Mills plant.

Recognizing the various problems inherently associated with the establishment of the proposed billet center in Singapore such as; the need for agreements in these countries for a common market; restriction of imports due to the shortage of foreign exchange; the limited domestic market in Singapore; the Mission proposes the possible alternatives:

(1) The installation, on the first instance, of a 250,000 electric steel making plant to supply the domestic demand of Singapore and of Indonesia. Electric arc furnaces of total capacity of about 150 tons is proposed.

(2) The installation of an additional mills of the same size (150 T/) thereafter, should the total demand for billets increased to about 500,000 T/s yearly from other sources in these countries, together with those in Singapore and Indonesia.

In this stage, a small section mill should be established to produce further products complimentary with the expansion of the steel making capacity.
A continuous casting unit is also suggested to produce billets ranging from 20 mm to 70 mm and up.

The exapnsion of the plant could be implemented progressively after the second stage as soon as the trend of demands would indicate a rise over 500,000 tons capacity which would warrant an expansion of the plant. Immediate steps should be taken to examine the most suitable type of machinery and equipment for this expansion. Comparative advantages of setting up either additional electric furnaces for steel making or the installation of a blast furnace — LD converters should be carefully investigated.

(3) Should there develop a case whereby two countries could agree for the probable expansion of their steel industry, supported by a large investment, the Mission could, after careful examinations, propose another alternative.
Further, the details of these alternatives are described in Part II of this report.

The Mission also suggests that the Singapore billet center could be undertaken (1) as an expansion of the National Iron and Steel Mill, Ltd. and (2) as an independent unit. In both cases, government assistance might be required in equal participation and granting the project a proper status, the first alternative, however, would be preferable.

6. CONCLUSIONS

The conclusions arising from the findings contained in this report are summarized below:

(1) The total capacity of the existing steel making mills in these countries was about 1.0 million tons in 1967, most of which was primarily produced by electric arc furnaces.

(2) The trend of future demand of steel products in the six Southeast Asian countries, China (Taiwan), the Philippines, Indonesia, Singapore, Malaysia and Thailand, would be about 13.5 million tons in 1985, of which about 6.0 million tons would be flat products.

(3) Three integrated steel plants would be required to supply the demand of flat products in 1985 in these countries, on the assumption that the annual production capacity of about 2.0 million tons of crude steel equivalent annually is the minimum economic size for each plant.

(4) With the construction in progress of one flat products plant in the Philippines and with the proposed establishment of a similar plant in Taiwan in 1974, another plant of about the same capacity would be necessary in the eastern Southeast Asia subregion. (Thailand, Singapore Malaysia)

Apart from flat products, there is a large demand in these countries for billets and small ingots, which are presently being imported and rerolled into round bars and wire rods. In addition, imports of light and medium sections are considerable because of the lack of rolling facilities for these products. The installation of a section mill for light and medium sections would appear necessary. Such a mill could be incorporated in the proposed billet center.

(5) Some of the main reasons for the slow progress in establishing steel plants in some of these countries are: (1) the difficulty in the procurement of enormous funds required for integrated steel plants; (2) the lack of sufficient high skills in management and the operation of these plants; and (3) the limited domestic markets which will not justify the establishment size of a minimum economically viable integrated steel plant.

(6) The steel industry by its nature is a capital intensive and low profit enterprise. The establishment of steel plants in economies of scale will require careful planning to avoid waste of resources. These include among others the study of: type of plants, investments, plant production cost, availability of domestic or imported raw materials, power, port facilities etc., and availability of skills in plant management and operation.

(7) There is a fierce competition for markets among the large steel producers. It would seem difficult for any one of these countries under present conditions to establish independently but in one attempt a large scale integrated steel mill which could manufacture steel products that would be competitive in the international market.

(8) A possible solution may be for several countries with similar economic conditions to plan a joint steel development in which each country might extend its cooperation to the industry of another country such as equity participation and or joint management in the enterprise and or the expansion of its facilities, sharing of markets, etc.

(9) *It would be helpful if the governments concerned could initiate measures and hold consultations to promote such regional cooperation, from a long range point of view.*

7. RECOMMENDATIONS

The recommendations arising from the preinvestment feasibility studies contained in Part II of this report in respect of the four specific projects suggested for these studies are:

(1) China (Taiwan) Flat Products.

The domestic demand of flat products in Taiwan will justify the establishment of an integrate flat products plant.

(i) In the second stage of the project, the use of imported slabs for the production of hot coils in 1974 – 1975 would result in high manufacturing cost. No exports could be expected at this stage.

(ii) The installation of an integrated steel plant with a capacity of 1.0 million tons in 1975 – 1976 to meet the increasing demand in the country and a small surplus for exports appears justifiable and viable. The production of hot coils will be limited by its steel making capacity. A small surplus for exports would be possible only for three years. This is due to the large domestic demand.

It is suggested that the capacity of plant in Phase III (1976) be increased from 1.0 million tons annually to 1.5 million tons to meet the domestic demand and a surplus for further exports.

Furthermore, it is also suggested that the plant capacity in Phase IV be increased from 2.0 million tons to 3.0 million tons annually (1980), if the trend of exports would warrant this. The plant site in Kaohsiung Harbor is considered suitable for this plant.

(2) Philippines

The construction of a flat products integrated steel plant now in progress is justified to meet the increasing demand in the country. The installation of additional stands in the steckel mill is suggested to produce hot coils not only for Iligan but also for other rolling mills in the country.

(3) Thailand

The construction of an integrated flat products plant in Thailand is recommended in a step by step basis as follows:

(i) First stage– the installation of one cold reversing mill with a capacity of about 78,000 tons in 1975 or earlier.

(ii) Second stage– the installation of a cold tandem mill in 1976 or immediately thereafter with a capacity of about 376,000 tons annually. This recommendation is premised in the installation of port facilities, power supply and other infrastructures of the plant before 1975. The proposed site of the plant should also have been investigated.

The immediate training of personnel before the construction of the plant is also suggested at an early stage.

(iii) Third stage– the installation of a hot strip mill enlarged with a blast furnace – LD facilities is also suggested at some later date after a careful study of the project.
The existing domestic and potential market in the country justifies this installation.

(4) Singapore

The construction of a billet center in Singapore to supply the billet requirements of the six countries (under the aegis of the common market) is recommended. The plant should be built in stages.

(i) First stage– electric arc furnaces steel making plant using domestic and imported scrap as raw material This initial production will supply only the market for Singapore and Indonesia of about 250,000 tons annually.

(ii) Second stage– additional electric arc furnaces to supply together with the first stage units about 500,000 tons of small ingots and billets.
The integration of this proposed plant with the National Iron and Steel Mills, Ltd. is suggested.

(iii) Third stage – it is suggested that if the trend of demand would warrant the expansion of the plant facilities, a careful study should be made of the type of machinery and equipment to meet this expansion. The comparative advantages and disadvantages of the electric steel making and the blast furnace processes should be evaluated in this study.

(5) Indonesia

The construction of a merchant bar mill and wire rod mill (rounds, shapes, etc.) to meet the total requirements of the country for these products is justified.
The reactivation of Tjilegon project is recommended.
Part of the Tjilegon mill machinery which have already been delivered is incorporated in the proposed layout prepared by the mission. In order to facilitate its installation, the construction of the water supply, the power plant and other infrastructures should be undertaken by the government.

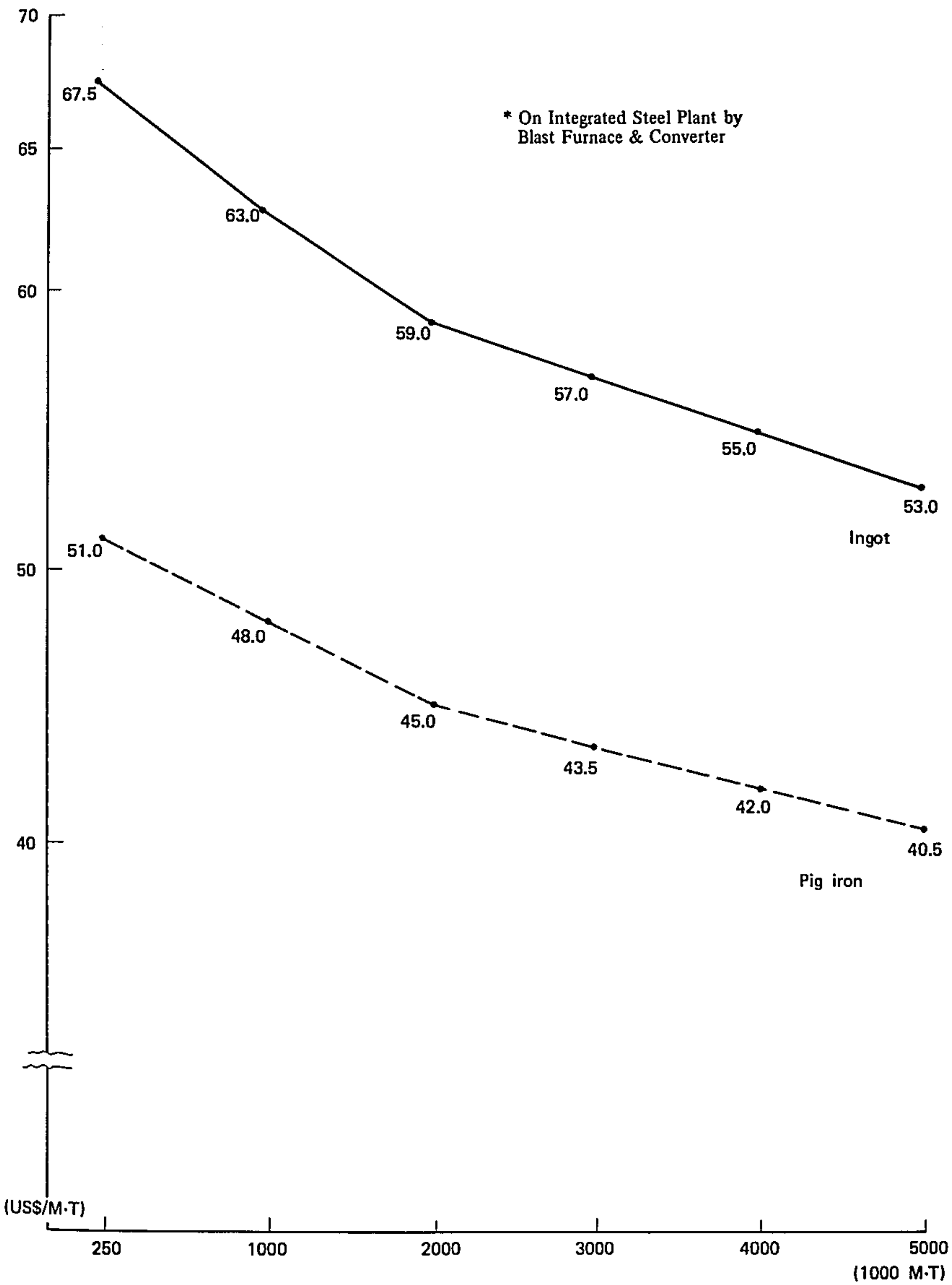
(6) Malaysia

Apart from the above four specific projects, the mission is of the opinion that an electrolytic tinning line of suitable capacity to meet the domestic demand of Malaysia and also to Thailand, Singapore and Indonesia, might be established.

This is suggested because Malaysia is a large producer and exporter of tin.
The establishment of this plant may be undertaken as soon as the demand for tin plates would warrant its installation.

The mission is of the opinion that the commercial success of these projects would require the protection of governments concerned particularly in their initial operations. Furthermore, the mission believes that the industry in these countries could be accelerated through the aegis of the common market. This, in essence, is the theme of regional cooperation envisaged by AIDC.

COST CURVE BY PRODUCTION SCALE



PART II

(COUNTRY REPORTS)

A. CHINA (TAIWAN)

B. THE PHILIPPINES

C. INDONESIA

D. SINGAPORE

E. MALAYSIA

F. THAILAND

A CHINA (TAIWAN)

A CHINA (TAIWAN)

A.1 Present Situation and Future Prospect of Demand for Steel Products in China (Taiwan).

A.1.1 Introduction:

Economic growth in Taiwan has been remarkable in recent years. GNP in 1967 attained a growth rate of 8.9% compared to the previous year and further industrialization and higher industrial level are expected in the years to come. With this for a background, the demand for steel products is rapidly increasing. The average growth rate of demand in the last several years has been 14% and the elasticity against the growth of GNP is 1.7, forecasting further increase in the demand for steel products for a considerably long period.

Table 1. Trend of GNP
(Based on Prices in 1964)

	1 million (NT$)	Ratio to Prv.yr.
1953	44,677	110.5
1954	48,622	108.8
1955	50,639	104.1
1956	52,658	104.0
1957	56,678	107.6
1958	60,083	106.0
1959	65,438	108.9
1960	69,007	105.5
1961	74,637	108.2
1962	80,586	108.0
1963	89,716	111.3
1964	102,492	114.2
1965	111,444	108.7
1966	119,627	107.3
1967	130,000	108.9

(Taiwan Statistical Data Book 1967)

Table 2. Ratio of Industrial Products
in Export Goods
(unit: %)

	Gross Export	Export of Industrial Products
1953	100.0	6.4
1955	100.0	6.1
1960	100.0	30.4
1961	100.0	39.7
1962	100.0	47.2
1963	100.0	39.5
1964	100.0	39.9
1965	100.0	41.3
1966	100.0	49.2

Table 3. National Net Production Classified by Industrial Resources

(Unit: 1 million NT$)
( ) Ratio: %

	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967
Total	35,947 (100)	41,614 (100)	50,833 (100)	47,087 (100)	61,344 (100)	70,636 (100)	84,843 (100)	92,200 (100)	102,188 (100)	115,007 (100)
Agriculture forestry, fishing	11,127 (31.0)	12,591 (30.3)	16,528 (32.5)	17,872 (31.3)	17,891 (29.2)	18,844 (26.7)	23,510 (27.7)	24,797 (26.9)	26,340 (25.8)	28,091 (24.4)
Mining	1,054 (2.9)	1,035 (2.5)	1,177 (2.3)	1,194 (2.1)	1,561 (2.5)	1,489 (2.1)	1,559 (1.8)	1,904 (2.1)	2,229 (2.2)	2,661 (2.3)
Manu-facturing	5,546 (15.4)	7,322 (17.6)	8,488 (16.7)	9,664 (16.9)	10,516 (17.1)	13,817 (19.6)	17,090 (20.2)	17,268 (18.7)	19,547 (19.1)	23,153 (20.2)
Construction	1,544 (4.3)	1,810 (4.3)	2,247 (4.4)	2,501 (4.4)	2,539 (4.1)	2,773 (3.9)	3,154 (3.7)	3,691 (4.0)	4,236 (4.1)	4,841 (4.2)
Transportation Communication utilities	1,907 (5.3)	2,087 (5.0)	2,724 (5.4)	3,592 (6.3)	3,836 (6.3)	4,135 (5.9)	4,945 (5.8)	5,889 (6.4)	7,045 (6.9)	7,939 (6.9)
Wholesale and retail trade	5,516 (15.3)	6,086 (14.6)	7,332 (14.4)	7,966 (14.0)	8,847 (14.4)	10,956 (15.5)	13,394 (15.8)	15,228 (16.5)	16,422 (16.1)	18,834 (16.4)
Wholesale and retail trade	5,516 (15.3)	6,086 (14.6)	7,332 (14.4)	7,966 (14.0)	8,847 (14.4)	10,956 (15.5)	13,394 (15.8)	15,228 (16.5)	16,422 (16.1)	18,834 (16.4)
Ownership of dwellings	2,610 (7.3)	2,833 (6.8)	3,114 (6.1)	3,586 (6.3)	4,176 (6.8)	4,767 (6.7)	5,209 (6.2)	5,515 (6.0)	6,045 (5.9)	6,675 (5.8)
Public admini-stration and defence	4,230 (11.8)	5,017 (12.1)	6,072 (12.0)	7,050 (12.3)	7,645 (12.5)	8,562 (12.1)	9,787 (11.5)	10,615 (11.5)	12,186 ((11.9)	13,938 (12.1)
Other service	2,413 (6.7)	2,833 (6.8)	3,151 (6.2)	3,662 (6.4)	4,333 (7.1)	5,293 (7.5)	6,195 (7.3)	7,313 (7.9)	8,138 (8.0)	8,875 (7.7)

With these economic situations for a background, the demand for steel in Taiwan has been increasing at a quick tempo. The rate of average annual increase of demand during 1953 – 1966 was 14%, the elasticity against the growth of GNP being 1.7. It is expected that there will be continuous increase of demand for steel for fairly a long period in the future.

Table 4. Apparent Consumption of Steel Products

	Q'ty (1,000 MT)		Q'ty (1,000 MT)
1952	78.3	1960	290.2
1953	107.6	1961	273.6
1954	128.8	1962	288.1
1955	142.3	1963	342.0
1956	161.1	1964	418.6
1957	180.3	1965	511.2
1958	197.1	1966	590.8
1959	259.5		

Based on the research data of the Government.

The actual trend of steel consumption per NT$ 1,000 million of GNP of Taiwan is shown in the Table No.5. Reflecting the tendencies toward the industrialization in the economy of Taiwan, steel product consumption has been increasing yearly.

Table 5. Quantity of Steel Product Consumption per GNP

	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966
Steel Consumption (1,000 MT) A	161.1	180.3	197.1	259.5	290.2	273.6	288.1	342.0	418.6	511.2	590.8
GNP B (1 billion NT$ 1964)	52.7	56.7	60.1	65.4	69.0	74.6	80.6	89.7	102.5	111.4	119.6
A/B	3.06	3.18	3.28	3.97	4.21	3.67	3.57	3.81	4.08	4.59	4.94

A.1.2 Forecast of demand for steel products

As to the forecast of demand for steel in the future, assuming that the economic background in which GNP will grow at 8% yearly taking the year 1966 as the base, it would be proper to estimate the quantity of steel product consumption per NT$ 1,000 million in GNP at about 5,300 tons during the period up to 1975, 5,500 tons from 1976 to 1980 and 5,700 tons from 1981 to 1985. The demand for steel products estimated on this assumption is shown in the Table No.6.

Table 6. Estimated Domestic Demand for Steel Products

(Unit: 1,000 tons)

	1966	1970	1971	1972	1973	1974	1975	1980	1985
Steel consumption	590	862	943	1,024	1,105	1,188	1,267	1,932	2,942
Annually rate	7.9%			8.0%				8.8%	8.8%

Comparison between the above estimation and that of the First Survey Mission as well as of the preparatory office, MOEA, is as follows:

(Unit: 1,000 t.)

Year	First Survey Mission	Preparatory Office MOEA	This Survey
1970	780	870	862
1975	1212	1280	1267
1980	1785	1720	1932
1985	2516	–	2942

Judging from the actual consumption of steel products in 1967 which amounted to 729,000 tons, the estimate by the First Survey Mission seems to be too low and that by MOEA for the years after 1980 may be considered too small when progressive trend of economy of Taiwan is taken into account.

A.1.3 Forecast of demand for flat products

The demand for flat products has been increasing yearly, and the trend of increase has shown remarkable upward curve since the beginning of 1960's. Regarding the demand for specific items of flat products, it will be proper to forecast, based on all accounts of informations gathered on the economic structure of Taiwan and its prospected phases of progress which leads us to believe that those industries of shipbuilding, machinery and construction would be the main factors of progress, that the ratio between the hot rolled and cold rolled sheet will be 50 – 50. As to the plates, especially, though the current actual demand is 12 – 15 per cent of all flat products, future development of shipbuilding industry must be taken into consideration and our estimation is made on the assumption that the demand will continue to increase.

Table 7 shows the estimated demand classified by type of flat products

Table 7. Forecast of Domestic Demand for Flat Products

(Unit: 1,000 tons)

		1966	1970	1971	1972	1973	1974	1975	1980	1985
Total Steel Product Demand		590	862	943	1,024	1,105	1,186	1,267	1,932	2,942
Hot Rolled	Plates		76	93	101	105	117	125	218	333
	Sheets / Strip and Hoops		96	109	119	132	138	147	217	332
	Total		172	202	220	237	255	272	435	665
Cold Rolled	Sheets / Strip and Hoops		63	87	97	108	119	130	255	445
	Galvanized Sheets		25	26	28	30	33	35	50	70
	Tin Plates		85	90	95	100	103	108	130	150
	Total		173	203	220	238	255	273	435	665
Total Flat Products		224	345	405	440	475	510	545	870	1,330

The comparison of the above estimate of flat product demand with those of the First Survey Missions, and the preparatory office, MOEA is as follows:

Year	First Survey Mission	Preparatory Office	This Survey
1970	314	350	345
1975	511	540	545
1980	788	760	870
1985	1,186	--	1,330

A.1.4 Forecast of demand for steel bars and sections

1.4.1 Actual demand and supply of steel bars and shapes

The demand for steel bars and sharpes is divided into two categories, domestic and export. The domestic demand can be calculated by the formula of "Import + Production – export = Apparent Domestic Consumption. The actual domestic consumption in the past is as shown in the Table below, which witnessed the increase of 16 times during 16 years from 1950 through 1966, the amount of consumption being 15,600 tons and 254,000 tons respectively.

When the trend of increase is broken down by every 5 years, however, it is known that the rate of increase has been declining in proportion to the rise of consumption level as shown below:

1950 – 1955	4 6 times	(annual rate. 35%)
1955 – 1960	2.3 times	(annual rate: 18.2%)
1960 – 1965	1.4 times	(annual rate. 7.0%)

With regard to the relation between the domestic apparent consumption of steel bars and that of whole steel products, the rate of increase of the latter during the period from 1950 to 1966 was 12 times, while that of steel bar was 16 times, which make the elasticity of steel bars to total steel products 1.33. But, if the last 5 years is taken, the said elasticity falls down to 0.8.

And further, the ratio of steel bars in the domestic apparent consumption of steel products is, as shown in Table 9, in down ward trend, having its peak in 1960. This fact can be presumably accounted for by the relative increase of the rate of flat products demand due to the rise of industrial production of the country.

The export of steel bars and shapes which was 1,000 tons in 1956 has been expanded to 65,000 tons in 1966. The export ratio (export ÷ production) for the recent several years is approximately 20%.

As to the aspect of supply, annual import of steel bars excluding shapes in the last few years was 4,000 tons at the highest, the items of which being restricted to those of standardized or large sized ones which can not be produced in Taiwan. The import of shapes has been increased remarkably since 1965 due to the increased demand for sheet piles and large sized shapes with the progress of various development projects.

The production of bars and shapes has achieved striking increase of 30 times in the period of 16 years since 1950 through 1966, the quantity of products in the above years being 11,900 tons and 300,000 tons respectively.

1950 – 1955	5.3 times	(annual rate 40%)
1955 – 1960	3.2 times	(annual rate 26%)
1960 – 1965	1.3 times	(annual rate 5.4%)

As to the steel bars, items such as round, deformed, square, hexagonal, half round bars, etc., are being produced locally, major part of which being round and deformed bars. These items are produced by rerolling small ingots and ship breaking scraps. Imported for scrap in 1967 were 117 old vessels with a total displacement of 400,000 tons (160,000 tons in 1966). In 1968, the total displacement will increase to 800,000 tons. This is one of the main characteristics of steel production in Taiwan.

Regarding shapes, production is all for medium and small sized shapes such as angles and channels including some light rails, and the major part of products is angle.

1.4.2 Demand and supply of wire rods and wire products

Wire rods in domestic demand includes steel wires, wire nets, wire ropes, hard steel wires, welding rods, etc. The demand has increased 7.8 times (annual rate: 13.7%) in 16 years from 1950 to 1966, the quantity being 9,000 tons and 70,000 tons for respective year.

The trend of increase in every 5 years since 1950 is as follows:

1950 – 1955	1.8 times	(annual rate 12.5%)
1966 – 1960	1.5 times	(annual rate 9.7%)
1960 – 1965	2.7 times	(annual rate 22.0%)

The ratio of wire rods and wire products to total steel products in the apparent domestic consumption is shown below.

1950	18.8%
1955	11.7%
1960	8.3%
1965	12.9%
1966	12.0%

Though the ratio varies with each year, the general tendency is in downward curve slightly.

Export of wire rods and wire products has been gradually increasing, having the figure of 14,000 tons in 1966.

Production of wire rods is limited to ordinary wire rod coils below 80 kg. All of the heavy coils and special steel wire rods are imported, though very small quantity.

With regard to the wire products, only small quantity of steel wire, wire rope, etc. are being imported.

The production of wire rods and wire products showed an increase of 43 times in 16 years from 1,800 tons in 1950 to 77,000 tons in 1966. The ratio of domestic production to demand (self-supplying rate) was 19.6% in 1950, 40.4% in 1955, 95.9% in 1960, and after 1961 the production exceeded the domestic demand, the ratio of 110% in 1966.

1.4.3 Total demand and supply of steel bars, shapes, wires and wire products.

The trend of total demand and supply of steel rods, shapes, wires and wire products is as shown in Table 8 below.

The self-supplying rate of these items to the domestic apparent consumption exceeded the 100% mark in and after 1958.

The ratio of the said items to the total domestic apparent consumption of steel products, which was 50.7% in 1950, increased to 65.4% in 1960, and since then began to show downward trend yearly and was 55.6% in 1966.

Table 8. Actual Demand and Supply of Bars, Shapes, Wire Rods and Wire Products

(Unit 1,000 tons)

		1950	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966
Bars & Shapes	Import	3 7	8 2	9 8	9 8	5.8	5.8	11.7	9.8	7.2	5.3	'2.5	10.5	19.0
	Production	11 9	63 1	78 8	89.0	106 9	158 9	200.5	184.8	181.5	214.8	235 8	257.0	300 0
	Export	–	–	1.3	0 9	11.5	29 4	46.4	53 1	47.2	56.6	50.5	43.5	65.0
	Apparent Consumption	15 6	71.3	87.3	97 9	101 2	135 3	165 7	141.5	141 4	163 4	187.8	224 1	254.0
Wire Rods & Wire Products	Import	7.4	9.9	11 2	1 8	5 6	2.9	3 7	3.5	5.4	4 6	4.4	5 6	7 0
	Production	1 8	6 7	8.2	20.8	19 2	21 9	23 1	36 9	38.1	56 7	66.0	71.2	77 0
	Export	–	–	–	–	0 2	1 2	2 7	6.5	4.6	13 3	5 9	11.0	14.0
	Apparent Consumption	9.2	16 6	19 4	22 6	24 6	23 6	24 1	33 9	38 9	48 0	64.5	65.8	70 0
Total	Import	11 6	18 1	21 0	11 6	11 4	8.7	15 4	13.3	12.6	9 9	6 9	16 1	26 0
	Production	13 7	69 8	87 0	109.8	126 1	180.8	223.6	221.7	219.6	271.5	301 8	328.2	377 0
	Export	–	–	1.3	0 9	11 7	30.6	49 1	59.6	51 8	69 9	56 4	54.5	79.0
	Apparent Consumption	24 8	87 9	106 7	120.5	125 8	158.9	189.8	175 4	180 3	211 4	252 3	289 9	324 0
Production / Apparent Consumption %	Bars & Shapes	76 3	88 5	90 3	90 9	105 6	117 4	121 0	130.6	128 4	131.5	125.6	114 7	118 1
	Wire Rods & Wire Products	19 6	40 4	42 3	92 0	78 0	92 8	95 9	108 8	97 9	118 1	102 3	108 2	110.0
	Total	55 2	79 4	81.5	91 1	100 2	113.8	117.8	126 4	121.8	128.4	119 6	113.2	116 4

Based on Data of Government

1.4.4 Forecast of demand for steel bars and shapes

As a means to forecast the demand for steel bars and shapes, following two methods were contemplated based on the available data.

1. Estimate by the trend of domestic apparent consumption of bars and shapes.
2. Estimate by the proportion of bars and shapes to the total domestic apparent consumption of steel products.

In the estimate by the trend of domestic apparent consumption of bars and shapes, it was estimated that the average rate of increase for the last several years will also continue for several years to come, and in addition, with the progress of industrialization, larger capital investment will be made to stimulate increase of demand for the said items.

In the estimate by the relative quantity of bars and shapes to the total domestic apparent consumption of steel products, the estimate should be made based on the corelation between the said items and the flat products. In this case, the increase of relative importance of the flat products will inevitably decrease the importance of the bars and shapes to some extent.

The result of the above is shown in Table 9 below. The domestic apparent consumption of bars and shapes, which was 254,000 tons of 1966, will be 532,000 tons in 1975 and 1,206,000 tons in 1985.

Though the export of bars and shapes will increase in figure, its export ratio of 20% in recent years is considered to become around 15 – 20%, deducing from the trend of export markets.

As to the bars and shapes, in spite of the estimate that the demm and for large sized bars and shapes will increase steadily, local production will not be made in the near future, and it is estimated that these items corresponding to 7–8% of domestic apparent consumption of total bars and shapes will have to be imported.

With regard to the production of bars and shapes, estimate was made on the assumption that small and medium sized items except larger size would be self-sufficient.

1.4.5 Estimate of demand and supply for wire rods and wire products

For the estimate of demand and supply of wires and wire products, the method similar to that adopted for the estimate of bars and shapes was adopted. The trend of increase of domestic apparent consumption is presumed to be a little lower than that for bars and shapes.

The export of these items will increase with constant upward trend to about 15% of total products.

With the progress of local production, the import of wires and wire products will gradually decrease to the extend that in the end very few special items including hard steel wires, wire ropes, etc. will remain in the import list.

With the exception of very special items, almost all wires and wire products will be produced domestically.

1.4.6 Total Domestic Apparent Consumption of bars, shapes, wires and wire products

The trend of increase in domestic apparent consumption of these items will be a little lower than that of total steel products, and the ratio of the former to the latter will also be going downward.

Table 9. Forecast of Demand and Supply of Bars, Shapes, Wire Rods and Wire Products

(Unit 1,000 tons)

			1960	1966	1970	1975	1980	1985	1970/1966		1975/1970		1980/1975		1985/1980	
									Rate of Increase	Annual Rate	Rate of Increase	Annual Rate	Rate of Increase	Annual Rate	Rate of Increase	Annual Rate
Total of Steel Products		Apparent Consumption	290.2	590 8	862.0	126 7	193 2	294.2	1.46	10.0	1 47	8.0	1.52	8 7	1.52	8.7
Bars & Shapes		Import	11.7	19.0	20 0	40 0	60.0	80.0	1 05	1.2	2 00	14 9	1.50	8 4	1.33	5 9
		Production	200.5	300.0	430 0	600 0	882.0	1,326 0	1 43	9 4	1 40	7.0	1.47	8 0	1.50	8 4
		Export	46 4	65 0	80 0	108.0	150.5	200.0	1.23	5.3	1.35	6.2	1.39	6 8	1 33	5.9
		Apparent Consumption	165.7	254 0	370.0	532.0	792 0	1,206 0	1.46	10 0	1.44	7.6	1 49	8.3	1.52	8 7
Wire Rods & Wire Products		Import	3.7	7.0	6.0	5.0	4 0	3 0	–		–		–		–	
		Products	23.1	77.0	113.0	156.0	215.0	325.0	1.47	10 1	1.38	6.7	1.38	6 7	1.51	8 6
		Export	2.7	14.0	16 0	21 0	26 0	34 0	1.14	3 4	1.31	5.5	1 24	4.4	1.31	5.5
		Apparent Consumption	24.1	70 0	103 0	140 0	193.0	294 0	1.47	10 1	1.36	6 3	1 38	6 7	1.52	8 7
Total (Bars, Shapes, Wires & Wire Products)		Import	15 4	26.0	26.0	45 0	64.0	83.0	1.00	–	1 73	11.6	1 42	7 3	1.30	5 4
		Production	223 6	377.0	543 0	756 0	1,097 0	1,651 0	1 44	3 4	1.39	6.8	1.45	7.7	1.51	8.6
		Export	49.1	79 0	96 0	129 0	177.0	234 0	1 22	5 1	1.34	6.0	1.37	6.5	1.32	5.7
		Apparent Consumption	189.8	324 0	473 0	672 0	985.0	1,500.0	1 46	10 0	1 42	7.3	1.47	8 0	1.52	8.7
Ratio to total Steel Products %	Shapes & Bars	Apparent Consumption	57 1	0	43 0	42 0	41 0	41 0								
	Wire Rods & Wire Products	Apparent Consumption	8 3	11.8	13 0	11.0	10.0	10 0								
	Total	Apparent Consumption	65 4	54 8	56 0	53 0	51.0	51 0								

A.1.5 Forecast of demand for billets

Materials to be used for production of bars, shapes and wire rods are such as steel scrap for re-rolling, billets and small ingots, and the selection of each of these items for use is to be determined by taking into consideration the different forms of production which varies depending upon the prices of re-rolling scrap, billet and ingot either imported or locally products. Therefore, the estimate on the quantity of billet to be imported, which is under the influence of such uncertain factors, will have to be made from wide range point of view since the definit estimate on the import quantity would not be obtained.

Although, the import of billet is influenced by various factors as mentioned above, import of a certain quantity of special steel (2 – 3% of total production) will be indispensable to the steel industry.

In Taiwan, small ingot of 80kg is used for rolling small bars and the imported ingot of 80 – 120kg is used for the production of large sized bars, with those of 200 – 150mm square

For rolling of wire rods, 500kg rimmed steel billet 8" x 8" and 80kg ingot 4" x 4" are used.

Table 10 Comparison between Demand-Domestic Capacity-Estimated Import & Lxport of Flat Products in Taiwan

(Unit 1,000 ton)

Year	D Demand			Required Hot Coil for (b) & (c) (as roll)	Production capacity		Import			Export	Remarks
	Plate	HR Sheet Strip Hoop	CR Sheet Strip, Hoop GI Sheet, Tin Plate		Hot Coil (as roll)	Plate (a-f)	Slab (e)	Plate (f)	Hot Coil (as roll)	Hot Coil (as roll)	
	(a)	(b)	(c)	(d)	(d)'	(a)'	d/0.97 or d-d/0.97	a 20 or a x 0.23	d-d	d-d	
1970	76	96	173	318	-	20	-	56	318		
1971	93	109	203	369	-	20		73	369	-	Cold mill completed
1972	101	119	220	400	-	20		81	400	-	
1973	105	132	238	436	-	20	-	85	436	-	Hot mill completed
1974	117	138	255	463	(1,180) 768 (463)	90	(478)	27			
1975	125	147	273	495	(1 170) 762 (495)	96	(510)	29		-	Completion of integration (1 million tons)
1976	157	158	315	570	(1,140) 733	121	-	36		163	
1977	173	172	345	608	(1,130) 720	133		40	-	112	
1978	188	187	375	662	(1,110) 706	145	-	43		44	
1979	203	202	405	715	(1,100) 693	156	23	47		-	
1980	218	217	435	767	(1 090) 677	168	93	50		-	Completion of integration (2 million tons)
1985	333	332	665	1,168	(900) 578	256		77			

(Note) 1 After 1974, 23% – 30% of total demand for plate, special products, are to be imported

2 With the existing production capacity of 60 000 T/Y for plate, actual production is estimated at 20,000 T/Y

3. The productive capacity of the hot strip mill to be completed in 1973 is estimated as follow

Plate 200 T/H x 0 85 (yield-slab) = 170 T/H

Coil 200 T/H x 0 97 (yield-slab) = 194 T/Y

Annual operating hours = 8,765 H/year x 75% = 6,500 H/year

4 Figures not parenthesized in the column (d') show the production on the basis of 1 million T/year ingot supply

Figures in parenthesis show the production when slab is freely available

Figures in the brackets show the quantity corresponding to domestic demand

A.2 Present Situation of Iron and Steel Industry in Taiwan

At present there are over 100 steel manufacturers in Taiwan. Of these, two plants are equipped with iron and steel making facilities, though they are small in scale. The steel products which totalled 117,000 tons in 1957 increased to 600,000 tons in 1967. The majority of these plants are engaged in the production of only small shapes and bars of various types from small ingot which is made by electric arc furnace or from steel scrap by re-rolling.

Except the 3-high hot plate mill which has been in operation since July 1965, for the annual production of 10,000 tons of ordinary plates of more than 1 inch thick and 5 feet wide, operation of the steel mill is limited to the second or third processing such as the production of small bars, wire rods, wires, nails, pipes, galvanized sheets, HD tin plates, etc. using imported billets, wire rod, hot coils, base plates, etc. All other sheets, large shapes, heavy rails, seamless pipes and special steel are being imported. Existing production capacity is as follow:

Pig iron making:	2 blast furnaces of 60 T/D and 10 T/D, 30 electric iron furnaces (600 – 50 KVA) having a total annual production capacity of 120,000 tons.
Steel making:	4 electric arc furnaces of 1 T/ch – 30 T/ch, 3 oxygen converters of 3 T/ch x 2, 5 T/ch x 1 and 1 bessemer converter, with a total annual production capacity being approximately 500,000 tons.
Bars and section rolling:	More than 90 small bar mills for the production of rolls of 7 – 16 inches diameter, having a total annual production capacity of 600,000 tons. At present, a 24 inch 3-high billet rolling mill is under construction, which will start its operation in the latter half of 1968.
Flat products rolling:	A 3 – high plate mill with a total annual production capacity of 60,000 tons and 4 hot coil shearing lines which can shear the plates up to 7 m/m thick, having a total annual production capacity of 40,000 tons.
Galvanizing:	5 lines of galvanizing facilities, having a total annual production of 60,000 tons.
Tinning:	4 lines of HD tin plate facilities with a total annual production capacity of 20,000 tons.
Pipe making.	10 electric arc welding pipe making facilities to produce ½ – 6 inches diameter-pipe and large sized spiral pipe, having a total annual production capacity of 65,000 tons.
Wire drawing and role making:	13 wire drawing and 7 wire rope making factories, with a total annual production capacity of 120,000 tons.

A.3 Raw Materials, Power, and Water Supply etc.

(1) Iron ore: There is no deposit of iron ore to be exploited economically in Taiwan. In the east, west and north parts of the island, there exist iron sand resources sporadically and in small quantity, and in the western mountain regions, some limonite. According to the recent survey, the total deposit of iron sands was reported to be only 123,000 tons, the quality of which being 40 – 60% of Fe, 6 – 12% of SiO_2, 0.10 – 0.5% of P, 0.07 – 0.15% of S and 2.5 – 5.6% of Ti. The quantity of the limonite deposit was reported to be not more than 500,000 tons, the quality of which being 25 – 35% of Fe, 20 – 40% of SiO_2 and 0.5% of P.

(2) Coal and coke: The workable coal deposits are estimated at 240 million tons which is sufficient to meet the future demand for about 50 years, if the mining is continued on the basis of 5 million tons per year as was in the past. The coal deposits are located mostly in the northern part of the island, and they belong to the bituminus type, the seams being narrow ones mostly.
Some of the mines in Chialo and Nancluing plains produce the coal suitable for coking, though the qualities vary. It is estimated that 32% of whole deposit (76,800,000 tons) is coking coal and the remaining 68% (163,000,000 tons) non-coking. There are about 310 coal mines in all in Taiwan, of which 42 mines produce nearly half of recent output of 900,000 ton/year of coking coal and 4,100,000 ton/year of non-coking coal. The productivity of each mine is not high, the rate of output being 0.35 tons per man-day, and accordingly the coal price is rather high. There are 55 mines which produce coking coal, some of them having the beehive coke ovens. The names of the firms which have coke ovens and their production capacities are as follows:

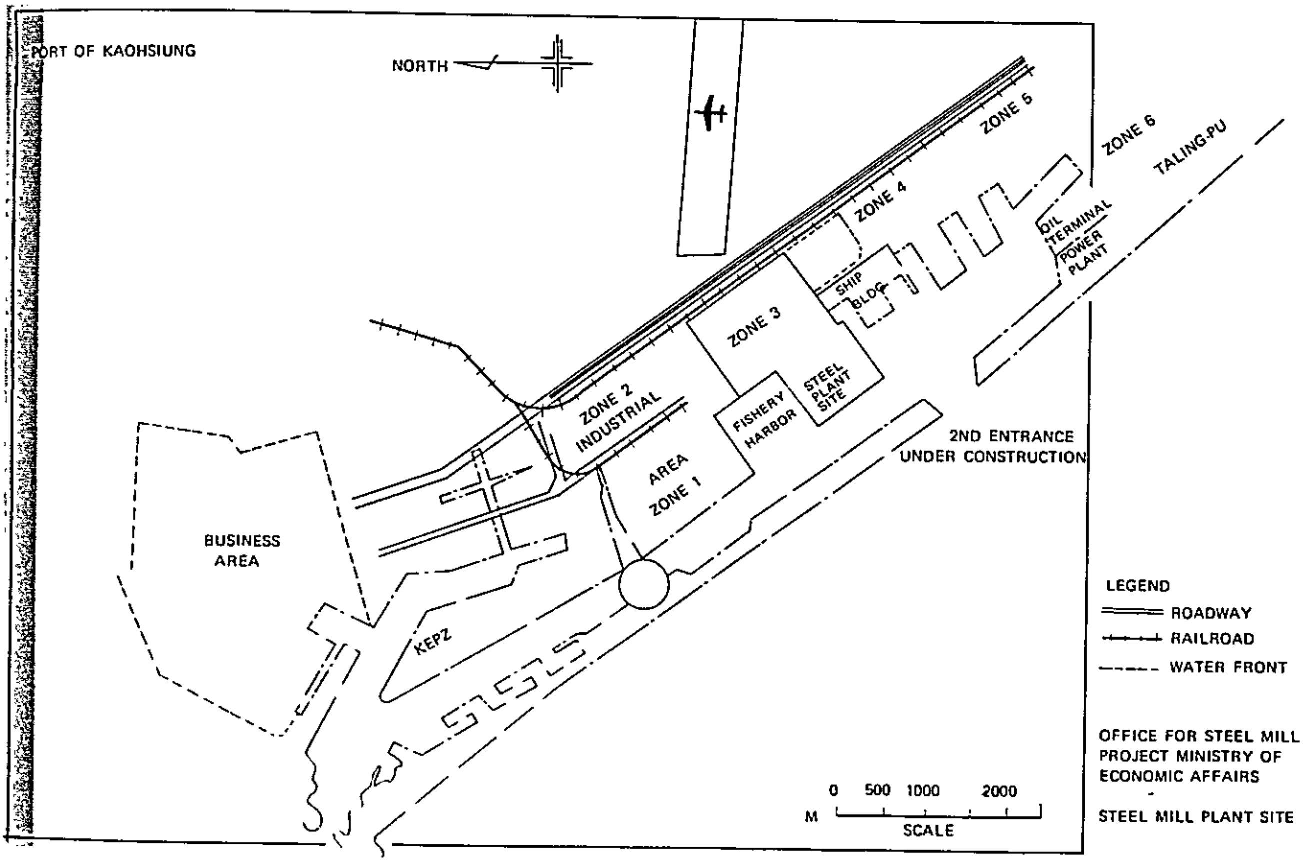
	Capacity (T/Y)	Quality	Ash %	V.M.%	S%
Pioneer Chemical Co.	144,000	For steel making	12.0	1.5	0.8
Hsinchu Gas & Coke Co.	19,000	For blast furnace	15.0	2.0	1.0
Cheho Chemical Co.	24,000	General use	22.0	3.0	1.0
Taipei City Gas Works	3,000	Semi-cokes	26.0	10.0	1.0
Beehive Ovens	350,000				
Total	540,000				

(3) Scrap: A total of 500,000 tons steel scrap was imported in 1967, about 60% of which being broken ships and dismantled to plate scrap at various places.

(4) Lime stone and dolomite: There are large deposits of limestone and dolomite in the north-eastern district of the island. The limestone reserve of Shimaoshan, the largest mine, is estimated at 52,000,000 tons, while dolomite reserve is said to be over 100,000,000 tons.

(5) Power: The rate of average annual increase of generating capacity by the existing plants is about 12.5%, the capacity of 392 MW in 1954 having been developed to 1580 MW. Nevertheless, power shortages have occurred always over recent years during dry seasons. At present, a thermal power plant of 300 MW capacity is now under construction for completion in the latter half of 1968 With this new plan the total generating capacity in 1972 is expected to be 3,510 MW.

Figure 1



A.4 Outline of the Kaohsiung Integrated Iron and Steel Plant Project

A.4.1 Background

In Taiwan the steel industry using the above mentioned electric arc furnaces has shown a rapid development in the post-war period partly due to cheap power supply. However, due to limited capacity and inefficiency of the existing facilities, coupled with the fact that the supply of scrap, principal raw material for the production of steel, has to depend largely on the import, the cost of products fluctuates constantly making it impossible to maintain stable prices. Furthermore, the lack of adequate flat products rolling facilities to satisfy ever increasing domestic demand has necessitated the expenditure of foreign currency annually totalling US$40 million for the import of these products. This situation is not only causing a delay in the development of steel oriented industry but also presents a serious problem of the balance of the international payments in Taiwan. Under these circumstances, the Taiwan Government, on one hand, is now pushing forward a drive for the rationalization and modernization of the existing steel industry. On the other hand, it is also contemplating the establishment of an integrated steel plant with an ultimate production capacity of about 2 million tons of steel ingot so as to accelerate the harmonious development of various industries. Concerning the steel industry in Taiwan, surveys have been conducted by the foreign technical consultants for a fairly long period in the past. As the conclusion of these surveys, it was adviced that, production of flat products be started in the first phase, and construction of an integrated steel plant should be completed five years afterward. Judging from the findings of our current survey on demand and supply of steel products, the above project is considered reasonable.

In January, 1968, the Preparatory Office MOEA, was set up under the jurisdiction of the Ministry of Economic Affairs of the Government, and at present a detailed plan is being prepared by the office. It is expected that by the end of 1968 a company will be established with the authorization of the Government and the construction work of the steel plant will start early next year.

A.4.2 Outline of the project

4.2.1 Phase of construction works

Phase I	(1969 – 1971)	Electrolytic tinning line	80 000 T/Y
		Cold tandem mill	500.000 T/Y
Phase II	(1971 1973)	Hot strip mill	1,000.000 T/Y
		Expansion of tinning line	160,000 T/Y
Phase III	(1973 1975)	Iron and steel making fac	1,000,000 T/Y (steel ingot)

Phase IV (1979 – 1981)	Expansion of the above facilities	2,000,000 T/Y (steel ingot)

4.2.2 Location: The plant will be built in Kaoshiung Port Industrial Zone No. 3, a reclaimed land covering an area of 240 hectares

A map, showing the Kaoshiung port area, is attached. The industrial zone embraces the port for which a 12 year expansion program has been carried on since 1958. The port is presently (–) 10 meter deep and the area in the vicinity of the 2nd entrance to the port is scheduled to be dredged to (–) 14.5 meter depth to permit ocean going ships up to 75,000 tons to berth at the pier. The zone is considered to have enough room for an integrated steel plant of 2 million tons capacity. Moreover, its location is convenient for the import of raw materials, and for the export and transfer of products, and for the supply of water, power and labor. It is considered that the site has excellent conditions.

4.2.3 Main Facilities and estimated construction cost

A detailed plan has already been prepared for the first and second phases. In the first phase hot coils and base plates for tinning are to be imported as raw materials, and slabs in the second phase

Iron and steel making facilities for the third phase and thereafter has not yet been decided. But this survey mission, based on available information, made an estimate for the equipments required and construction cost as follows:

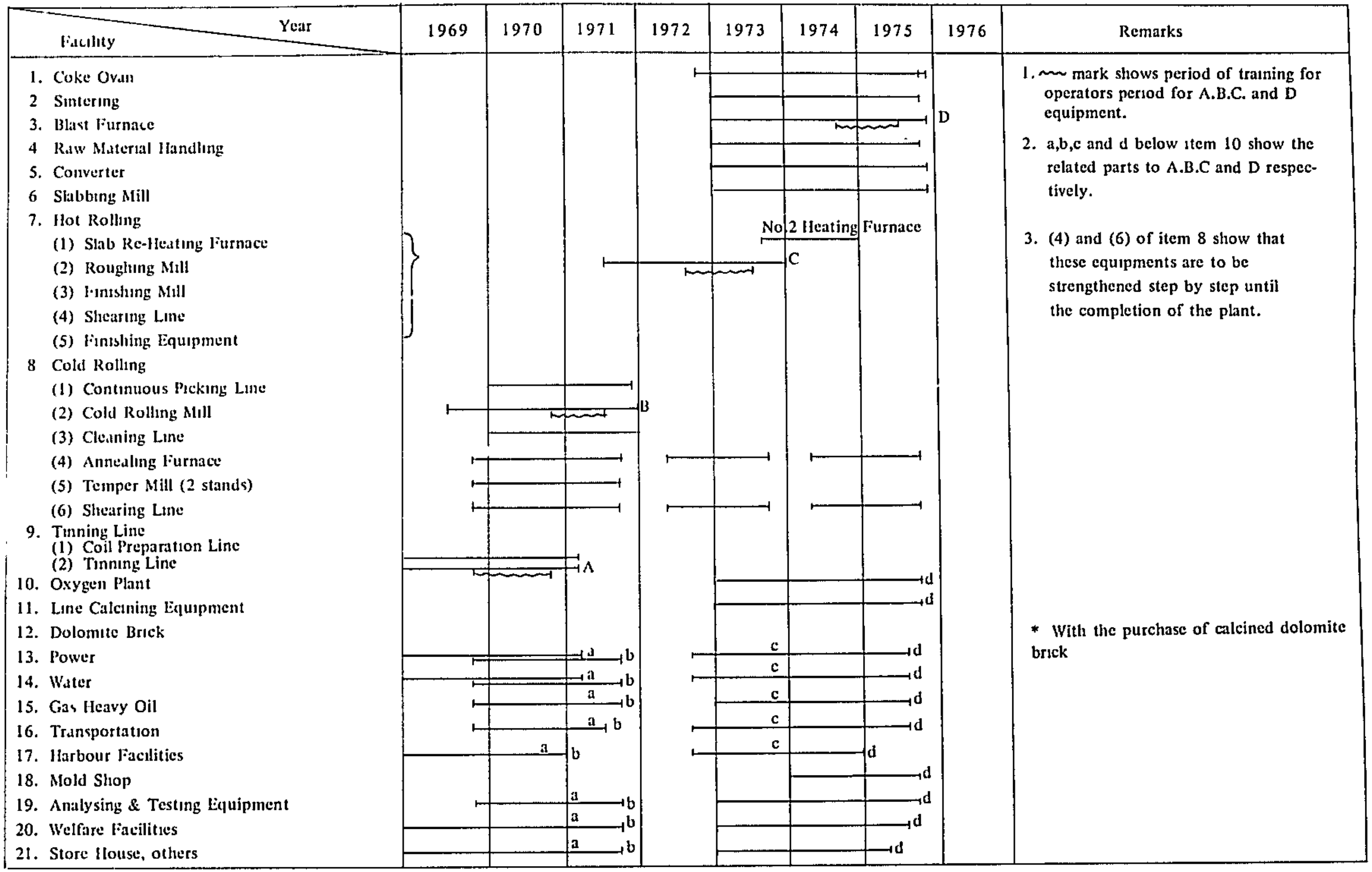
Table 11. Estimated Construction Cost

(unit: ¥1 million)

Equipment	Main Specification	Cast	Remark	Additional Const. Cost for 2 million Tons	
				Main Specifications	Cost
1. Coke oven	1,500 T/D 15.5T charge, 90 ovens of 400 width x 13,000 length x 4,400 height	3,800		1. Same to the left	2,900
2. Sintering facility	3,000 T/D	2,500		2. "	2,500
3. Blast furnace	2,700 T/D capacity, internal volume 2,000 m^3, heavy oil blast 30 kg/T	6,200		3. "	6,200
4. Material handling facilities		2,100		4. Material handling	1,130
5. Converter	90 T/ch x 2,160 m^3	5,000	LDG recovery system	5. 90 T/ch x 1	3,500
6. Slabbing mill	ingot treating capacity 2,000,000 T/year, soaking pit 4 batteries	5,900		6. 4 batteries of soaking pits and others	1,700
7. Hot rolling mill		13,500	¥700 million for No.6 stand excluded	7. hot rolling	1,400
(1) Slab re-heating furnace	150 T/H x 2			(1) heating furnace 150 T/H x 1	(500)
(2) Roughing mill	roll width 2,200mm, max. speed 290m/minute	(12,000)		(2) roll shop	(200)
(3) Finishing mill	roll width 1,400mm, max. speed 610m/minute (at No.5. stand) six stands in the future. min. thickness 1.2mm			(3) No.6 finishing stand	(700)
(4) Shearing line		(500)			
(5) Finishing equipment		(1,000)			
8. Cold rolling mill		10,000	¥500 million for No.6 stand excluded	8. the second cold rolling mill	10,000
(1) Continuous picking line		(2,000)			
(2) Cold rolling mill	roll width 1,400mm, max. speed <-1,100m/minute				
(3) Cleaning line	six stands in the future, min. thickness 0.15mm	(7,500)		same to the left, tentatively	
(4) Annealing furnace	batch type, 35 cover, 77 base				
(5) Temper mill (2 stands)					
(6) Shear line		(500)			

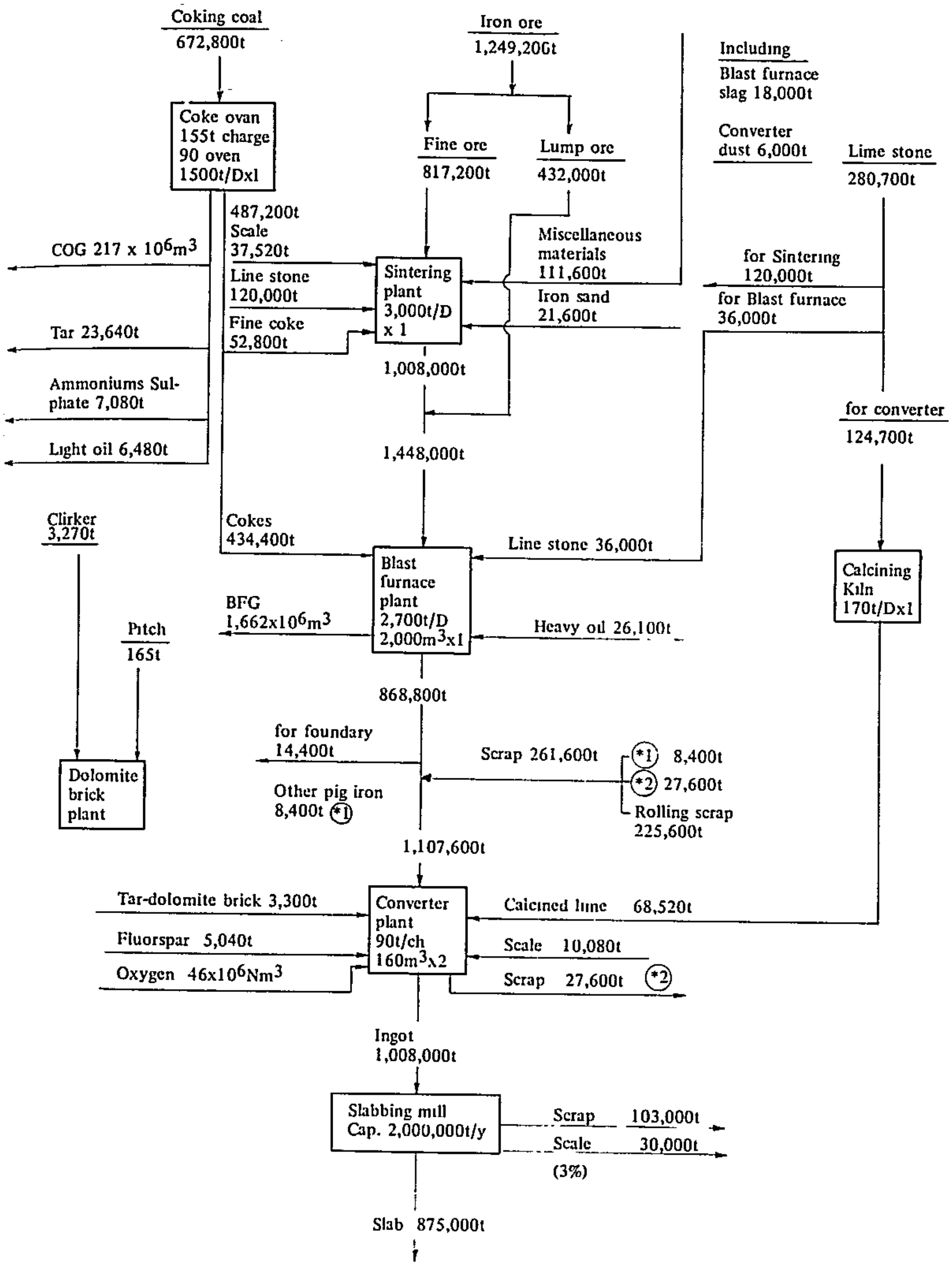
9. Tinning line		3,000		9. surface treating	3,050
(1) Coil preparation line		(300)		(1) coil preparation line and galvanizings line	(2,300)
(2) Tinning line and shear	max. speed 800 ft/m, later 1,600 ft/m in the future	(2,700)		(2) speed increasing of electrolytic tinning line 1,600 ft/m	(750)
10. Oxygen plant	6,000 Nm^3/H	1,800	Include 1 to be added 1 year later	10. 6,000 Nm^3/H No.3	900
11. Lime calcining equipment	170T/D x 1	240		11. same to the left	240
12. Dolomite brick		0	By purchasing burned dolomite brick	12. "	0
13. Power	100T/H boiler 3, Independent power generator 10,000 KXx2, Trans., 11,000 Nm^3/H air compressor x 3	4,330		13. boiler 2. Independent power generator 1, air compressor 2 etc.	2,730
14. Water		3,900		14. "	880
15. Gas, heavy oil		2,300	Include ¥270 million of LDG	15.	900
16. Transportation	ore 1,500T/H unloader x 2, coal 300T/H unloader x 1, crane 20T x 2 for products	2,400	Include rail and road	16. ore unloader 1 crane for product	2,100
17. Harbour	depth 12m (in the future 13m for 70,000 ton ship)	2,600	Include dredging	17.	0
18. Mold shop		200		18.	100
19. Testing, Analizing		700	Include scale center ¥130 million	19.	100
20. Welfare		2,700		20.	1,600
21. Store House, etc.		1,000		21.	800
Total		74,170	≑206,000 (1,000US$)	Total	42,730 ≑ 119,000 (1,000US$)

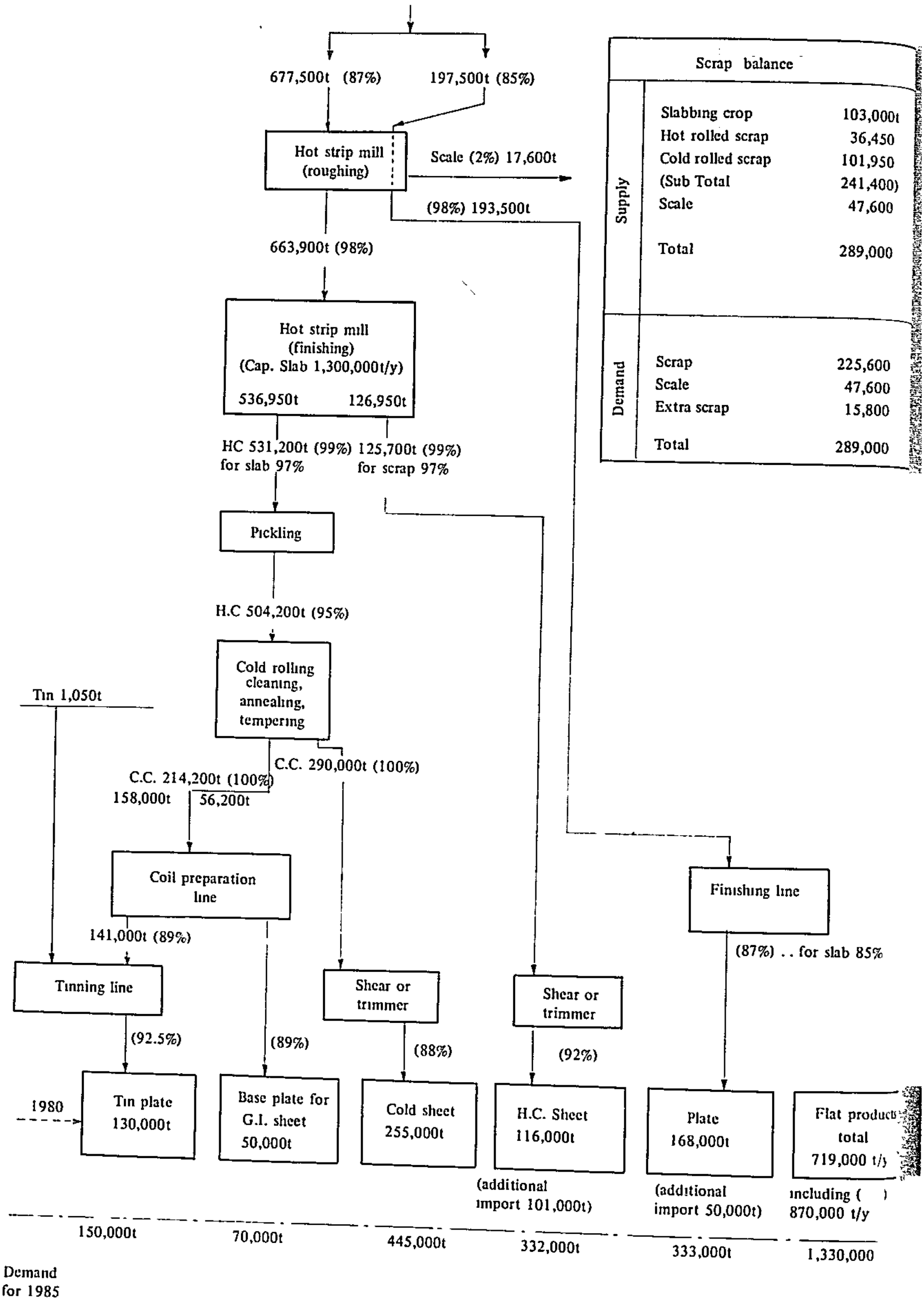
4.2.4 Construction Schedule



4.2.5 Production plan and operational data (flow at 1 million tons capacity of steel ingot)

(1) Production flow chart and scrap balance





677,500t (87%)
197,500t (85%)
Scrap balance
Supply
Slabbing crop 103,000t
Hot rolled scrap 36,450
Cold rolled scrap 101,950
(Sub Total 241,400)
Scale 47,600
Total 289,000
Demand
Scrap 225,600
Scale 47,600
Extra scrap 15,800
Total 289,000
Hot strip mill (roughing)
Scale (2%) 17,600t
(98%) 193,500t
663,900t (98%)
Hot strip mill (finishing) (Cap. Slab 1,300,000t/y)
536,950t
126,950t
HC 531,200t (99%)
for slab 97%
125,700t (99%)
for scrap 97%
Pickling
H.C 504,200t (95%)
Cold rolling cleaning, annealing, tempering
Tin 1,050t
C.C. 290,000t (100%)
C.C. 214,200t (100%)
158,000t
56,200t
Coil preparation line
Finishing line
141,000t (89%)
(87%) .. for slab 85%
Tinning line
Shear or trimmer
Shear or trimmer
(92.5%)
(89%)
(88%)
(92%)
1980
Tin plate 130,000t
Base plate for G.I. sheet 50,000t
Cold sheet 255,000t
H.C. Sheet 116,000t
Plate 168,000t
Flat products total 719,000 t/y
(additional import 101,000t)
(additional import 50,000t)
including ( ) 870,000 t/y
150,000t
70,000t
445,000t
332,000t
333,000t
1,330,000
Demand for 1985

(2) Gas, water and power balance etc.

Gas Balance

Generation	1910 m³/pig x 72,400 = 138,500 x 103 m3 C.O.G. 320 m³/charged coal x 56,400 = 18,100 x 103 m3	Production	Estimated Unit consump-tion x 103 kcal/t	Calorie Required x 103 kcal	Distribution		
					C.O.G. x 103 m³/month	B.F.G. x 103 m³ month	Heavy Oil
Demand	Hot stove	Pig iron 72,400t /month	500 (excluding heavy oil)	36,200,000	0	45,200	*1 2,170t (30 kg/t)
	Sintering plant	84,000	40	3,360,000	700	0	0
	Coke oven	coal charged 56,400	640	36,100,000	2,820	28,200	0
	Miscellaneous for steel making				220	0	0
	Soaking pit	84,000	290	23,360,000	2,090	16,700	0
	Hot rolling Reheating furnace	73,000	500	36,500,000	6,420	7,130	0
	Cold rolling Annealing furnace	42,000	370	15,550,000	3,240	0	0
	Lime kiln	5,710	1,500	8,570,000	0	0	922
	Others				1,670 *2	0	0
	Boiler	120,000	800	96,000,000	886	25,340	7,680
	Loss		C.O.G. 0.3% B.F.G. 11.5%		54	15,930	0
Total					18,100	138,500	10,772

Note:

1. Converted calorie B.F.G. 800 Kcal/m³, C.O.G. 4,800 Kcal/m³
   Heavy oil 9,300 Kcal/kg
2. *1 Heavy oil in the column of hot stove is for blast furnace.
3. *2 chemicals 100 x 10³ Kcal ammonium sulphate 5. x 590 T/month = 59,000 x 10³ Kcal/month
   = C.O.G. 12.3 x 10³ m³/month = 20 x 10³ m³/month
   Repairing & Engineering C.O.G. 250 x 10³ m³/month
   Miscellaneous C.O.G. 1,400 x 10³ m³/month
4. In the above table, no L.D.G. distribution is made, so as to make clear the efficiency of recovered L.D.G.
   L.D.G. recovery rate is estimated as
   60Nm³ x 90%/ingot T x 84,000T/month x 2,100 Kcal/Nm³ = 4,530 x 10³Nm³/month
   x 2,100 Kcal/Nm³ = 9,520 x 10⁶ Kcal/month
   (equal to 1,020T of heavy oil). Therefore, if L.D.G. is recovered, 7,680T of heavy oil for boiler should be made 6,660T.

Steam Balance

	Production ton/month	Estimated unit Consumption kg/ton	Steam demand ton/month	Remarks
Pig iron making	72,400	330	23,900	21,370t: for blower; 2,530t: for general use
Coke	40,600	7	280	
Chemicals	Coal charged 56,400	2.6 T/H x 0.7	1,300	
Steel making	84,000	1.4 T/H	1,040	
Hot rolling	73,000	7	510	
Pickling	44,300	91	4,030	
Cleaning	17,800	280	4,980	
Electrolytic tinning	11,750	190	2,230	
Auxiliary: Boiler feed water heating		12% of total generated steam	14,540	
Welfare			4,390 (Welfare, Oxygen, Bath Room, Others)	430T/month
Oxygen	4,300 x $10^3 m^3$	$0.02/10^3 m^3$		90T/month
Bath Room				2,100T/month
Others				900T/month
Power Generation	13,500 x 10^3 KHW	4.5 (kg/KWH)	60,800	
Losses			2,000	
Total			120,000	Average 167T/H

Electric Power Balance

		Production t/month	Estimated Unit Consumption KWH/t	Distribution 10^3 KWH/month
Pig iron making		72,400	14	1,015
Sintering		84,000	30	2,520
Coke		40,600	14	570
Converter Converter dust removing		84,000 84,000	21	1,765
Slabbing		84,000	30	2,520
Continuous hot rolling		73,000	100	7,300
Hot rolled sheet finishing		9,700	9	87
Plate finishing		14,000	54	756
Cold rolling, annealing tempering		42,000	190	10,000
Cold rolled sheet, Base plate for G.I. sheet } finishing		25,500	9	230
Tinning		10,800	155	1,675
Auxiliary	Steam	120,000	7.5	900
	Oxygen	4,300 x 10^3m^3	0.9	3,900
	Water	Fresh water of recovered water & pure water 9,540 x 10^3m^3 sea water 4,000 x 10^3m^3	180KWH/1,000 m^3 87 "	2,088
	Others			1,430 *1
	Lightning		51,200 KWH/d	1,590
Losses			3.1% of grand total	1,354
Total				39,700
Power station			500 x 10^3 KWH	500
Grand Total				40,200 *2

Note: 1. *1 Chemicals 100, Repairing & engineering 240, transportation 490, lime 280 and others 320; 1,430 in total

*2 Independent power generation 13,500 x 10^3 KWH ..... Average 18,750 KW

Purchased power 26,700 x 10^3 KWH ..... Average 37,000 KW

Water Balance

	Production t/month	Unit consumption m^3/t Those enclosed in ( ) are sea water	Distribution $10^3 m^3$/month		
			Fresh or recovered water	Pure water	Sea water
Pig iron making	72,400	29.0 (16.5 blast)	2,100		1,195
Sintering	84,000	1.0	84	-	
Coke	40,600	6.0	244		
Converter	84,000	9.5	798		
Oxygen generator	4,300 x $10^3 m^3$	15.0 $m^3/10^3 m^3$(62)	646		267
Slabbing	84,000	7.0	588		
Hot rolling	73,000	30.0	2,190		
Pickling	44,300	6.0	266		
Cold rolling	42,000	8.0	366		
Annealing + tempering	42,000	1.5 + 1.5	126		
Cleaning	17,800	0.5	9		
Tinning	11,750	3.6	423		
Chemicals	56,400 charged coal	1.7/charged coal x 70%	70		
Others		28,200 m^3/day inc. pure water	470	400	
Power generator	13,500 x 10^3 KWH		0		2,490
Loss		8.3% (1.0%)	750	40	48
Total			9,100 *	440	4,000

Note: 1. * Of 9,100 x $10^3 m^3$/month, approximately 65% is recovered water and 35% make up water.

(3) Various Unit Consumption

Unit Consumption of Roll and Mold

		Quantity to be treated t/month	Unit Consumption kg/t		Amount of Consumption of Roll
			W.R.	B.R.	
Slabbing roll		Ingot 84,000 t (slab 72,700 t)	0.075	/	Note 6,300 kg * When edging roll is used, add 0.02 kg/t x 84,000 t/month = 1,680 kg
Hot roll roughing	for plates	Slab 16,400	0.6	0.03	WR 9,840 kg BR 492 10,332 kg
	for coil	Slab 56,300 (coil 54,700)	0.7	0.03 } 0.2	WR 39,410 kg BR 1,689 41,099 kg
Hot roll finishing		Slab 56,300 (coil 54,700)	1.0	0.17 }	WR 56,300 kg 9,571 65,871 kg
Cold rolling	for shearing	Unsheared cold coil 24,200	1.0	0.2	WR 24,200 kg BR 4,840 29,040 kg
	for tinning & galvanizing	Cold coil 17,800	2.2	0.2	WR 39,160 kg BR 3,560 42,720 kg
Skin pass		Cold coil 42,000	0.5	0.03	WR 21,000 kg BR 1,260 22,260
Total					217,622 kg (* Note: Same as above)

	Ingot Production (month)	Unit Consumption	Required Amount of Mold & Board (month)
	(A)	(B)	(A) x (B)
Mold	84,000 t	9.5 kg/t	800 t
Board	84,000	3.3	280
Total	84,000	12.8	1,080

Required Amount of Smelted Pig Iron

(Production by Direct Pouring Method)

	Required Amount of Mold & Board: t/month (A)	Yield Rate (B)	Required Amount of Pig Iron: t/month (A) – (B)
Smelted Pig Iron	1,080	0.9	(14,400 t/y) 1,200

Unit Consumption of Brick

Type		Unit Consumption kg/ingot[t]	Required Amount of Brick (ingot 1 million ton/year)
Converter	Tar-dolomite brick	0.43 (13%)	430 t/year
	Synthetic-dolomite brick	1.81 (55%)	1,810
	Calcined dolomite brick	1.06 (32%)	1,060
	Sub-total	3.30 (100%)	3,300
Casting ladle		4.10	4,100
Ladle stopper sleeve		0.75	750
Nozzle		0.08	80
Bottom pouring runner brick		0.25	250
Top pouring bottom brick (graphite)		0.10	100
Stopper head (graphite)		0.04	40
Torpedo car (8 cars)		0.60	600
Hot metal ladle (5 stands)		0.25	250
Total		–	9,470 t/year

Combination of Materials

	Dolomite Clinker kg/t	Synthetic Dolomite Clinker kg/t	Magnesia Clinker kg/t	Total kg/t	Pitch kg/t	Anthracene kg/t	Wax kg/t	Total kg/t	Brand Total kg/t	Yield Rate %
Tar-dolomite brick	690	0	295	985	45	5	0	50	1,035	97
Synthetic dolomite brickq	0	690	295	985	45	5	0	50	1,035	97
Calcined-dolomite brick	0	900	220	1,120	0	0	30	30	1,150	92

(4) Manpower

The strength of personnel needed for an integrated steel plant differs according to various economic and social conditions, beside the locational conditions of the plant, including existing related industries, labor conditions, and wage standards which form the background of the enterprise. At this juncture, the following estimate was made on the strength of personnel required for the proposed plant based on the average standards available:

Production dept.		
Pig iron making	300 persons	(Coke oven, sintering, blast furnace)
Steel making	300	(Converter, lime)
Rolling	800	(slbagging, hot and cold rolling, tinning)
Total	1,400	
Auxiliary dept.	800	(power, repairing & engineering, storehouse, inspection)
Management dept.	550	(engineers, administratives)
Miscellaneous works and others	1,950	
Grand total	4,700	

(5) Technical Recommendations

Although the period of stay in Taiwan of this survey mission was short and only limited data was available, the mission in its best effort presents the following recommendations, which, we are afraid, may not be as concrete as the mission originally intended.

1. Since the process method to be adopted for iron and steel making has not been determined yet, the mission refrains from commenting on this matter. However, for the completion of an integrated steel plant by 1975, construction works must be started in 1973, therefore the process method for steel making should be determined by 1972 at the latest. Since the direct reduction process of iron making is a new technique and is not generally practiced, it will require very long period to investigate the merits and demerits of this method, compared with the blast furnace method.

2. In 1974 and 1975, the period from the completion of hot mill to the completion of the integrated plant, some 500,000 tons of slabs are required to be imported. Since it is generally difficult to obtain a large quantity of slabs (the semi-products) compared to hot coils (the primary products), a careful arrangement

must be made before purchasing this product. Numerically speaking, there is a possibility to move up the time of completion of integrated plant by two years and to start the production of crude steel in 1974 (about 700,000 tons of crude steel is expected to be in demand in 1974). But it is necessary to reappraise the merit of this measure by taking full account of the capital investment and profitability compared with the case of imported slabs. The surplus crude steel in this case can be allocated to the production of hot coil and plates for export. And then, the method of iron and steel making must be determined without delay.

3. In the hot rolling mill plan, excellent equipments project such as the hot tandems (originally 5 stands and lastly 6 stands), cold tandem (originally 5 stands and lastly 6 stands) and 2 tandem temper mills have been adopted.

4. As a matter of commonsense, it is desirable that the planning for a whole or a unit plant should be worked out so that it can meet future expansion of the plant or installation of new equipments. For example, possibilities can not be denied that, in the future, a continuous casting line might be installed next to the converter or a surface treating line in such a manner as continuous galvanizing line might be installed in the cold mill plant. Thereofre, in planning the layout of the plant, attention must be given to the progress of techniques and the trend of demand, and to prevent excessively complicated arrangement which may hinder future development of the plant.

As the area of 240 hectares for the proposed plant site is large enough to accommodate even 3 million tons year plant, if necessary, it is considered necessary to have a clear and definite vision for the future of the plant.

5. In the paragraph of "Rough Estimation of Construction cost for One Million T/year Plant" and the "Production flow chart" mentioned above, it was proposed to install one mill of blast furnace of 2700 T/day (2,000 m^3) and two converters of each cap. 90 T/ch. The proposal was made for the following reasons with paragraphs 4 above taken into consideration.

(1) To utilize costly land as effectively as possible.

(2) To reduce construction cost.

(3) To reduce the number of operating personnel.

(4) To reduce unit consumption and to increase productivity.

6. In the preceding paragraph, a mold making method by pouring smelt pig iron from the blast furnace was proposed, because it quickens the turn over of the capital, though it may increase the cost of construction and required more workers.

7. In order for Taiwan to realize production more than its domestic demand and to contribute to the regional cooperation, the Government project for the integrated steel plant should be changed so that the initial production will be 1.5 million tons annually instead of 1 million tons.

After such change are made, the production capacity at the final stage of integrated steel plant will be 3 million tons instead of 2 million tons.

Comparison between Demand-Domestic capacity-Estimated Import & Export of Flat Products in Taiwan
at 1.5 million tons capacity of steel ingot

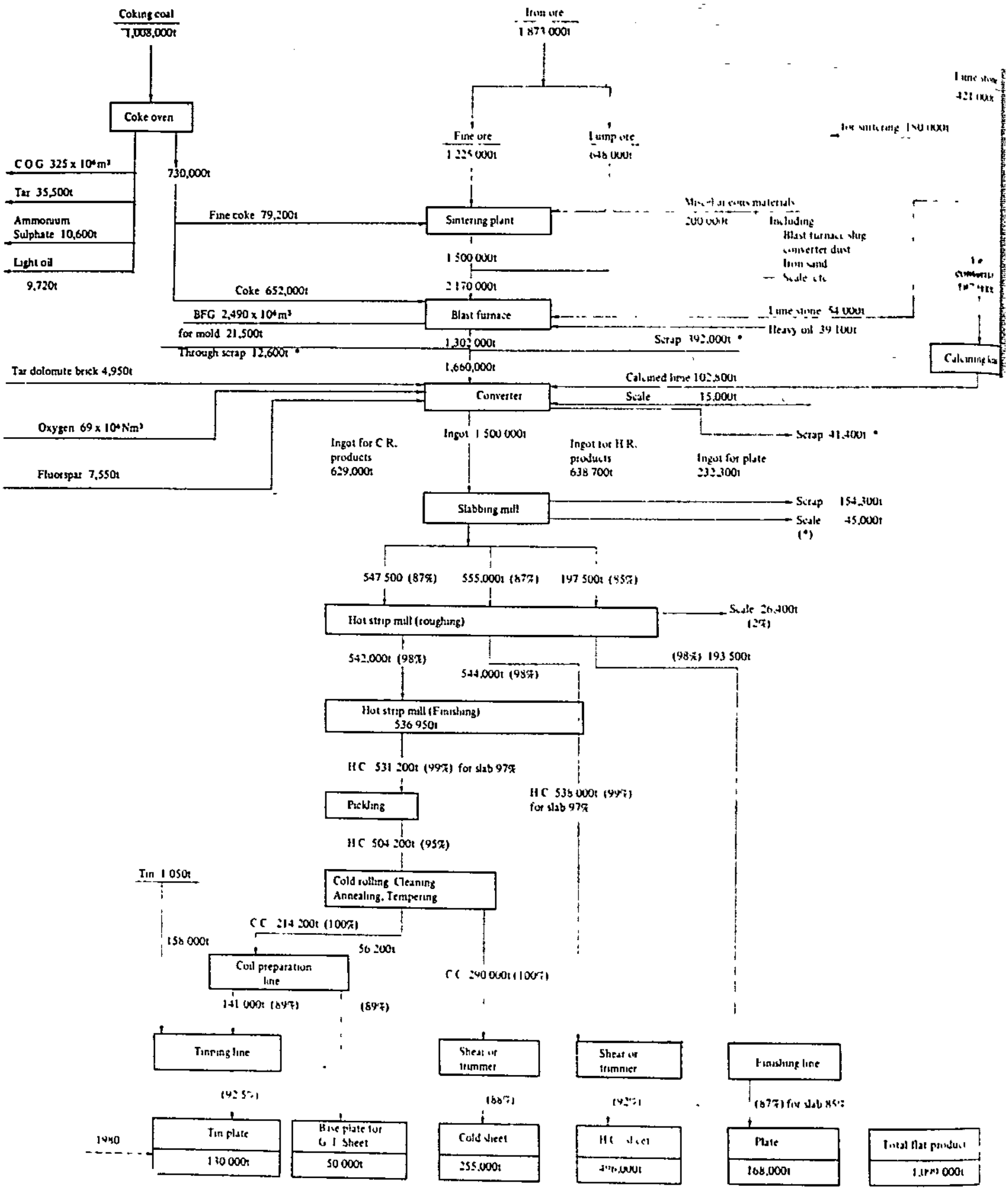
(Unit 1,000 ton)

Year	Domestic Demand			Required Hot Coil for (b) & (c) (as roll)	Production Capacity		Import			Export	Remarks
	Plate	HR Sheet Strip Hoop	HR Sheet Strip, Hoop GI Sheet, Tin Plate		Hot Coil (as roll)	Plate (a-f)	Slab (e)	Plate (f)	Hot Coil (as roll)	Hot Coil (as roll)	
	(a)	(b)	(c)	(d)	(d)	(a)'	$\frac{d}{0.97}$ or $\frac{d-d'}{0.97}$	a-20 or ax0.23	d-d'	d'-d	
1970	76	96	173	318	–	20	–	56	318	–	
1971	93	109	203	369	–	20	–	73	369	–	
1972	101	119	220	400	–	20	–	81	400	–	Cold mill completed.
1973	105	132	238	436	–	20	–	85	436	–	
1974	117	138	255	463	(1,180) (463)	90	(478)	27	–	–	Hot mill completed
1975	125	147	273	495	(1,170) (495)	96	(510)	29	–	–	
1976	157	158	315	570	(1,140) 1,078	121	–	36	–	508	Completion of integration (1.5 million tons)
1977	173	172	345	608	(1,130) 1,075	133	–	40	–	467	
1978	188	187	375	662	(1,110) 1,072	145	–	43	–	410	
1979	203	202	405	715	(1,100) 1,070	156	–	47	–	355	
1980	218	217	435	767	(1,090) 1,069	168	–	50	–	302	
1985	333	332	665	1,168	(990) 1,045	256		77			Completion of integration (3 million tons)

(Note) 1. Figures not parenthesized in the column (d') show production on the basis of 1.5 million T/Year ingot supply

2. Note 1, 2 and 3 of the preceeding table are applicable to this table

Production Flow Chart at 1.5 Million Tons Capacity of Steel Ingot



4.2.6 Estimate of Production Cost

Output: 1,008,000 tons of steel ingot
719,000 tons of steel product

Items	Quantity (T)	Unit Price (US$)	Amount (US$1,000)	Remarks
1. Raw material			46,711	*1
Imported coking coal	504,600	23.23	11,722	
Domestic coking coal	168,200	16.30	2,742	
Imported lumps ore	432,000	15.84	6,843	
Imported fine ore	817,200	14.71	12,021	
Lime stone	280,700	3.50	983	
Heavy oil	129,264	30.00	3,878	
Iron sand	21,600	10.00	216	
Fluorspar	5,040	43.00	217	
Tin	1,050	4.466.00	4,689	
Others	—	—	3,400	
2. Operation cost			34,491	
Wages	4,700		6,566	*2
Depreciation			12,875	*3
Repair & maintenance			5,150	*4
Electric power	10^3KWH 320,400	0.00764	2,458	
Water	43,500,000T	0.03	1,305	
Moulds & rolls	2,612T	550.00	1,437	*5
Pickling material			300	
Refractories			900	
Others			3,500	
3. By-products (credit)			(-) 1,717	
Returned scrap	15,800T		(-) 553	
Tar	23,640		(-) 709	
Ammonium sulphate	7,080		(-) 164	
Light oil	6,480		(-) 291	
4. Production cost			79,485 (US$ 110.55/ton)	

Note: *1 The unit prices of imported materials are calculated by adding current customs tariffs and charges to CIF prices.

*2 5% annual escalation is estimated.

*3 Total investment is US$206 million; average service life of 16 years, culculated by straight line method.

*4 25% of construction cost is alloted.

*5 1080 T/month of mould and accessories is to be produced internally.

*6 Average per ton cost is US$110.55.

4.2.7 Profitability study and recommendations

The following is a general description of anticipated financial aspect of an integrated steel plant under the conditions mentioned previously, including some assumptions. It is hoped that these estimates are regarded as those aimed for an average plant and not for a particular plant in Taiwan.

Financial Plan

(1 million ton of steel ingot)

(unit: US$1,000)

Fund Required		Source of Fund	
1. Land	7,000	1. Capital	110,000 (40%)
2. Construction cost	206,000	2. Foreign long term loan	123,000
(Imported machineries)	(123,000)	3. Domestic loan	38,000
(construction works)	(83,000)	(Long term loan)	(38,000)
3. Engineering services	6,200	(Short term loan)	(–)
4. Training expenses	800		
5. Prestart-up expenses	2,000		
6. Organization expenses	3,000		
7. Interest during construction period	15,000		
8. Working capital	31,000		
Total	271,000	Total	271,000

Note:
1. Engineering service fee is estimated at 3% of construction cost.
2. Training expense is estimated for 300 employees including engineers, foremen, and workers for a period of 6 months.
3. Prestart-up expenses include estimated total expenses for base plate, raw material, spare parts, consumable supplies, wages required during prestart-up period.
4. Organization expenses include such expenses for inauguration of the company, opening of the office, research works, etc.
5. Interest during construction period is estimated for the period of three years. And the rate is assumed at 6-7/8%.
6. Working capital required is estimated on the basis: construction cost x 1.5% (≒ amount of sales for 4 months)

As stated previously, on the assumption that the construction of rolling section by step-by-step means during phase I through phase IV followed by integration, the cost required for the completion of the facilities having a capacity of 1 million ton crude steel during a period from phase I through phase III alone amount to US$206 million. As shown in the above table, the total fund required for an integrated steel plant is expected to amount such an anormous figure of US$271 million, procurement of which is expected to be very difficult. To solve this difficult financial problems and to prevent possible suspension of the project, it is necessary to adopt following steps for mapping out a concrete working plan.

(1) Accurate estimation on the demand for steel products in the future.
(2) Concrete plan as correctly as possible.
(3) Prospect of situations (in relation to profit and loss, fund, and plant expansion) classified by years.
(4) Clearer indication of policy of the Central Government and other agencies.
(5) Legislative measures on basic matters, if necessary.

The availability of fund can be studied only after these steps have been taken. The Taiwan Government is presently studying measures for the protection and promotion of steel industry, taking into account the points mentioned above.

The amount of capital of an enterprise should be determined according to the nature and the form of the enterprise. Particularly for the enterprise requiring such huge capital as in steel making industry, investment equivalent to about 40 – 50% of the gross capital is generally considered appropriate for the initial stage of operation.

The amount of foreign credit was estimated for the amount deemed necessary to cover the import in the construction cost. It is considered that substancial part of the required fund to cover import must depend on the foreign credits. In this connection, combined use of the followings may be considered.

(1) Japanese yen currency credit
(2) ADB Development fund
(3) Makers' credit

Estimate of Profit and Loss

(1 million ton of steel ingot)

Though the estimation of production cost has already been made, the estimate of price has an important bearing in the estimate of profitability.

In Taiwan where, a large portion of demand has been met by the import due to insufficient facilities for the production of flat products, the price of imported products may be taken as the basis for profitability study. But for the estimation of profit and loss, the amount of sales has an important bearing. The following estimate was made on sales on the basis of CIF price of various products which are considered to be international standard price.

Plates	168,000TY x 95.00$ = 15,960
Hot rolled sheets (including H.C.)	166,000 x 92.00 = 10,672
Cold rolled sheets	225,000 x 117.00 = 69,835
Galvanized sheet	50,000 x 152.00 = 7,600
E.T. Tin sheets	130,000 x 217.00 = 28,210
Total	719,000(128.34) 92,277

(Estimated Profit and Loss)

(Unit: 1,000US$)

1. Estimated sales revenue	92,277	(100%)
2. Total production cost	(–) 79,485	
3. Gross profit	12,792	(13.9)
4. General administrative and selling expenses	(–) 4,614	5% of sales (including sales tax)
5. Operating	8,178	(8.9)
6. Non-operating expenses	(–)13,504	
Interest	(9,144)	
Miscellaneous losses	(4,360)	Amortization of deferred assets (divided equally for 5 years)
7. Net profit (before tax)	(–) (5,326)	

Even when the production reaches full capacity of 1 million ton of steel ingot, considerable deficit is expected to be inevitable as the production unit is relatively small compared with the amount of capital investment.

Incidentally, the above table shows a static figure of a steel plant of 1 million ton capacity at a certain period and by no means shows a dynamic figure of the plant through the period of construction and operation.

Though it may differ depending on the way the construction is implemented, a period of five to six years may inevitably elaps before the plant is put in full operation. In that case it is evident that fixed expenses such as the interest and depreciation expenses will be such an enormous amount which will never be covered by the production and profit at the start-up period, and an accumulated deficit of about US$15 – 20 million will be unavoidable.

This means that even at the period of full operation of the plant, favorable turn of profitability may not be expected and moreover, because of overlapping with the timing for additional investment for expansion of the plant to 2 million ton capacity, it is expected to encounter considerable difficulty unless some measures are to be taken.

Apart from its applicability to Taiwan, the establishment and operation of an integrated steel plant requires not only techniques in steel making but also high technical standard in related industries.

Therefore, in planning the construction of a steel plant, it is of prime importance to anticipate operating difficulties in these respects and the resultant factors for the increase in production cost.

Especially, in view of the recent tendencies of the world toward larger scale of steel industry, the plant having a production capacity of one to two million ton will not be able to survive international competition unless being favored by excellent conditions peculiar to that country such as favorable supply of raw material and labor force.

The reason the country desires to establish a new steel plant, inspite of all the anticipated difficulties, may be that the country wishes to make the steel industry as the nucleuse of national industry in preparation for industrial development of the country.

In such a case, adequate protection and promotion measures of the Government will be required at the initial stage even when the project is to be managed by private sector. And until such time as the domestic demand exceeds the production and the facilities operate to the full capacity, Government aid to relieve the problems of deficit and fund to the maximum extent possible will be indispensable.

B THE PHILIPPINES

B THE PHILIPPINES

B.1 Present Situation and Future Prospect of Demand for Steel Products

B.1.1 Forecast of demand for steel products

The economy of the Philippines had made a rapid recovery in the post-war period. The production in the country had already reached its pre-war level in 1949 but the government is presently working out a new 4 year Economic Program for the Philippines (1967 – 1970) with the aim of promoting further industrialization and also of the balanced development of both the industry and the agriculture centering on the public works. Real growth rate of economy in 1950's was over 6% but the growth rate in the past several years dropped to around 4%. Average growth rate recorded during the period from 1962 to 1966 was 4.6%. However, the growth indicated an increasing tendency for capital investment in relation to the demand for steel products. Therefore, it is expected that with the further accumulation of social overhead capital and industrialization, the rate of steel products in demand will increase accordingly.

The ratio of the fixed capital formation
to the Philippines' gross national expenditure

Yr.	%
1953	7.1
1955	7.2
1960	10.1
1961	12.9
1962	12.6
1963	12.9
1964	14.7
1965	14.0

(Note) Internal fixed capital formation is the gross of the housing investment, private enterprise facilities investment and government capital formation.

Reflecting the movement of the general economy of the Philippines, the growth rate of the annual steel consumption in the period of 1958 to 1966 was as high as 11.3 per cent (15% in the past five years from 1962 to 1966).

Steel consumption growth ratio as against GNP in the period of 1958 to 1966 was 2.45 and in 1962 to 1966, 3.26.

The above fact indicates that the consumption and investment of the Philippines' national economy are increasingly turning into the steel consumption type, serving to prepare the foundation for that country's future industrial development. Thus, it may be said that the Philippines has potential for a greater growth of demand for steel. Based on the foregoing, the future demands for steel is estimated to be as follows:

Table 1. Actual demand for steel products in the Philippines and prospects of futu e demand

(Unit: 1,000 ton)

	1964	1965	1966	1967	1970	1971	1972	1973	1974	1975	1980	1985
Total steel products	547	565	563	734	965	1,047	1,130	1,213	1,295	1,378	1,837	2,370
Flat products	274	289	283	417	481	517	555	593	631	671	882	1,134
Others	273	276	280	317	484	530	575	620	664	707	955	1,236

B.1.2 Forecast of demand for flat products

1.2.1 Forecast of demand for flat products

One of the features of the Philippines' steel consumption is that the consumption ratio of flat products is so high as accounting for nearly 50% of the total steel consumption, and consumption of cold rolled sheets is 1.3 times that of hot rolled sheets. This is attributed to the fact that demand is big for galvanized sheets for roofing and tin plates for conniny and containers.

Table 2. Percentage breakdown of flat products to total steel consumption

(Unit: %)

	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967
Hot rolled flat products	9.3	13.6	12.2	11.3	12.0	14.4	16.1	14.8	12.9	20.5
Cold rolled flat products	35.3	39.5	40.6	41.9	38.8	36.2	33.6	35.0	34.1	39.6
Total flat products	44.6	53.1	52.8	53.2	50.8	50.6	49.7	49.8	47.0	60.1

Demand (= imports) of flat products have grown from 135,600 tons in 1958 to 283,300 tons in 1966, or 2.09 fold increase, and an average annual growth rate of 9.7%. (a 3.08-fold increase, or 13.3 percent per annual from 1958 to 1967). The ratio of flat products consumption to that of total steel products it, as is shown in the above table, showing a decreasing tendency. However, of the flat products consumption, hot rolled flat products are increasing the ratio, reflecting the fact that industries of this country are moving toward producing heaver produce goods. This movement is estimated to continue in the future.

Table 3. Import of Flat products

(Unit: 1,000 ton)

	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967
Hot rolled products										
Plate	7.9	19.2	18.1	15.8	21.5	27.3	35.9	42.2	33.9	70.2
Sheet	8.5	4.6	8.9	8.2	7.3	14.5	39.6	15.0	14.6	9.7
H.R. Hoop, Strip	3.0	5.2	4.9	2.9	1.5	6.7	9.0	9.9	10.5	32.7
Welded Pipe	9.5	11.5	10.3	18.5	8.8	17.0	14.7	19.1	18.8	31.3
Sub-total	28.9	40.5	42.2	45.4	39.1	65.5	99.2	86.2	77.8	143.9
Cold rolled products										
C.R. Sheet	47.1	70.8	70.3	88.3	77.7	99.3	125.9	157.6	168.4	222.6
C.R. Hoop, Strip	0.7	2.5	1.7	1.6	1.1	2.4	2.5	2.1	2.0	2.4
G.I. Sheet	20.5	4.1	4.1	8.5	2.5	5.9	5.1	4.0	2.6	2.2
Tin Plate	38.2	42.4	63.5	68.8	45.1	58.1	40.0	36.8	31.9	41.0
Others	0.2	0.6	0.4	1.0	0.5	0.7	0.8	2.0	0.6	5.3
Sub-total	106.7	120.4	140.0	168.2	126.9	166.4	174.3	202.5	205.5	273.5
Total flat products	135.6	160.9	182.2	213.6	166.0	231.9	273.5	288.7	283.3	417.4

Data: The Japan Iron and Steel Federation

From the above data, the future ratios of flat products are forecast as follows:

Table 4. Prediction of ratios of flat products
to overall demand for total steel products

(Unit: %)

	1968 – 70	71 – 75	76 – 80	81 – 85
Hot rolled products	15	16	17	18
Cold rolled products	35	33	31	30
Total flat products	50	49	48	48

(Note) Hot rolled products ..... include plates, sheets, hot rolled hoops, strip and welded steel pipes.

Cold rolled products .... include cold rolled sheets, cold rolled hoops, strip, galvanized sheets, tin plates and others surface coated sheets.

Table 5. Forecast of demand for flat products

(Unit: 1,000 ton)

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1985
Hot rolled products												
Heavy plates	60	66	72	78	84	92	99	107	114	121	130	176
Medium plates, and sheets	87	95	104	113	122	132	143	153	164	175	187	254
Total	147	161	176	191	206	224	242	260	278	296	317	430
Cold rolled products												
Cold rolled products	40	44	49	53	58	62	67	72	77	82	87	134
Galvanized sheets	170	179	188	197	206	215	225	235	245	255	265	320
Tin plates	119	127	135	144	152	160	167	174	181	188	198	230
Others	5	6	7	8	9	10	11	12	13	14	15	20
Total	334	356	379	402	425	447	470	493	516	539	565	704
Total flat products	481	517	555	593	631	671	712	753	794	835	882	1,134

1.2.2 Market situation and prices

At present the Philippines is producing galvanized sheets and tin plates, but base plates are all imported. Their details are as follows:

(a) Price: Plate about US$100 per M.T., C & F Manila

(b) Size:

3/16" x 6' x 20'		(4.76 mm)
1/4" x 6' x 20'		(6.35 mm)
5/16" x 6' x 20'		(7.93 mm)
1/4" to 7/8"	6' x 20'	(6.35 – 22.2 mm)
1/4" to 5/8"	6' x 30'	(6.35 – 15.8 mm)

(c) Quality: ASTM grades A - 7 or A - 36

(d) Miscellaneous charges to be added to the C & F value

Customs Duty 15% add value

Documentary Stamps	P 5.75 per entry
Wharfage	P 200 per metric ton
Arrastre	P 7.50 per metric ton
Stevedoring	P 2.10 per metric ton
Brokerage Fees	Variable
Warehousing	P 7.00 per entry
Advance Sales Taxes	7% of 125% of landed cost
Freight (pier to warehouse)	P 7.50 per metric ton

Source: Board of Investment's data, June 1968

B.1.3 Forecast of demand for billets

Billets are used for the production of bars, wire rods and small size shapes, so that the demand for them are influenced by the production of the above steel products. The actual results of their demand and supply in the past ten years are shown as follows:

Table 6. The actual demand and supply for shapes, bars, wire rods, and wire products

(Unit: 1,000 ton)

		1958	1959	1960	1961	1962	1963	1964	1965	1966	196
Structural Shapes and Sections	Import	19.9	12.5	10.5	7.4	16.3	22.6	63.9	30.4	9.4	16.
	Production	–	–	–	–	–	–	–	–	0.6	6
	Export	–	–	–	–	–	–	–	–	–	-
	Apparent consumption	19.9	12.5	10.5	7.4	16.3	22.6	63.9	30.4	10.0	22.
Bars and Rods	Import	28.0	17.0	22.4	35.5	29.7	28.4	45.8	51.2	73.4	78.
	Production	60.1	59.4	71.7	83.8	80.9	94.6	99.6	124.3	132.7	151
	Export	–	–	–	–	–	–	–	–	–	-
	Apparent consumption	88.1	76.4	94.1	119.3	110.6	123.0	145.4	175.5	206.1	229.
Wire and Wire Products	Import	40.4	40.0	35.6	54.8	31.7	30.3	43.4	38.5	25.2	14.
	Production										
	Export										
	Apparent consumption										
Total	Import	88.3	69.5	68.5	97.7	77.7	81.3	153.1	120.1	108.0	108.
	Production	60.1	59.4	71.7	83.8	80.9	94.6	99.6	124.3	133.3	157.
	Export	–	–	–	–	–	–	–	–	–	-
	Apparent consumption (A)	148.4	128.9	140.2	181.5	158.6	175.9	252.7	244.4	241.3	266.
Production Apparent Consumption %	Structural Shapes and Sections										
	Bars and Rods	68.2	77.7	76.2	70.2	73.1	76.9	68.5	70.8	64.4	66
Apparent consumption of total steel products (B)		303.2	311.7	337.7	414.9	339.7	442.1	346.7	565.0	563.0	734.
(A)/(B) %		48.9	41.4	41.5	43.7	46.7	39.8	46.2	43.3	42.9	36

Data of Philippines government and The Japan Iron and Steel Federation

Table 7. Forecast of Demand and Supply for Shapes, Bars, Wire Rods and Wire Products

(Unit: 1,000 ton)

		1960	1966	1970	1975	1980	1985	1970/1966		1975/1970		1980/1975		1985/1980	
								magnification	annual magnification	magnification	annual magnification	magnification	annual magnification	magnification	annual magnification
Total of steel products	Apparent consumption (A)	337.7	563.0	965	1,378	1,837	2,370	1.71	14.4	1.42	7.4	1.33	5.9	1.29	5.2
Structural Shapes and Sections	Import	10.5	9.4	–	1	20	26	--						1.30	5.4
	Production	–	0.6	60	80	100	120	100		1.33	5.9	1.25	4.6	1.20	3.7
	Export	–	–	–	–	–	–	–							
	Apparent consumption	10.5	10.0	60	81	120	146	600.0		1.35	6.2	1.48	8.2	1.21	4.0
Bars and Rods	Import	22.4	73.4	55	51	24	10								
	Production	71.7	132.7	295	460	650	880	2.22	22.1	1.55	9.3	1.41	7.2	1.35	6.3
	Export	–	–	–	–	–	–	–							
	Apparent consumption	94.1	206.1	350	511	674	890	1.69	14.1	1.46	7.9	1.31	5.7	1.32	5.7
Wires and Wire Products	Import	35.6	25.2	10	8	6	4								
	Production														
	Export														
	Apparent consumption														
Shapes, Bars, Wire Rods, Wire Products Total	Import	68.5	108.0	65	60	50	40								
	Production	71.7	133.3	355	540	750	1,000	2.66	27.8	1.52	8.7	1.38	6.8	1.33	5.9
	Export	–	–	–	–	–	–	–							
	Apparent consumption (B)	140.2	241.3	420	600	800	1,040	1.74	14.9	1.42	7.4	1.33	5.9	1.30	5.4
(B)/(A)	%	41.5	42.9	43.5	43.5	43.5	43.9								

The melting capacity of the Philippines is considerably large, but the country in the recent years has been importing large amounts of billets each year. It is because the imported billets are relatively cheap as the supply of domestic scrap is limited and the price of imported scrap is high

Estimates of actual demand for billets

(Unit: 1,000 ton)

		1958	1959	1960	1961	1962	1963	1964	1965	1966
Structural Shapes and Sections	Production	–	–	–	–	–	–	–	–	0.6
Bars and Rods	Production	60.1	59.4	71.7	83.8	80.9	94.6	99.6	124.3	132.7
Total	Production	60.1	59.4	71.7	83.8	80.9	94.6	99.6	124.3	133.3
Theoretical Amount of demand for billets	(94%)	64	63	76	89	86	101	106	132	142
Domestic production of steel ingots		74.1	74.2	88.9	101.4	100.0	95.9	57.8	74.8	
Import of billets		1.0	–	0.7	6.2	1.0	36.1	94.3	104.5	119.1

Source: Philippines Gov't data, and ECE-UN data

Future demand for billets depend on the tendency of demand for the above three products. But with the advance of industrialization, demand for bars and wire rods are expected to gradually increase, in order to meet which establishment of suitable production facilities will come to be needed. Based on this assumption, the following forecast is made of the increasing production of these steel products.

Forecast of demand for billets

(Unit: 1,000 ton)

	1960	1966	1970	1975	1980	1985
Production of shapes, bars and wire rods	71.7	133.3	355	540	750	1,000
Conversion into demand for billets, yield: 94%	76	142	378	574	798	1,064

Estimation of the import requirement for billet is difficult for it depends on the international market conditions of scraps and billets as well as the Philippines' protective measures for domestic open-hearth and electric furnace makers.

Size and price of imported billets and customs duties

(based on data of Board of Investments)

Sections	Lengths
80 x 80 mm	10 m to 13 m
70 x 70 mm	5 m to 7 m
100 x 100 mm	1.5 m to 6 m
63 x 63 mm	1 m to 4 m

Quality: Typical analysis of imported billets

1. Carbon Content – 0.08 – 0.13%

   Tensile strength max. – 50 Kg/mm^2

2. | | | | | |
   |---|---|---|---|---|
   | C | – | 0.15 | – | 0.20% |
   | Mn | – | 0.45 | - | 0.60% |
   | P | – | 0.06 | – | max. |
   | S | – | 0.06 | | max. |
   | Si | – | 0.35 | | |

Duty: Billets enter the Philippines duty free

Price: Range – $73 – $77 per ton C & F Manila

B.2 Present Situation of Iron and Steel Industry in the Philippines

At present, there are five major steel manufacturers in the Philippines. All of these plants are now producing only small ingot by melting scrap with electric arc furnaces and are rolling the ingot to produce reinforced bars and wire rods. Besides, there are 23 small plants which are engaged in mere rolling because of lack of melting facilities. In addition, there are five galvanizing plants which are operating only about 50 to 60% of their capacity because of shortage of base plate supply.

Main production capacity is as follows:

		Steel making Capacity (T/Y)	Hot rolling Capacity (T/Y)	
1	Iligan (NASSCO)	70,000	45,000	
2	Marcelo Steel	36,000	129,000	
3	Philippine Blooming	36,000	40,000	286,200
4	Central Steel	35,000	45,000	
5	Union Steel	7,500	27,200	
6	Mar Steel and Others	–	94,000	
	Total	184,500	380,200	

		Galvanizing Capacity (T/Y)			Tinning Capacity (T/Y)
1	Puyat Steel	60,000	1	Elizalde	72,000
2	Jacinto Steel	54,000			Rolling Capacity
3	Southern Industrial	48,000			Cold (T/Y)
4	Bacnotan Cement	25,000	2	Southern Rolling	
5	Davao Steel	24,000			120,000
	Total	211,000			

		Pipe & Tube making cap. (T/Y)			Electric pig iron making (T/Y)
1	Republic Steel	48,000			
2	Super Industrial	11,000	3	Panganiban	
3	Union Tubes & Pipe	11,000		Smelting	12,000
4	Goodyear Steel Pipe	6,000			
5	International Pipe	18,000			
	Total	94,000			

B.3 Raw Materials, Power, Water Supply etc.

(1) Iron ore: The Philippines has six iron ore mining companies, of which the largest is the Philippines Iron Mines, its yield accounting for 60% of the total production of iron ore in the country.

The amount of its deposits was estimated at about 3,000 million ton as of the end of 1965.

The quality and deposits of the ore are roughly assessed as follows:

Hematite and Magnetite	Fe 39 – 64%	97 million tons
Titaniferrous Magnetic Sand	Fe 53 – 60%	17 million tons
Laterite	43%	2,800 million tons
Total		2,914 million tons

The total production of iron ore in 1966 was 1,467,000 tons in quantity and 56 million Pesos in value. Nearly all of them are exported to Japan today.

(2) Coal and coke: The Philippine's coal industry has been rebuilt for the military industries after World War II, with an annual output of 50,000 tons maintained. This industry has since been progressively expanded on strength of Japan's war reparations, etc., including the development of the Malangas Mine at Cebu in 1951 by the hands of the Portland Cement Company as a governmental undertaking. At present, twenty-four small and medium coal mines are being operated, though intermittently, but with rationalization being limited, their operating scales are also limited.

The presumed amount of deposits of coal in the Philippines was 75,000,000 tons or so as of December 1964. As for the production amount of coking coal (12,270 – 13,900 BTU) in the Philippines, it is only 10,000,000 tons produced by the aforementioned Malangas Mine.

The consumption amount of coal in 1965 inclusive of imported coal – was about 94,000 t/yr, and that of coke was no more than 23,000 t/yr. In the near future, however, increases in their demands are expected for use at Iligan Steel Mill (121,500 t/yr), Santa Ines Steel Corp. (182,000 t/yr), J. Panganiban Smelting Plant (42,000 t/yr), and Filmay Carbo-electric Pig Iron Plant (28,000 t/yr). To meet such increases in demands for coke, CEPOC Foundry Coke Plant is expected to put its Malangas beehive oven into operation for a daily production of 60 tons of coke.

(3) Limestone: This mineral is found in various places in the Philippines in large amount. Even the mines alone already development, are enough to supply the necessary amount of limestone for the domestic industry. Its yield in 1966 was 2,400,000 tons and its deposits as of the end of December 1965 were assumed to total 5,800 million tons.

(4) Electric Power: The Philippines is endowed with abandant water resources that can be converted and utilized for electric power generation. The National Power Corporation has installed a hydro-capacity of 316,000 KW out of the 341,000 KW generated capacity of all hydro-electric plants in the country. Total energy generated by all hydro-electric plants has reached 1,554 MKH in 1964 or 41% of the total energy generated for electric power The geographical distribution of generated hydro-electric capacity provides 209,500 KW in Luzon, 1,400 KW in Visayan and 54,700 KW in Mindanao.

The electric power available from principal rivers in the Philippines is estimated in Table below. The Maria Cristina Hydro-electric Plant in Mindanao was already installed two 23,000 KW generating units. Installation cost and additions to the transmission plant required a total investment of P12.3 million. Energy available is 430 million KWTT per year. Maria Cristina is constructing a third unit, a 50 MW unit, which will raise its capacity to a total of 100 MW and the energy available at 780 million KWTT per year.

Electric Power Available on Principal Philippine River

River	Location	Electric Power Potential (KW)
Agno	Luzon	420,000
Abulug	Luzon	120,000
Agus	Luzon	10,000
Agus	Mindanao	750,000
Angat	Luzon	230,000
Marikina	Luzon	70,000
Cbico	Luzon	75,000
Magat	Luzon	90,000
Ulut	Samar	45,000
Pulangi	Mindanao	175,000
Alat	Mindanao	15,000

B.4 Flat products rolling Mills in the Philippines and Expansion Plan

In the Philippines three makers are engaged in the production of hot and cold rolled sheets. Their details are as follows:

Cold mill (1) The Philippine has one existing cold mill with a rated capacity of about 120,000 MT/yr. for the production of cold rolled sheet for galvanizing Southern Rolling Mill.

(2) The construction of two other cold rolling mills is underway. One plant, the Elizalde Iron and Steel Corporation, will have a capacity of 140,000 MT/yr. and majority of production shall be in the form of black plates and the rest for galvanized sheet manufacture. The second plant, the Iligan Integrated Steel Mills, Inc., shall have a 4-stand continuous cold mill and is expected to be operational by the early part of 1969 with an initial annual production of 210,000 MT of cold rolled sheet.

Hot mill (3) The Iligan Integrated Steel Mills, Inc. is also presently laying the foundation for the hot mill for the production of hot rolled coils and light plates. This mill is expected to start production by 1970.

Now, the thesis imposed on us is to study the cooperation between regions for the production of hot rolled coils and plates. In this connection we shall describe briefly on the above (1) and (2), within our knowledge about them, and give a little more detailed account, particularly, on Iligan Integrated Steel Mills which was central of our interest.

B.4.1 Southern Rolling Steel Corporation

We were unable to inspect the Southern Rolling Mill because lack of time. For this reason we can't elaborate any further than stated above.

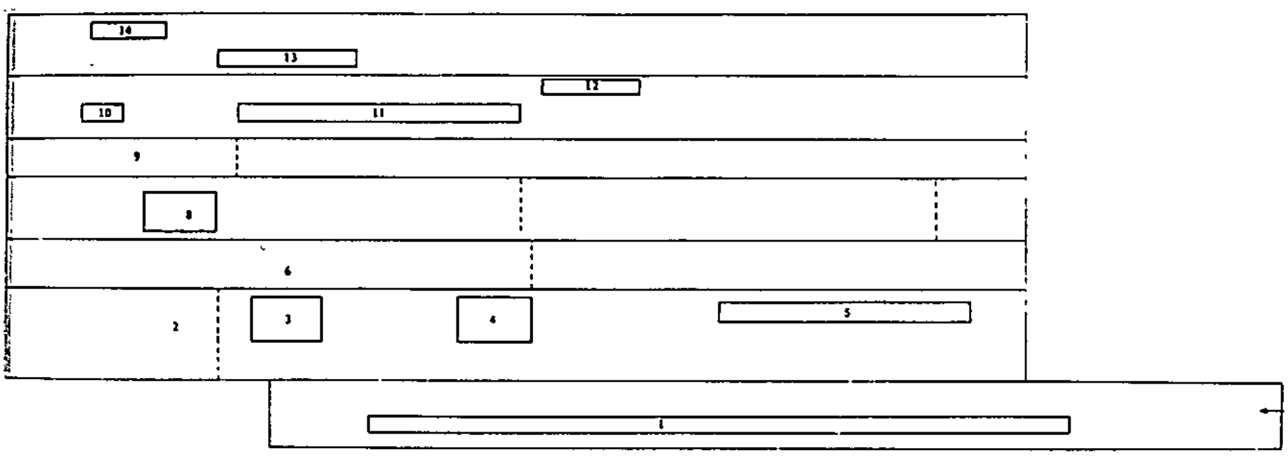
B.4.2 Elizalde Iron and Steel Corporation (ELISCO)

The outline of the plant layout is as indicated in Fig. 1.

At the moment, the work for installation indicated in the layout as Nos. 1 through 9 and their attendant facilities, foundation laying and construction is being proceeded with. The plant is expected to start operation in 1969. The installations Nos. 10 through 14 are already in operation with imported cold coils as materials. These cold rolling mills are designed rationally after making a detailed study, but their production capacity cannot necessarily be said sufficient when it is only 140,000 t/yr.

Nevertheless, this plant, together with Iligan Integrated Steel Mills Inc's plant (to be described later), will become the Philippines' two major modern plants.

Fig 1 ELISCO Plant Layout (Main Equip)



continuous strip pickling line
rolls shop
4 high combination cold reversing mill
4 high cold reversing mill
electrolytic cleaning line
motor & electric room
annealing furnace

8 4 high 2 stands temper mill
9. machine shop
10. coil preparation line
11 electrolytic tinning line
12. inspection line
13 sheet shearing line
14 slitting line

B.4.3 Iligan Integrated Steel Mills Inc. (IISMI)

Below are given an outline of the information we had from the Philippines Government and the IISMI management and our assumption formed on the basis of such information:

4.3.1 Background

The Steel mill project was conceived by the Philippines Government in 1952 and the responsibility for developing the project was assigned to a government controlled corporation, the National Shipyards and Steel Corporation (NASSCO). On November 9, 1960, the responsibility for implementation of the project was transferred to private investors, the Jacinto Group, who later incorporated under name of Iligan Integrated Steel Mills, Inc. (IISMI). On January 22, 1964, IISMI was granted a loan of $62.3 M by the U.S. Export-Import Bank. On August 16, 1965, the properties of NASSCO in Iligan City were purchased and taken over by IISMI and construction of the integrated plant commenced.

4.3.2 Location

The plant is situated in Iligan City on north coast of Mindanao Island in southern Philippines. The location was selected because of the availability of cheap hydro-electric power from the Maria Cristina system. Iligan Bay opens into Mindanao Sea and provides a good harbor for ocean shipping. If we are allowed to give the two points we feel rather worried about, they are:

(1) The plant is rather too far from Manila, the greatest consumption center for the steel products in the Philippines;

(2) Availability of ground space being limited, difficulty will attend a future possible extention of the site when need arises.

4.3.3 Construction Steps and Facilities

IISMI's construction program can be divided roughly into the following four stages:

(1) First stage: This stage is devoted to the construction of the Marchant Mill, that is the mother body of IISMI, and the electric furnace to produce the said mill's Material, that is, small ingots, (which are already working smoothly), the main installations of which are as follows:

1. Demag 25-ton Electric Furnace for melting scrap, capacity 125 MT per day.

2. Merchant mill for reinforcing bars, average capacity 10 MT per

(2) The second stage is for the construction of the cold mill, which outline is as follows:

The plant is being constructed making the fullest use of Philippine personnel and Philippine contractors. When the plant is ready for operation, all foreign operating specialists shall be assigned Philippine understudies, who shall be trained until such time as they are fully capable of taking over the responsibility for the various operations.

Koppers International, C.A. and Koppers Company, Inc., as technical consultants, prepared the general engineering, supervised the procurement of machinery and the detailed design of the integrated plant. Koppers International is supervising the construction of the plant and shall supervise the commissioning of the completed plant. Koppers shall continue to advise and collaborate in the commercial operation, management, and administration of all the activities of IISMI. The cold mill and finishing facilities shall be constructed first and put into operation using imported semi-finished steel. The cold mill shall be operational towards the end of 1968. The cold mill is somewhat different in details from the Elizalde cold mill now under construction, but both cold mill become the country's most excellent equipment.

1. Deep water pier, 753 ft. (230 meters) long, with unloading crane for ore, coke and limestone.
2. Blaw-Knox Tandem Cold Mill. 4-stand, 66" wide, 1000/15000/15000/1750 HP main drive motors, finishing speed 1500 FPM. will can be expanded to 5-stand with a finishing speed of 3000 FPM.
3. Blaw-Knox Temper Mill, single-stand, 66" wide, driven by a 600 HP motor, maximum line speed 2000 FPM.
4. Blaw-Knox Hot Rolled Shearing and Trimming Line for coils 20" to 60" wide, 0.0625" 0.25" thick, line speed 50/150 FPM.
5. Blaw-Knox Hot Rolled Slitting Line for coils 20" to 60" wide, 0.0625" to 0.25" thick, line speed 100/300 FPM.
6. Blaw-Knox Continuous Pickling Line, entering coils 20" to 60" wide, 0.0625" to 0.25" thick, 28" I.D., 60" O.D., maximum coil weight 30,000 lbs. Pickling speed 75/250 FPM.
7. Blaw-Knox Cold Rolled Shearing and Trimming Line. Entering coils 0.02" to 0.0625" thick, 20" to 60" wide, 20" I.D., 60" O.D., 30,000 lbs.

maximum weight, 100/300 FPM line speed.

8. Blaw-Knox Alkali Cleaning Line. Entering coil 20" to 38" wide, 0.007" to 0.025" thick, 20" I.D., 60" O.D., 30,000 lbs. maximum weight, 350/1000 FPM line speed.
9. Blaw-Knox Electrolytic Tinning Line. Entering coil 0.007" to 0.025" thick, 20" I.D., 60" O.D., 30,000 lbs. maximum weight, 150/600 FPM line speed, 32,000 ampere maximum plating current.
10. Lee Wilson Annealing Furnaces consisting of twelve (12) furnaces and thirty-six (36) bases.
11. Roll Shop consisting of No.5 roll lathe, No. 55 and No. 28 roll grinders.
12. One (1) lot of overhead electric travelling crane.
13. General Facilities consisting of maintenance shop, quality control laboratory, warehouse, change houses, plant protection building, water pumping station and reservoir, railroad system and plant roads.
14. Initially, steam shall be generated in "package boilers". With the installation of the blast furnace, central station boilers shall replace the package boilers.

(3) The third stage is for the construction of the hot strip mill, for which foundation work has already begun, the outline of which is as follows:
The hot mill shall follow the cold mill and shall be completed in 1970. The hot mill will be operated on purchased slabs to produce hot rolled coils for the cold mill and light plates.

1. Soaking pits consisting of four (4) batteries of 4-cells.
2. Slab reheating furnace.
3. Blaw-Know Combination Blooming/Slabbing/Plate Mill, 114" wide, capable of handling ingots up to 33,000 lbs. maximum weight. Principal drive shall be two (2) General Electric 3500 HP D.C. motors.
4. Blaw-Knox Reversing Hot Strip Mill, 66" wide, driven by 5000 HP motor Delivered coils 28" I.D., 30,000 lbs. maximum weight or 500 lbs. per inch of width, thickness from 0.062" to 0.25".
5. One (1) lot of overhead electric travelling crane.

(4) The fourth period will see the construction of the iron and steel making facilities an outline of which is as follows:
Furthermore, the Iligan Steel Project shall be equipped with a blast furnace and basic oxygen converter plant by 1974. The iron and steel making facilities shall

be constructed after the hot mill. This will complete the integrated plant which shall process Philippine iron ore into steel products.

Among the improvements envisioned to increase production and efficiency are continuous casting and enlargement of the iron shop. The Iligan Integrated Steel Mills Project contemplates the installation of a continuous casting facility for the production of billets by 1975. The materials used here are slated to be obtained as follows:

There are iron deposits in the island of Mindanao, namely Sibuguey and Aurora in Zamboanga province and in southern Cotabato. Coal from Malangas, also in Zamboanga province, is suitable for blending with imported coal for the manufacture of metallurgical quality coke.

Limestone deposits abound in northern Mindanao. Iron ore pellets are available from the Philippine Iron Mines at Larap, in southern Luzon.

Agus River, some two kilometers from the plant, shall be the source of process water.

The presently-conceivable main facilities are as follows:

1. Conveyor system for pier to storage beds to furnace.
2. Blast furnace, 25 ft. (7.62 m) hearth diameter, complete with accessories. Hearth may be enlarged to 27 ft. (8.23 m) in the future.
3. Oxygen gas, coke and limestone shall be purchased from others during into intial years of operation.
4. Two (2) 60 MT B.O.F. vessels with auxiliaries.

   The abovementional program, if indicated in order of work, is as follows; and the outline of the IISMI facilities layout is shown in Fig. 2 and 3.

	1968	1969	1970	1971	1972	1973	1974	1975	1976	Remarks
merchant mill	———	———	———	———	———	———				----- under construction
cold mill	-----	———	———	———	———	———				——— under operation
hot mill	-----	-----	———	———	———	———				
iron & steel making						-----	-----	———	———	

4.3.4 Production plan prepared by IISMI

The earlier feasibility studies dated September, 1962 set an intial annual production target of 329,000 MT of ingots and 256,000 MT of finished products. Recent market studies however projected consumption of steel products to exceed one million tons by 1971, thus requiring up-dating of the IISMI production plans and facilities. The plant shall have an intial annual production of about 570,000 MT of ingot and 430,000 MT of finished products.

The plant has been designed with an ultimate capacity of more than a million tons of finished products. In view of the increase in productive capacity, a blast furnace shall be adopted instead of a battery of electric smelters.

The principal products shall be predominantly flat products consisting of tin plates, merchant bars, rebars, cold rolled sheets, skelps, hot rolled sheets and plates, billets and pig iron. The proposed intial product mix is tabulated in next table.

1969	Tin Plate	40,000 MT
1968	Merchant Bars	10,000
1972	Rebars	50,000
1968	Cold Rolled Sheets	70,000
1968	C.R. Sheets and Coils	130,000
1970	Skelp	60,000
1970	Sheets & Light Plates	70,000
	TOTAL	430,000MT

Fig 2 GENERAL ARRANGEMENT OF ILIGAN INTEGRATED STEEL MILLS, INC.

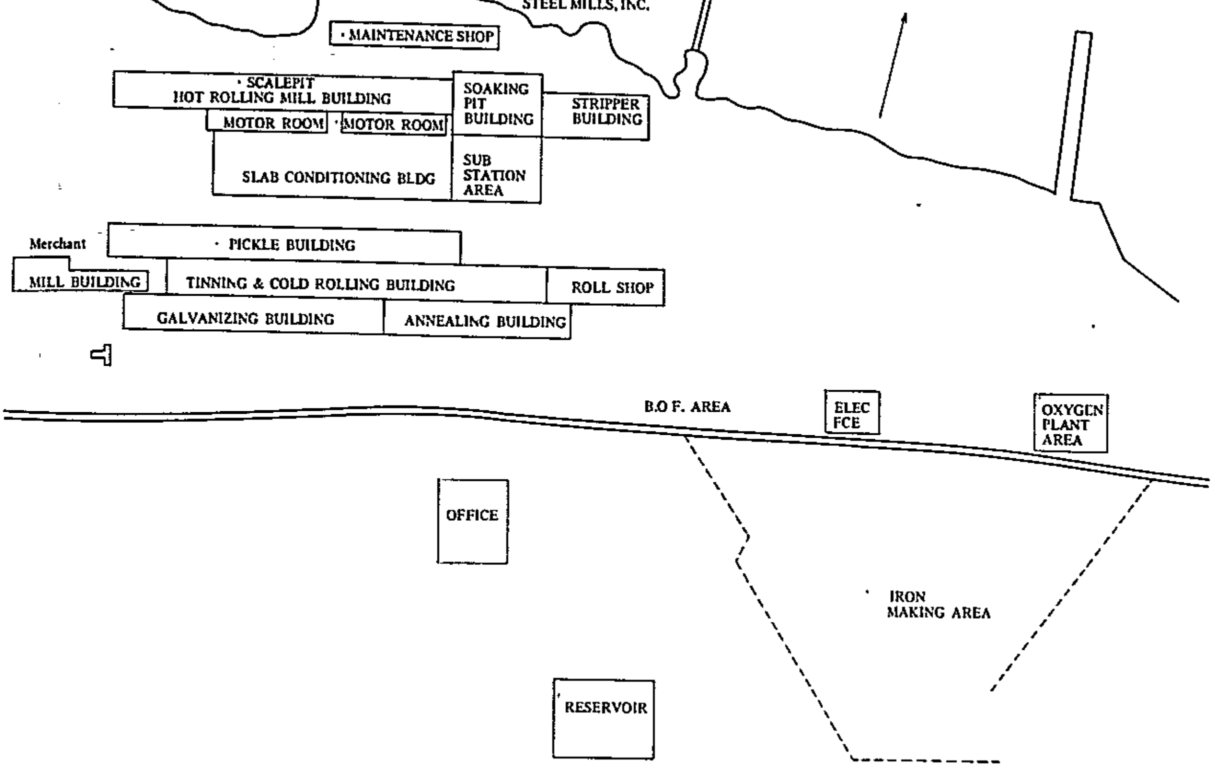
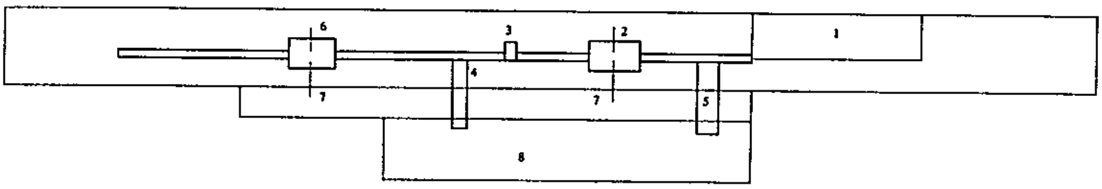
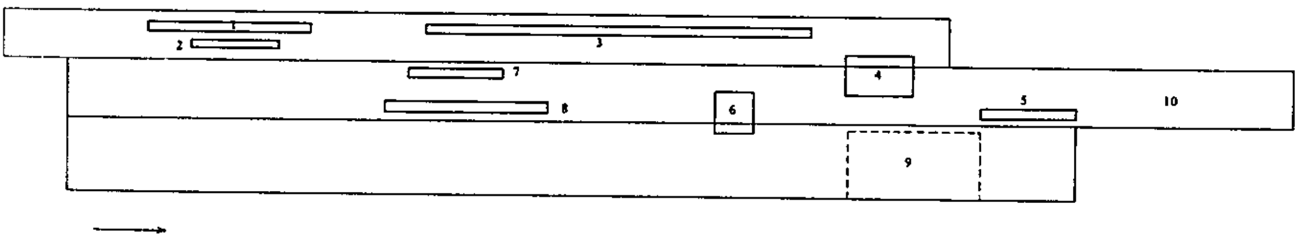


Fig 3 HOT MILL LAYOUT (size-no scale)



1 soaking pits
2 combination blooming/slabbing/plate mill
3 shear
4. slab transfer
5 slab reheating furnace
6. reversing hot strip mill
7. motor room
8. slab conditioning yard

COLD MILL LAYOUT



1 hot rolled shearing & trimming line
2 hot rolled slitting line
3 continuous pickling line
4 tandem cold mill
5 Alkali cleaning line
6 temper mill
7. cold rolled shearing line
8. electrolytic cleaning line
9 annealing furnace
10. roll shop

4.3.5 Our presumed production capacity of hot strip mill by this survey mission.

For study of regional cooperation, the determination of the capacity of HSMI's hot strip mill is most important and which we must be well familiar with. Unfortunately we could not obtain the detailed data necessary for it. But, based on the generally known facts, let us study the outline of its production capacity in the following:

(1) Production capacity according to the intial construction plan (in case of using ingot)

Assumption is made as follows from the contents of the facilities aforementioned (with one unit of the slab reheating furnace):

o When rolling ingot to slab:

230 t/hr (make ingot weight 10 t/piece mean)

o When rolling slab to plate:

90 t/hr (make slab weight 4.5 t/piece mean)

o When producing hot coils from slab:

60 t/hr (make slab weight 7 t/piece mean; in this case, however the combination mill itself has 250 t/hr or so, which is restricted by the capacity of the hot reversing mill)

o When breaking down:

250 (")

o Capacity of the hot reversing mill:

60 t/hr (")

(a) Combination mill

If working percentage is made 0.68:

Working time = 24 hr. x 30 days x 0.68

= 490 hr./month

If rolling hours from ingot to slab and from slab to breakdown are made 113 hr/month, 87% yield, and 377 hr/month, 87% yield respectively,

rolling production capacity is:

ingot to slab = 230 t/hr. x 113 hr. x 0.78

= 22.600 t/month (slab weight)

slab to breakdown = 60 t/hr. x 377 hr.

= 22.600 t/month (slab weight)

(b) Hot reversing mill

When operated in direct connection with the combination mill of (a), the working hour of this mill is 377 hr/month, and its working percentage 52%. This mill is put at rest when the combination mill is put to slabbing, so that the value 52% is approximate to the maximum of its working percentage. If it is expressed in equation:

Working time = 24 hr. x 30 days x 0.52 = 377 hr/month

Rolling amount of slab to hot coil

= 60 t/hr. x 377 = 22,600 t/month (slab weight)

If the yield is made 97%:

Hot coil production = 22,600 t/month x 12 months x 0.97

= 263,000 t/yr.

(2) Capacity according to initial construction plan (in case of using slab) in 1970 – 1974.

IISMI is slated to use, pending the completion of the iron & steel making facilities, imported slab as raw material, that is for the period of 1970 – 1974. Since it doesn't need rolling ingot to slab through the combination mill, it makes it possible to allot all the time for rolling to the integrated operation for breakdown in the combination mill and strip-rolling in the hot reversing mill, so that the coil production capacity can be elevated.

If the working percentage of the combination mill and the hot reversing mill is made 0.6 all along:

mill working time = 24 hr. x 30 days x 0.6 = 432 hr/month

Rolling amount of slab to hot coil = 60 t/hr. x 432 = 26,000 t/month (slab weight)

If the yield is made 97%:

hot coil production = 26,000 t/mon. x 12 mon. x 0.97

= 303,000 t/yr.

The total of finished flat products, according to IISMI's production program for the first period is 370,000 t/yr, which means that IISMI's planned production capacity is above our presumption.

However our presumption is a calculation made on the basis of an assumption, and so it unavoidably has some error. It is very desirable that IISMI's production capacity is greater than our presumption.

(3) Capacity of hot strip mill in and after 1975 if facilities are improved and expanded as planned.

Conceivable measures for improving the bottleneck for production under the initial plan are as follows:

1. To install one more unit of scale breaker;
2. To reduce the number of passing steps by setting up three additional stands;
3. To increase heating capacity by installing one more slab reheating furnace

(presumed capacity, 114 T/H/furnace; as there is no space for installing more than two heating furnace, it is effective to install ones with larger heating capacity; here, however, it is considered on the assumption that the same capacity heating furnaces are to be installed.)

With the above three measures adopted, the capacity of the hot reversing mill can be elevated to 120 t/hr., from which if the capacity of the mill is presumed:

(a) In case of combination mill:

Working time = 24 hr. x 30 days x 0.68% = 490 hr/mon. rolling time from ingot to slab 184 hr/mon., yield 87%; rolling time from slab to breakdown 306 hr/mon.

Rolling capacity:

from ingot to slab = 230 t/hr. x 184 hr. x 0.87 = 36,800 t/month (slab weight)

from slab is breakdown = 120 t/h x 306 hr = 36,800 t/mon. (slab weight)

(b) Hot reversing mill:

The working time of this mill operating in direct connection with the combination mill is 306 hr/month, accordingly the working percentage is 42.5%. This is considered the maximum as a working percentage as described in (1), because the frequency of roll exchange increases with the increase of the production quantity.

If it is expressed in an equation:

working time = 24 hr x 30 days x 0.425 = 306 hr/mon.

rolling amount of from slab to hot coil = 120 t/hr x 306
= 36,800 t/mon. (slab weight)

If the yield is made 97%:

hot coil production = 36,800 t/mon. x 12 mon. x 0.97
= 428,000 t/yr.

4.3.6 Demand for hot coils in the Philippines and IISMI's supply capacity.

Demands for hot coils and their supply capacity of IISMI, if calculated based on the above presumptions, become as indicated in the table below. In this calculation, consideration was made that so long as the hot coil production capacity is short, production operation is directed chiefly to hot coils, with less regard to the production of thick plates.

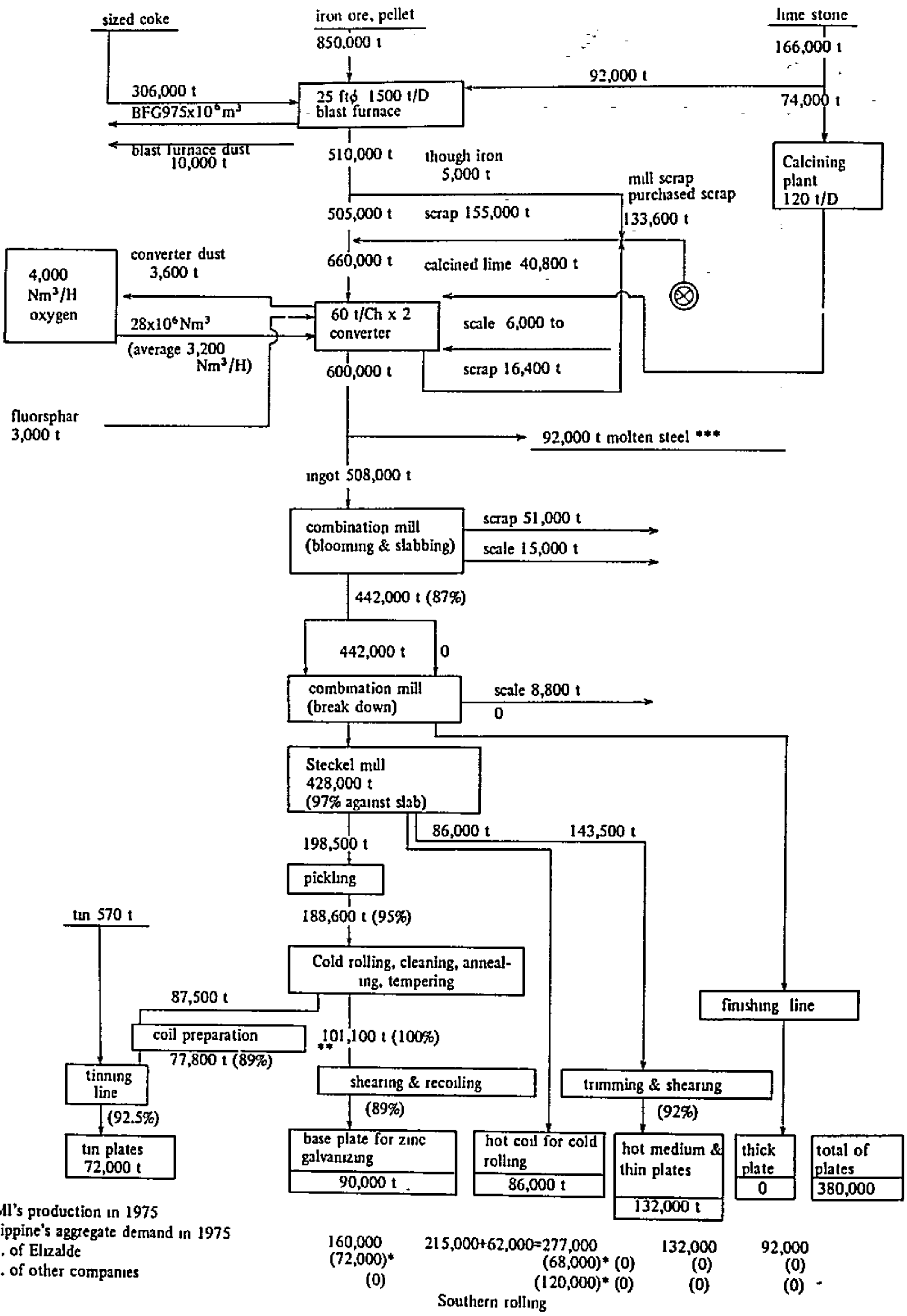
Table 8. Comparative Between Demand-IISMI Capacity-estimated Import of Flat Products in the Philippines

(Unit: 1,000 ton)

Year	Plate	Demand			Required hot coil for (b) & (c) (as roll)	Production capacity (IISMI)		Import				Remarks
		Medium plate & HR sheet	CR sheet GI sheet & Tin plate	Other cold rolled sheet		Hot coil (as roll)	Plate	Slab	Plate	Other cold rolled sheet	Hot coil (as roll)	
	(a)	(b)	(c)	(d)	(e)	(e)'	(a)'	e'/0.97	(a)	(d)	e – e'	
1970	60	87	329	5	496	303	–	313	60	5	193	
1971	66	95	350	6	531	303	–	613	66	6	228	
1972	72	104	372	7	567	303	–	313	72	7	264	
1973	78	113	394	8	605	303	–	313	78	8	302	
1974	84	122	416	9	641	303	–	313	84	9	338	Completion of integration expansion of hot strip mill.
1975	92	132	437	10	677	428	–	–	92	10	249	
1976	99	143	459	11	716	428	–	–	99	11	288	
1977	107	153	481	12	754	428	–	–	107	12	326	
1978	114	164	503	13	793	428	–	–	114	13	365	
1979	121	175	525	14	831	428	–	–	121	14	403	
1980	130	187	550	15	875	428	–	–	130	15	447	
1985	176	254	684	20	1,109							

Note "Other cold rolled sheets" include specially surface-treated sheets, stainless sheets and etc.

Estimated production flow of IISMI in 1975 based on the domestic demand, equipment project for IISMI and the production capacity of other companies surveyed by the Mission.



(Note)

1. * mark indicates a lack of hot coil rolling equipment.
2. ** mark indicates the need for IISMI to consider space for expansion of shear and rewinder equipment in the future.
3. *** mark indicates one of the followings:
   1. steel ingot
   2. Billet & bloom
   3. Reduced production of steel ingot (Demands for bar steels amount to 540,000 t/yr. IISMI's existing capacity is about 36,000 t/yr.)
4. It is very obvious that the bottlenecks is in the hot strip mill capacity of 428,000 t.

Scrap balance			
Supply	Scale	23,800 t	
	Slabbing crop	51,000	104,200 ◎
	Hot rolled scrap, Cold rolled scrap	53,200	
	Total	128,000	
Demand	Scale	6,000	
	Scrap	133,600	
	Total	139,600	
	To be purchased	29,400 ◎	
	Surplus scale	17,800	

4.3.7 Technical recommendations

In the Philippines, as stated above, even after the completion of the hot strip mill, short supply of hot coils and thick plates is inevitable, to meet which their imports are necessary. As means to reduce their imports, the following two plans are conceivable:

(Plan A) Improvement & expansion of IISMI facilities

As the IISMI's project is unclear in terms of space measurements, let us consider rather generally how IISMI can produce more hot coils.

(1) To lessen rolling operation from ingot to slab in order to improve the capacity of the combination mill: To achieve it, the following methods are considered. (a) By having a separate slabbing mill (see an attached figure), the combination mill will be operated only for break down of slab. (b) By installing the continuous slab casting equipment near the converter, the combination mill operation time from ingot to slab will be reduced enough, because the casting equipment will produce slab suitable to it in respect of metalugical quality and sizing.

In the case of (a), the presumed capacity of combination mill + steckel mill is:

120 t/hr x 432 hr/mon. x 12 mon./yr x 0.97 (yield)

= 620,000 t/yr. x 0.97

= 600,000 t/yr.

In the case of (b), the presumed capacity becomes intermediate between the aforementioned 428,000 t/yr and (a)'s 600,000 t/yr, that is, about 500,000 t/yr.

(2) To improve the capacity of the Steckel mill: For this purpose, it is desired to add two more finishing mills so as to make all the six stands completely continuous and to add a coiler. In this case the presumed capacity of the Steckel mill becomes as follows.

capacity of the combination mill

(ingot to slab) 230 t/hr x 272 hr x 0.87 (yield) = 54,500 t/mon. (slab weight)

(slab breakdown) 250 t/hr x 218 hr = 54,500 t/mon. (slab weight) directly connected with steckel mill.

and so annual hot coil production capacity is:

54,500 t/mon. x 12 mon/yr x 0.97 (yield) = 635,000 t/yr.

(3) A simultaneous application of the above (1) and (2) in also possible.

The presumed capacity in the case of (2) + (1) (a):

250 t/hr x 490 hr/mon. x 12 mon/yr x 0.97 (yield)

= 1,470,000 t/yr x 0.97 = 1,420,000 t/yr;

and in the case of (2) + (1) (b), the presumed capacity is intermediate between about 500,000 t/yr and 1,420,000 t/yr, that is, about 1,000,000 t/yr, a little below the above

From our view above, the most feasible seems to be the implementation of (2), followed by rationalization according to (1)(B), before carrying out (3). At any rate, the following conditions must be solved at first:

a. Future availability of space for carrying out the extension and addition of facilities

b. Relations between the facilities for making iron and steel;

c. Payability of investment.

(4) Additional installation of soaking pits and reheating furnaces will be required to achieve these improvements and expansions. As for reheating furnaces are concerned, there is a space available only for 2 more furnaces. Therefore, the total capacity of these two furnaces should be designed to produce 250 tons per hour, equivalent to the mill capacity.

(Plan B) Establishment of new hot strip mills in districts outside of Iligan

In this case the following conditions should be given special attention:

a. Selection of the leading company for the establishment and the timing of the construction of the mills and facilities;

b. Selection of types of mill and determination of capacity, in relation to demands,

c. Consideration on possible future expansion, particularly the availability of space,

d. Relations between facilities for making iron and steel.

C INDONESIA

C. INDONESIA

C.1 Present Situation of Supply and Demand for Steel Products and Future Trend in Indonesia

C.1.1 Introduction

A great effort is being made in the emerging Indonesia. In 1965 the first objective was directed toward the stabilization of its economy. Apparently many problems remain to be resolved. The government is now working on a 5 year economic rehabilitation program which is scheduled to start in 1969. The emphasis of the program is placed on improving the standard of the living of the people and the establishment of sound economy. Its direction is oriented towards (1) increased production of food and clothings, (2) housing construction, (3) promotion of employment, (4) promotion of export and substitute for import and (5) improvement of infrastructures.

In view of these problems, it is extremely difficult under present conditions to make a prediction on the future of steel consumption in Indonesia. The survey mission attempted to forecast the steel demand in the country under the prevalent conditions.

1. 1966 – 1969 Transitional period
2. 1970 – 1975 Stabilization and rehabilitation period
3. After 1976 Expansion period

Although it is difficult to grasp any accurate figures on the actual state of supply and demand for steel products of the past partly due to lack of statistical data, and estimation is made on the result of study of survey data furnished by the Ministry of Industry of the Indonesian Government and the Japan Iron and Steel Federation and of UN ECE statistics. With this estimation as a basis, the forecast of future trend is made as follows.

Table 1. Estimated demand for steel products

(Unit: 1,000 ton)

	1964	1965	1966	1970	1971	1972	1973	1974	1975	1980	1985
Total steel products	175	263	152	314	327	340	353	366	379	484	618
Flat products	48	65	31	112	117	122	127	133	139	181	244
Others	127	198	121	202	210	218	226	233	240	303	374

C.1.2 Constitution and growth rate of demand for steel products

Demand for steel products during a period from 1950 through 1966 was 100,000 tons at the lowest and 350,000 tons at the highest. Demand during this period shows variation each year and therefore does not clearly indicate the trend of demand for steel products. As to the future prospect, however, (1) against an average annual growth rate of 3.6% during a transitional period from 1966 through 1969, it was estimated that (2) the growth rate for 1970 through 1975, the period of stabilization and rehabilitation, would be 3.8% and (3) the annual growth rate for the years after 1976, the expansion period, would be 5.0%, showing a gradual increase in the growth rate.

Breaking down the demand for steel products into flat rolled steel and other type of steel rolled as shapes, and bars, the ratio of shapes and bars is extremely high. It is expected, however, that the ratio of flat products will see an gradual increase in the future.

This estimate is based on the anticipated increase in the demand for galvanized steel sheet for roofing, furnitures and containers, etc. and steel hoops for domestic production of welded pipes. It is expected, therefore, that the ratio of shapes and bars will decline accordingly.

Table 2. Percentage break down and growth rate of demand for steel products

	Constituent ratio by items %							Average annual growth %			
	1964	1965	1966	1970	1975	1980	1985	1970/ 1965	1975/ 1970	1980/ 1975	1985 1980
Total steel Products	100	100	100	100	100	100	100	3.6	3.8	5.0	5.0
Flat Products	27.4	24.7	20.4	35.7	36.7	37.4	39.5	11.5	4.4	5.4	6.1
Others	72.6	75.3	79.6	64.3	63.3	62.6	60.5	0.4	3.5	4.8	4.3

C.1.3 Forecast of demand for cold rolled sheets

In addition to the present demand for cold rolled sheet for consumption in the form of machinery, furniture and other end products, a potential demand exists for base plate for galvanization since a plan for domestic production of galvanized sheet after 1967 is being progressed. It is expected, therefore, that the demand for cold rolled sheet will increae rapidly following a stepped-up-domestic production of galvanized sheet.

Table 3. Forecast of demand for cold rolled sheet

(Unit: 1,000 ton)

	1965	1966	1967	1970	1971	1972	1973	1974	1975	1980	1985
Cold rolled sheets	9	4	15	32	43	54	65	76	87	121	166
GI base plate	–	–	4	20	30	40	50	60	70	96	131
Others	9	4	11	12	13	14	15	16	17	25	35
Galvanized sheets	23	17	30	60	63	66	69	72	75	96	131
Import	23	17	26	40	33	26	19	12	5	–	–
Domestic production	–	–	4	20	30	40	50	60	70	96	131
Tin plate	6	6	10	17	17	17	17	18	19	24	29
Import	6	6	10	17	17	17	17	18	19	–	–
Others	27	4	12	23	24	25	26	27	28	36	49
Total of flat products	65	31	63	112	117	122	127	133	139	181	244

C.1.4 Forecast of demand for bars and sections and present demand for billets

1.4.1 Import of merchant bars and forecast of demand for billets.

Actual demand for merchant bars in Indonesia may be grasped by interpreting import as an equivalent to demand. Actual import record based on the government data is as follows.

Table 4. Actual import record of merchant bars and others

(Unit: 1,000 ton)

	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966
Bars, round, half-round, square, rectangular and flat iron	13.2	9.2	8.9	16.6	49.3	14.5	8.8	22.3	18.6	10.6
Bars, profile iron	29.5	12.9	16.7	12.2	15.1	18.8	11.2	13.8	17.7	7.7
Bars, others, n.e.s.	1.4	0.3	0.5	0.6	2.5	3.0	0.4	0.6	0.5	0.3
Concrete steel	78.4	13.4	35.9	36.6	84.8	29.3	28.3	32.8	72.0	41.6
Wire, bare or annealed	6.9	12.6	31.5	17.0	22.0	16.0	19.8	12.7	34.0	16.0
Wire, coated with base metals	8.0	13.3	11.3	2.9	10.5	6.8	7.3	5.5	5.6	3.4

Forecast of future demand for merchant bars based on the present trend of demand for all steel products is as follows.

Table 5. Forecast of demand for merchant bars and others

(Unit: 1,000 ton)

	1964	1965	1966	1970	1971	1972	1973	1974	1975	1980	1985
Bars	55	106	67	94	99	102	107	111	114	145	185
Shapes	14	18	8	16	16	17	17	18	19	24	30
Wire rods & wires	20	41	20	31	32	33	34	36	38	48	62
(Sub Total)	89	165	95	141	147	152	158	165	171	217	277
Others	38	33	26	61	63	66	68	68	69	86	97
Total	127	198	121	202	210	218	226	233	240	303	374

1.4.2 Estimated distribution of demand for merchant bars

Distribution of demand for merchant bars in Indonesia is generally estimated as follows judging from the number of mills and the distribution of population. High demand in the western district (Java) is due to a high demand in construction and machinery industries.

Table 6. Estimated distribution of demand for merchant bars

	Distribution ratio %
West Jave	40
Central Java	23
East Java	30
(Total for Java Islands)	93
Sumatra	5
Others	2
Total	100

1.4.3 Market conditions and price of merchant bars

Market price of steel products fluctuate considerably because of incomplete existing distribution channel, restriction of import and also due to accelerated inflation but is determined by import price in principle.

Import price (C & F) in the very recent case surveyed by the Indonesian Government is as follows

Various charges for imported steel products after C & F is approximately 20% of C & F prices. Although the import duties is being exempted since May 1968, the sales tax (5% of sales price) is still in effect.

Current Importing Price List of Iron and Steel Product in Indonesia

G. I. Sheet					
B W G 32		C & F Djakarta	US$ 208.00	per M/Ton	
B W G 32			200.00		
U S G 37			219.00		
Cold Rolled Sheet					
1/16"	3' x 6'	C & F Djakarta	US$ 138.80	per M/Ton	
1/32"	3' x 6'	" "	140.80	"	
0.35 mm	3' x 6'	" "	149.80	"	
Cold Rolled Strip					
0.9 mm x 54 mm		C & F Djakarta	US$ 158.00	per M/Ton	
1.0 mm x 67 mm		" "	158.00	"	
Wire Rod		" "			(95.25)
Angle					
3 mm x 25 mm x 25 mm		C & F Djakarta	US$ 134.75	per M/Ton	(118.75)
3 mm x 30 mm x 30 mm		" "	129.75	"	
4 mm x 50 mm x 50 mm		" "	124.75	"	
5 mm x 60 mm x 60 mm		" "	124.75	"	
Flat Bar					
1/8" x 5/8"		C & F Djakarta	US$ 148.63	per M/Ton	(146.75)
3/16" x 5/8"		" "	138.63	"	(136.75)
3/16" x 1"		" "	128.63	"	(126.75)
1/4" x 1"		" "	127.63	"	(127.75)
1/4" x 1½"		" "	127.63	"	
Ship Plate					
3/16"	6' x 20'	C & F Djakarta	US$ 142.12	per M/Ton	
1/4"	6' x 20'	" "	132.62	"	
5/16"	6' x 20'	" "	128.62	"	
3/8"	6' x 20'	" "	125.62	"	

Plain Round Bar (12 m One folded at Centre)

1/4" in Coil	C & F Djakarta	US$ 116.75	per M/Ton	
5/16"	" "	116.75	"	
3/8"	" "	116.75	"	(108.75)
1/2"	" "	113.75	"	(105.75)
5/8"	" "	111.75	"	
3/4"	" "	111.75	"	
1"	" "	111.75	"	
1/4"	" "	124.63	"	
5/16" x 1½"	" "	127.63	"	

Galvanized Iron Wire

B W G 8	C & F Djakarta	US$ 136.75	per M/Ton
10	" "	139.75	"
12	" "	142.75	"
14	" "	148.75	"
16	" "	155.75	"
18	" "	172.75	"
20	" "	184.75	"
22	" "	196.75	"
24	" "	210.75	"

Nail Wire

B W G 6	C & F Djakarta	US$ 127.75	per M/Ton	(127.75)
8	" "	126.75	"	(126.75)
9	" "	127.75	"	
10	" "	128.75	"	
11	" "	129.75	"	
12	" "	130.75	"	
13	" "	131.25	"	
14	" "	132.75	"	
16	" "	138.75	"	

Electrolytic Tinplate Prime Quality — C & F Djakarta

Base Weight	Coating Coating		
80 lb.	0.50 lb. 20" x 28"	US$ 253.31	per M/Ton
80 lb.	0.50 lb. 21" x 30"	248.32	"

90 lb.	0.50 lb. 20" x 28"	US$ 237.45	per M/Ton
90 lb.	0.50 lb. 21" x 30"	233.01	"
90 lb.	0.75 lb. 20" x 28"	247.79	
90 lb.	0.75 lb. 21" x 30"	243.33	"

Dipped Coke Tinplate Prime Quality — C & F Djakarta

Base Weight	C Coating		
90 lb.	1.25 lb. 20" x 28"	US$ 272.52	per M/Ton
90 lb.	1.25 lb. 21" x 30"	268.09	"

Figures in parenthesis at right of each page indicate current importing prices in September through October 1968 based on the data furnished by the Planning Dept. of the Indonesian Government.

Table 7. Iron & Steel Products
Imports Duties and Other Charges on Imported Products

No. Items	Import Duty %	Surcharges %	Sales Tax %
1. Concrete Bar	0	0	5
2. Angles/Section	0	0	5
3. Channel	0	0	5
4. Flat Bar	0	0	5
5. Wire Rod	0	0	5
6. Nail Wire	5	0	5
7. Hoop/Strip	0	0	5
8. Billet	0	0	0

Current Market Price

As per current BE-Rate, I US$=Rp 300-, the market price in general can be said the C & F price in US$ multiplied by Rp 400-

(Planning Department data)

1.4.4 Standard size of merchant bars

Standards of JIS, DIN and NP are being used in Indonesia.

Although the size of merchant bars varies depending on their respective use, demand for the size 5.5 – 12 mm in diameter is great in construction field and there is only a little demand for the size 12 mm or more. Demand for deformed bars is not great either. A concrete bar of 12 m long is folded in two for transportation reasons. Larger size of 6.3 – 50.8 mm in diameter is in demand for machine manufacturers.

1.4.5 Product transportation cost

Inland freight on the Java Island after its revision on May 1, 1968 is as follows.

Transport by truck between Djakarta and Bandung .... 5 RP/Kg.

Transport by truck between Djakarta and Surabaya .... 15 RP/Kg.

Transport by railway between Djakarta and Surabaya .... 22.5 RP/Kg.

Freight of sea transportion between Djakarta and Surabaya is about in midway between that of truck and that of by railways.

(Conversion rate in July 1968 was 300 Rps = 1 US$)

1.4.6 Demand for billets

Demand for billet in Indonesia may be divided into (1) demand by existing iron and steel works and (2) potential demand in connection with the new merchant mill project.

(1) Demand by existing iron and steel works

Demand by existing iron and steel works refers to that by the Air Trading Co. The plant is currently utilizing large size merchant bars which were left as an excess of construction project in Indonesia for raw material necessary for production of steel products. A plan is being worked out for the construction of an open hearth furnace for the production ranging from steel making to rolling in the future. It can be said, therefore, that the billet is not in the least demand by this company.

(2) Potential demand in relation with a new merchant mill project.

On the premise that the construction of the above mentioned merchant mill comes to a realization matching with the trend of demand in Indonesia, the quantity of billet required for the production by this mill is estimated as shown in the following Table 8.

Table 8. Forecast of demand for billets

(Unit: 1,000 ton)

	1966 actual	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1985
Demand for bar, shape and wire rod	95	141	147	152	158	165	171	180	189	198	207	217	277
Import of bar, shape and wire rod	80	121	127	132	138	–	–	–	–	–	–	–	–
Production of bar, shape and wire rod by existing facilities	15	20	20	20	20	20	20	20	20	20	20	20	20
Production of bar, shape and wire rod by new project	–	–	–	–	–	145	151	161	169	178	187	197	257
Quantity of billet required for the production by new project	–	–	–	–	–	154	160	170	180	190	200	210	273

C.2 Present Situation of Iron and Steel Industry in Indonesia

The only existing steel rolling plant in Indonesia at present is the Air Trading Co., which was established in the suburbs of Djakarta in 1954 and started its commercial operation in 1956 – 57. This company, in addition to its future expansion plan, is now engaged in the rerolling of scraps with its three 8"/10" cross country mills. It is producing about 20,000 to 30,000 T/Y of merchant bars ranging from 5.5 mm to 12 mm in diameter.

The Tumbak mas is currently operating galvanizing line and the additional line is under construction. Production capacity of this plant after the completion of additional facilities is estimated at 21,000 T/Y (2 shifts).

The Bakrie Brothers Co., is producing 25,000 to 30,000 meter/day of the furniture tubes and conduit pipes along with about 150 T/month of nails.

C.3 Outline of Iron and Steel Project in Indonesia

C.3.1 Introduction

Probe into the possibility of establishing full-scale iron and steel industries in Indonesia dates back to 1955 when the Indonesian Government awarded an contract to WEDEXRO Co. of West Germany for the execution of a preliminary survey, but the primary object of the survey was on the three primary raw materials for steel making, namely iron ore, coal and scraps. The WEDEXRO, as a result of its survey, made the following recommendations:

(1) To build three steel making plants having a total annual capacity of 100,000 tons, which will use scraps as the main raw material by open hearth process.

Table 9 Import of Steel Products in Indonesia

(Unit M T)

	Statistics No.	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966
Plate									12,900	12,000	9,000	18,100	1,000
Sheet	7690	59,233	81,697	124,916	58,081	75,777	45,928	84,794	13,500	6,300	5,600	4,900	1,000
Cold rolled sheet									2,000	1,100	5,800	9,200	3,700
Hot rolled hoop & strip	7760	9,340	4,188	1,199	1,500	4,064	3,866	2,627	100	500	700	400	–
Cold rolled hoop & strip									2,300	3,300	700	2,000	1,000
Galvanized steel sheet	7730 7740	1,495	2,654	1,633	583	271	868	441	7,300	16,900	23,600	22,800	17,000
Tin plate	7700	25,278	20,293	23,698	19,021	29,925	18,603	36,899	14,600	24,100	2,100	6,000	5,800
Other processed coated sheet	7710	412	1,633	3,145	3,072	1,691	452	946	100	100	200	1,300	1,400
Other processed coated hoop & strip	7720 7750								–	–	–	–	100
(Sub Total)		95,758	110,465	154,589	82,257	111,728	69,717	125,707	52,800	64,300	47,700	64,700	31,000
Ingot and semi-finished steel									9,900	–	–	–	–
Steel bars	7610	64,701	54,601	91,640	22,689	44,897	53,336	134,240	33,109	36,534	54,983	90,371	51,947
Polished bars	7640								900	600	200	300	400
Shapes	7620	23,378	16,069	30,990	13,219	17,257	12,940	17,769	21,930	11,761	14,490	18,220	8,040
Sheet pile	7630												
Rails	7850	133	4,635	3,850	2,411	452	9,776	11,203	43,400	4,400	7,600	3,900	7,300
Wire rods	7650	2,479	2,712	6,975	12,650	31,548	17,039	22,039	16,015	19,890	12,785	34,088	16,050
Steel wire													
Galvanized wire	7660	10,436	10,267	8,066	13,388	11,332	2,986	10,584	6,890	7,346	5,523	5,670	3,404
Other steel wires													
Barbed wire	7670	2,497	1,304	425	110	52	28	29					
Wire mesh	8490												
Wire nail	8510	29,975	20,544	22,946	5,711	2,965	323	2,438	600	2,200	1,100	800	500
Other nails									300	100	200	..	..
Wire rope & stranded wire	8480	878	1,277	1,779	1,190	636	1,572	1,918	1,000	600	1,100	1,100	1,100
Bolt, Nut	8540	2,291	3,705	4,964	2,090	886	2,565	2,067	2,700	1,500	3,600	1,700	1,300
Steel pipe	7790, 7800 7810, 7830 7840								25,000	18,000	16,300	19,900	3,000
Cast iron pipe	7780	652	1,265	594	1,620	3,312	31	306	10,100	2,000	9,300	6,400	2,600
(Sub Total)		137,420	116,379	172,229	75,078	113,337	100,596	202,647	171,884	104,931	127,081	182,549	105,641
Total		233,178	226,844	326,818	157,335	225,065	170,313	328,354	224,644	169,231	174,781	247,249	136,641

(2) To build a pig iron plant equipped with a small blast furnace, having a total annual capacity of 30,000 tons at Lampung to supply pig iron to the steel making plants mentioned above.

The Indonesian Government, taking into consideration these recommendations, formally approved the following three projects in 1960.

1. To construct a pig iron plant having a total annual capacity of 35,000 tons in Lampung.
2. To construct a steel making plant having a total annual capacity of 100,000 tons in Tjilegon.
3. To implement the Kalimantan survey project with the aim to construct an integrated steel making plant having a total annual capacity of 250,000 tons of steel ingot.

Of these projects, the Tjilegon and the Kalimantan survey projects were carried out in compliance with the agreement signed in April 1962 between the Indonesian Government and the U. S. S. R. on technical and financial assistance. However, the Tjilegon project was suspended in 1965 and the contract with the U. S. S. R. has since been cancelled.

C.3.2 Outline of the Lampung Project

As a result of several surveys on natural resources and geology made in 1956 and again in 1961 in compliance with the contract signed by Wedexro of West Germany in November 1955, a deposit of 300,000 tons of hematite and Magnetite of high grade was confirmed and the total reserve was estimated at 2,050,000 tons. However, because of scattered distribution of small deposit, this project is not economically feasible in spite of high quality of the deposits.

The coal in Bukit Asam, South Sumatra, was not appropriate for use for coking according to a check made by the Wedexro and as a result, double coking process was recommended as an alternate plan. A pilot plant was constructed by Lurgi company in Tandjung Enim in 1961 but it has never been put into operation due to various reasons.

As to the limestone, surveys were made by the above mentioned Wedexro and the Indonesian parties concerned in both 1961 and 1963 and as a result of these surveys, deposits were discovered in Pematang Mas 19 Km from the highway south of Telukbetung in the Lamppung area. The total deposit is estimated at 2,000,000 tons and is considered explorable.

Proposed site for the aforementioned blast furance having a 35,000 T/Y capacity is located 1.5 Km north of Pandjang Harbour. The present port facilities are two piers, each capable to accommodate a ship of 10,000 T class. Although the port is not equipped with cargo handling facilities at present, there is plenty room for improvement, if these facilities are to be established in the future.

The proposed site, though on the flat area, is free of the menace of flood. As to the water sources, the Geruntang River is flowing 1.5 Km from the proposed site and the supply of water at the rate of 50 L/sec is available. Topographical maps, soil investigation and land preparation, and master plan drawing were already completed in 1965 and field offices, werehouses, etc have also been furnished.

Furthermore, a joint survey conducted by Nisso Steel Mfg. Co., Ltd. of Japan and The Indonesia's Mining Ministry revealed a deposit of high grade magnetic sand with an average Fe-55% amounting to 6,500,000 T in the Tjilatjap Djampang area. The survey also confirmed the availability of magnetic sand with Fe - 35% of the quantity equivalent to the former.

C.3.3 Outline of the Kalimantan Survey Project.

The Kalimantan Survey project, as previously stated, was completed in 1965 with technical assistance of the U.S.S.R.. Although a feasibility study has not been made yet, the Martapura area 40 Km from the Bandjarmasin Harbor, is being considered as the proposed site. This site is located in the center of the area having a distance of 40 to 50 Km from the deposit of raw materials such as iron ore, coal, etc and provides means of transportation from the port by way of road and river.

As to the water sources, the Martapura River is available without any difficulties even in the dry season. Power supply is available from a hydraulic power plant having a capacity of 30 Km in Riam Kanan which is 15 Km from the site.

Following is a summary of preliminary surveys which have already been completed.

(1) Aeromagnetic survey: Covered an area of 54,000 Km^2 in southeast of Kalimantan. The result showed a bright prospect for the Meratus area.

(2) Aerial photo survey: 60% complete for the area mentioned above.

(3) Topogeodetic work: 70% complete.

(4) Geological survey: As a result of this survey, a deposit of 9,000,000 T of iron ore was confirmed but the area covered was only 0.13% of the total area of the Maratus area. In the southern Kalimantan, a deposit of 450,000,000 T latelite ore was discovered and a preliminary survey and sampling are being conducted. The deposit of Binuang coal near the said ore deposits, though not explored yet, is estimated at 86,100,000 T and an analysis of the sample is said to have proved its appropriateness as coking coal.

C.3.4 Outline of the Trikora (Tjilegon) Project

3.4.1 Summary:

Following is the description of the project according to the official data furnished by the Indonesian Government:

Name of the Project	:	Trikoka Steel Factory	
Location	:	Tjilegon, West Java.	
Supplier	:	Tjaspromexport for steel Plan Machineries	
		Technoprom Export for Materials and Machineries of Power Station.	
Contract Price	:	US$36,000,000.-	
Product	:	51,000 T/Y Reinforced Concrete bars	
		18,000 " Construction Steel	
		15,000 " Steel Wire	
Total		84,000 T/Y	
Raw materials	:	Scrap and Pig iron approx.	111,000 T
Additional	:	Ferro Manganese	900
		Ferro Silicon	150
		Aluminium	50
		Iron ore	4,500
		Lime Stone	3,500
		Bauxite	1,000
		Lime	1,500
		Magnesite Powder	1,000
		Dolomite	2,000
		Chromite	100
		Refractory Bricks	6,230
		Powder	800
		Moulds and Bottom Plates	3,900
		Fuel	30,000
Process	:	Open Hearth refining and rolling	
Power	:	Three Units of thermal Power Station of KW capacity each.	12,000

Construction work under the Trikora Project was inaugurated on May 20, 1962 under the supervision and assistance of the U.S.S.R.

Though it was originally scheduled to be completed at the end of 1965, the work had to be suspended due to various reason, particularly the lack of Rupia fund, and the construction work was completely halted in October 1965.

3;4;2 Present position of construction work.

(1) Delivery and maintenance of machinery

Approximately 75% of required machinery, equipment and materaials to be imported have already arrived and transported to the plant site. The remainder consists primarily of the facilities for open hearth furnace and is not expected to arrive for the time being. Following is the description of delivered machinery and equipment supplied in compliance with the contract signed by the U.S.S.R. on April 5, 1962.

Item	Gross Weight (T)	Delivered	Not delivered	Installed
Open hearth furnace	3,366.4	917.4	2,449.0	–
Merchant	6,068.3	5,398.9	669.4	–
Auxiliary equipment	1,719.7	1,641.3	78.4	474.7
Total	11,154.4	7,957.6	3,196.8	–
Thermal power	4,082.6	3,481.0	601.6	226.0
Grand total	15,237.0	11,438.6	3,798.4	700.7
(%)	(100)	(75)	(25)	(4.6)

Of the rolling equipment, delivered equipment is said to account for 90% for merchant mill and 75% for wire drawing. During the peak of construction 2,000 workers were engaged in the work and 70 Russina engineers (totaling 200 including their families) were supervising the work. Currently, 90 employees in Oxygen plant, 70 in repair shop, 140 maintenance men and 150 others, a total of 450 are assigned to the plant. The Indonesian Government provided an appropriation of 1,000,000 rupi during a period of 1967 through 1968 for the maintenance of these equipment and provided a security measure by installing a plant fence and at the same time is continuously taking necessary measures such as inventory, check and maintenance of machinery and equipment.

(2) Present position of suspended construction work.

Of the total project area covering an area of 400 hectars, plant site covering an area of 50 hectars has already been completed of land preparation and the engineering drawings of the plant, thermal power plant, facilities for Marak Port, pipe lines for water supply and drainage systems and the reservoir have all been completed. On the other hand, following construction works were suspended after the completion of 25% as a whole.

Suspended position of facilities is as follows.

Open hearth furnace plant	:	Foundation work alone is 100 % complete.
Thermal power plant	:	Building is 80 % complete.
Rolling mill	:	Building is 30 % complete. Part of the building with completed roofs are being used for the storage of machinery and equipment.
Oxygen plant	:	Facilities including air compressor room is 100 % complete and is in operation. 200 bottle/day sale is being accomplished.
Repair shop	:	Building is 100 % complete. Installation of machine tools is 95 % complete. The facilities are presently operated by a private sector on lease and agricultural implement (sprayer) are turned out and sold by this sector.
Vehicle maintenance shop	:	Building is 80 % complete.
Refractory warehouse	:	100 % complete. Assortment and storage of refractories are now in progress.
Water supply station	:	Approximately 60 % complete.
Railroad	:	Construction of railroad of considerable length has been completed. Three diesel engine locomotives are assigned.
Reservoir	:	Civil work alone is 60 % complete.
Water pipe line	:	2 Km out of the total 40 Km is complete.
Employees housing	:	Out of the 1,500 units under the employees housing plan, 200 units for officials have been completed and are in use.
Power for construction	:	Four diesel generators, each having a capacity of 400 KVA are now in smooth operation, and generated power is supplied to the oxygen plant.

In addition to this, main project under consideration calls for the construction of a reservoir at the Rava Danu Lake, which will be the source for the 40 Km pipe line, however the work has not started yet. Also the construction equipment, trucks, bull-dozers, etc. that numbered as many as 150 at the time when the project was in full swing now holds only 30 % of them. Those in reusable condition is said to account for 15 % of the remaining 30 %. Rupi funds invested in the 1962 – 1965 period amounted to about five million US dollars.

(3) Description of main facilities and estimated cost of construction

At the time of this survey, the Indonesian Government was in the process of executing a contract with the Granite City Co. of the United States for the basic survey on the reconstruction of the Tjilegon facilities, which prevented the survey mission from obtaining detailed information on the projected facilities. Therefore, the information available was only from the field survey and inquiries made to the personnel concerned. With this information and UNIDO data as a reference and with many assumptions, the survey mission in its capacity has summarized the findings of the survey as outlined below.

(Unit: US$1,000)

Item / Facilities	Unit	Weight of equipment	Main specifications and capacity	Construction cost (estimated) Import price	Const. cost	Total	Remarks
Steel making plant		3,543 T		2,461	550	3,011	
1. Open hearth furnace	3		50 T/ch 2 ½ Ch/day 100,000 T/year oil fired				
2. Scale breaker							
3. Slab yard							
4. Raw material storage							
5. Lime and doromite plant							
Rolling mill		5,201 T		9,696	700	10,396	
1. Ingot buggy			Ingot weight 0.5 T				
2. Ingot re-heating furnace	2						
3. 2 high cogging mill	1		Reversing type, D C 1,800 Km motor, roll dia 650 mm, 9 – 13 pass				
4. Billet shear	1		6.4 – 18 m billet length prior to shearing				
5. Billet re-heating furnace	1		60mm, 80mm square section, 4.6 m, 5.5 m, 6 m length				
6. 3 high roughing mill	1		Reversing type, D C 600 Kw motor, roll dia 530 mm				
7. Intermediate roughing mill	1		2 stands, 2 high mill, roll dia 370 mm, D C 450 Km motor x 2				
8. Finishing mill	1		6 stands, 2 high mill, roll dia 4 stands – 370 mm, D C 450 Kw motor x 4; 2 stands – 270 mm, D C 350 Kw motor x 2				
9. Rod mill	1		6 stands, roll dia 270 mm, D C 800 Kw motor				
10 Wire drawing equipment	1		5 drawing machines: 4 machines – 6.5 mm dia max. rod (raw material); 1 machine – 3.2 mm dia max. wire (raw material), 0.75 mm dia min. wire (product); production rate 3 T/Hour, weight of wire rods in coil 80 – 85 Kg				
			Pickling line				
			Annealing line				
			Galvanizing line				
Gas, steam and power facilities and piping		169 T		317	93	410	
Repair shop and laboratory equipment		446 T	Foundry, forging & welding, machining, assembling and electric repair facility. Foundry sand control, analytical, chemical and metal-lographic equipment	826	60	886	
Water supply and sewerage and piping		605 T	Off-plant piping 1,000 mm ϕ x 39 Km length + On-plant piping (supply capacity – 830 L/sec.)	957	4,643	5,600	Include off-plant piping materials. Dam construction work also included.
Transportation and storage facilities		282 T		412	788	1,200	
Electric equipment and others (A)				451	–	451	
Building steel frame and construction materials, and others				9,059	3,441	12,500	Freight cars and locomotives included
Engineering drawings				800	–	800	
Thermal power plant (B)	3	(A)+(B) 680 T	12 Mw turbo-generator x 3 with 75 T/h boiler x 3	8,768	432	9,200	All wiring included
Power for construction			400 KVA x 4	235	–	235	
Civil work for foundation					9,500	9,500	All other materials included
Total				33,982	20,207	54,189	

C.4 Merchant Mill in Indonesia.

C.4.1 Conclusions reached by the survey mission

Present position of the Tjilegon project have already been outlined in the foregoing section. Apart from the circumstances of the past which lead the Indonesian Government to the planning and the execution of this project, the survey mission considers it more competitive from a standpoint of production cost if a more economically feasible merchant mill of low construction cost is to be constructed in the other site which fulfill the following requirements.

(1) Conveniently located for the arrival of billet and other materials.
(2) Conveniently located for the shipment of products.
(3) Conveniently located for water supply and sewage treatment.
(4) Conveniently located for the utilization of labor force.
(5) Satisfactory soil foundation.

However, the intention of the Indonesian Government, as has been stated previously, is not to give top priority to the steel making industry under the present circumstances. It is also natural with the government to take some measures for the Tjilegon Project for the reactivation of usable machinery and equipment taken out of service, which have already incurrent debt by the investment of rupia equivalent to five million US dollars.

Recommendations made by the UNIDO mission in March 1968 on the Tjilegon Project include:

(1) First phase: Wire drawing equipment is to be completed first of all and put in operation
(2) Second phase: Merchant mill is to be completed.
(3) Third phase: A steel making plant is to be reconsidered by taking into account the future trend of steel making process.

The above recommendations are considered appropriate as a whole. However, in view of anticipated increase in the demand in the future, an alternative plan calling for the construction of facilities through the second phase under a single project may also be appropriate. The Indonesian Government, primarily based on this thought, has decided to reactive the Tjilegon facilities and is now seeking a partner for the project and at the same time has given special consideration to it by appropriating 80 million Rps in the budget for this fiscal year.

Although the Tjilegon project reactivation plan will be discussed in detail hereinafter, the problem with the Tjilegon project is, first of all, that this project involves as an integral part such element as water supply, power generation and harbor facilities, which, should come under the category of regional development. Therefore, if the operation on commercial base is to be expected, drastic measures will have to be taken by the government.

C.4.2 The Tjilegon Project reactivation plan

Forecast of demand for shapes and bars in Indonesia has been stated previously. Following is the details of previous forecast by product lines and years.

(Unit: 1,000 ton)

	1970	1971	1972	1973	1974	1975	1976
Merchant bars	94	99	102	107	111	114	120
Shapes	16	16	17	17	18	19	20
Wire rods & steel wires	31	32	33	34	36	38	40
Others	61	63	68	68	68	69	72
Total	202	210	226	266	233	240	252

In view of the estimated actual demand for bars and sections amounting to 121,000 ton in 1966, and estimated demand for the year after 1970 as indicated in the table shown above, early completion and reactivation of the Tjilegon facilities should be considered as a matter of course also from the standpoint of saving of foreign currency.

It is advisable that the first phase be designated for wire drawing operation by using imported wire rods as raw material and the second phase for the operation of merchant mill using imported billet as raw material.

Apart from the required construction period which will be discussed separately, a reactivation plan aimed at the completion of the project at the end of 1973, taking into consideration required preparation work under existing circumstances, has been formulated as follows.

4.2.1 Description of main facilities and estimated construction cost.

Estimated construction cost has already been discussed previously. The following table shows the cost of merchant mill (including wire drawing) and a few related facilities required for the operation of the mill, extracted from the aforementioned cost. Of course, because of lack of inventory lists, many assumptions had to be made, however, the total cost estimated at around US$12.37 million is considered highly excessive for the facilities having an annual capacity of around 100,000 tons.

(Unit: US$1,000)

Facilities \ Classification	Estimated Construction Cost			Const.Cost spent
	Total	Imported items	Const. cost	
Merchant mill Billet re-heating furnace 3 high roughing mill Intermediate roughing mill Finishing mill Wire rod mill Wire drawing equipment	7,170	6,700	470	
Repair & laboratory equipment	(906)	(826)	(80)	(906)
Power equipment & piping	110	90	20	
Water supply & sewerage and piping	190	140	50	50
Heavy oil supply equipment and piping	60	40	20	–
Electric equipment & wiring	250	150	100	50
Transportation facilities	300	200	100	–
Maintenance, repair & fabrication of equipment	220	–	220	–
Foundation work	1,400	–	1,400	350
Architectural work	2,370	1,800	570	350
Engineering	300	–	300	50
Total	12,370	9,120	3,250	850

(Note) Figures in parenthesis are not included in the total.

If the merchant mill (including wire drawing) alone is to be completed first under the Tjilegon Project, the total cost required including the price of imported terms is roughly estimated at US$12.37 million and of this amount, importing price (per original contract) is estimated at US$9.12 million and the construction cost at around US$3.25 million. Since the construction cost already spent for the completed portion of foundations and buildings is estimated at around US$850,000, the Rupia funds required for the completion of the merchant mill is estimated at around 3.25 million – 0.85 million = US$2.4 million.

4.2.2 Construction Schedule

Item			1971	1972	1973	1974
Preparatory Work		Transportation, maintenance and fabrication of equipment, preparatory work for reopening of construction.	Elect. equip.	Machinery		
Construction work	Building & Civil work	Foundation work (including road) Architectural work				
	Rolling Mill	Installation of rolling mill Operator training		Installation Training	start-up	
	Auxiliary Facilities	Substations & wiring Water supply & sewage and piping Heavy oil supply equipment and piping Transportation facilities Maintenance and repair	Railroad maintenance (completed)			
Commercial operation						→

Completion of wire drawing facilities at initial stage may be acceptable. However, with the consideration of the requirement for the completion of related facilities, it would be more economical to plan for the completion of merchant mill at the same time.

It seems that the equipment that are now in storage after their arrival at Tjilegon from the U.S.S.R. is not the all that are required for the facility and some of the equipment have to be fabricated in Indonesia. It is necessary therefore to complete the preparation as early as possible of the list of equipment that are to be fabricated domestically and to make a careful plan and arrangement so that these equipment are ready for procurement by the time of installation indicated in the construction schedule above.

4.2.3 Production planning and operating personnel

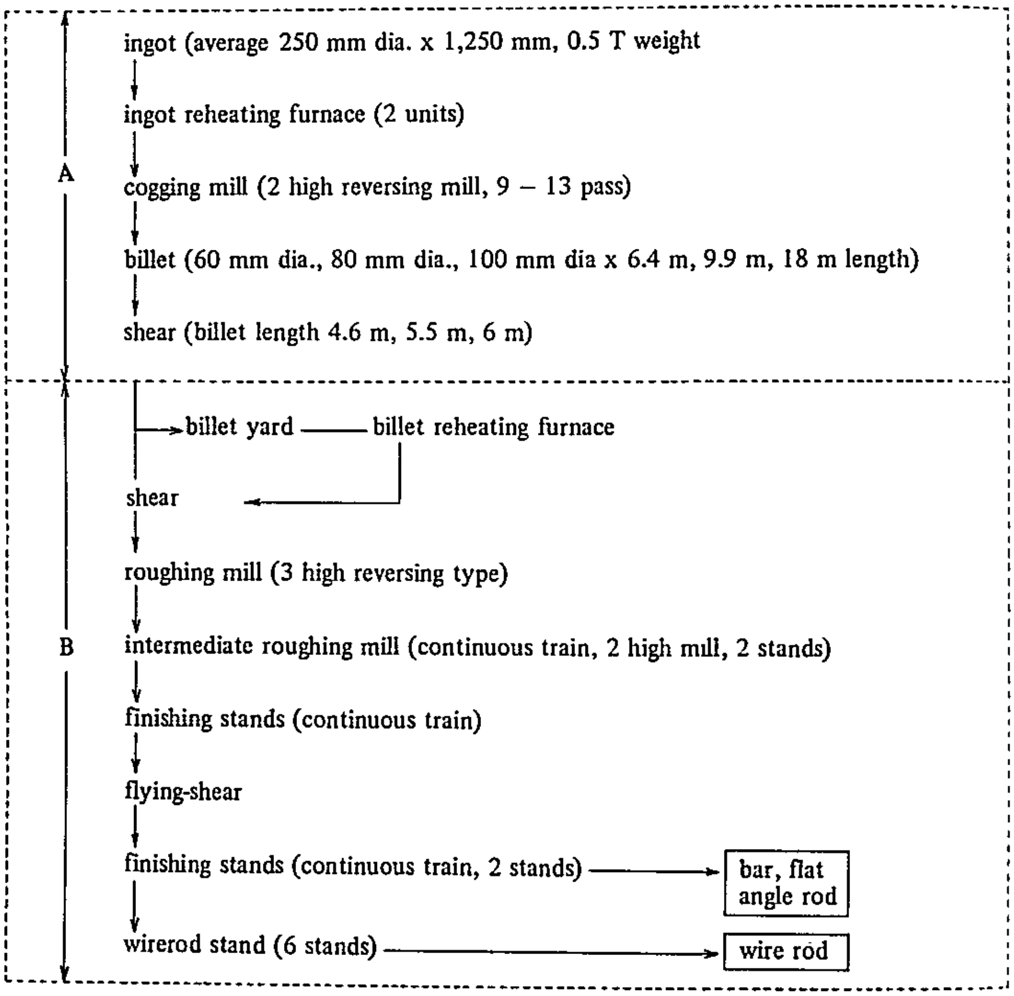
(1) Review of production capacity

For the production planning for this mill, the original plan proposed by the

Indonesian Government and the plan recommended by the UNIDO mission compare as follows.

	Indonesian Government original plan	UNIDO plan
Raw material	Ingot	Imported billet
Products		
Merchant bar and other light sections	69,000 T/Y	43,000 T/Y
Wire rod	15,000 "	43,000 "
Total	84,000 "	86,000 "

On the other hand, the facilities and the capacity of the merchant mill are estimated as follows:



A = those included in the initial project. B = range of construction in the case of rolling mill which uses imported billet. Next, let us see the production capacity of the facility.

(a) Production of wire rod

Assumption is made that 6ϕ is produced from a typical size 60 mm x 60 mm billet with continuous train.

Judging from the length of tilting table at the 3 high roughing mill, rolling length after roughing is estimated at around 10 m. On the other hand, to produce a 6ϕ rod from 60 mm angle, billet will require rolling from 17 to 19 passes. Considering the mill layout that has a continuous train of 14 stands from the rear intermediate roughing stand to the finishing stand, it is presumed that the roughing mill requires from 3 to 5 passes.

Under these conditions, the billet of 3 m in length (it is presumed that the layout is designed to cut the billet of 6 m long in half with a shear after heating) and 84 Kg in weight will probably rolled to the length of 9 m at the roughing mill. Assuming the rolling speed of roughing mill is 2 m/sec, the time required for rolling would be approximately:

$$\frac{(3\ \text{m} + 9\ \text{m}) + 2 \times 5\ \text{pass}}{2\ \text{m sec}} = 15\ \text{sec.}$$

Assuming that the handling and loss time including pitch time of the loaded billet is 10 sec, the average time would be 25 sec/piece. Accordingly, the mill capacity would be:

3600 sec (1 hr) + 25 sec = 145 piece/hr

84 Kg x 145 = 12.2 T/h

If the working ratio is to be 80 %:

Average operating capacity = 12.2 T x 0.85 = 10.4 T/H

Assuming that the mill after intermediate roughing stand is designed to match this capacity, a check should be made at finishing stand. Assuming the delivery speed at the finishing stand is 20 m/sec:

$$\text{Passing time} = \frac{84\ \text{Kg (weight of billet)}}{0.22\text{Kg (unit weight of rod)}} \quad 20\text{m/sec} \quad 19\ \text{sec.}$$

Accordingly, on the assumption that the rolling interval of each piece is 5 sec, the time required for one piece will be 19 sec. + 5 sec. = 24 sec. which is considered to reasonably match the capacity of roughing mill. Since the effective hearth area of billet heating furnace is estimated to be about 50 m^2, the heating capacity of the furnace is considered to be around 28 T/H, thus leaving sufficient room for the mill.

Accordingly, the production capacity of rod is estimated at 11 T/H.

(b) Production of bar

Same assumption as for (1) is made for the production of 16 ϕ bar from the typical size 80 mm x 80 mm billet.

If the length of billet is 2.75 m (billet 5.5 m long is to be sheared in half after heating) and the weight of the same is 138 Kg, entire process will probably require 13 or 15 pass and the roughing mill will require rolling of 5 or 7 pass.

Assuming that 5 pass is required and the length after roughing is 12 m, the rolling time will be approximately:

$$\frac{(2.75\text{ m} + 12\text{ m}) + 2 \times 5\text{ pass}}{2\text{ m/sec}} = 18.5\text{ sec}$$

Assuming the handling and loss time including pitch interval of loaded billet is 12 sec, the time required will be an average 30 sec/piece.

Accordingly, the mill capacity will be:

3600 sec (1 hr) + 30 sec = 120 piece/hr

138 Kg x 120 = 16.5 T/H

If the working ratio is to be 85 %:

Average working capacity = 16.5 T x 0.85 = 14 T/H

Assuming the delivery speed at the finishing stand is 8 m/sec, the passing time of the material will be:

$$\frac{138\text{ Kg (weight of billet)}}{1.58\text{ Kg (unit weight of bar)}} - 8\text{ m/sec} = 11\text{ sec}$$

Accordingly, if rolling interval of each bar is to be 5 sec, the time required for one piece will be 16 sec, indicating sufficient time for the finishing mill against the roughing mill.

In this case, however, the length of final product will be about 87 m, which requires shearing of the product for placing it in cooling bed which measures about 40 m in length.

Accordingly, production capacity for bar is assumed to be 14 T/H.

Since rod is consumed in the same plant as the base material for drawing, if the production is matched with the maximum capacity of wire drawing mill and the demand for the rod and the remaining time is allocated to the production of bar, possible production capacity at the peak will be:

Rod	11 T x 3500 hours =	38,500 T/Y
Bar etc.	14 T x 5140 hours =	72,000 T/Y
Total		110,500 T/Y

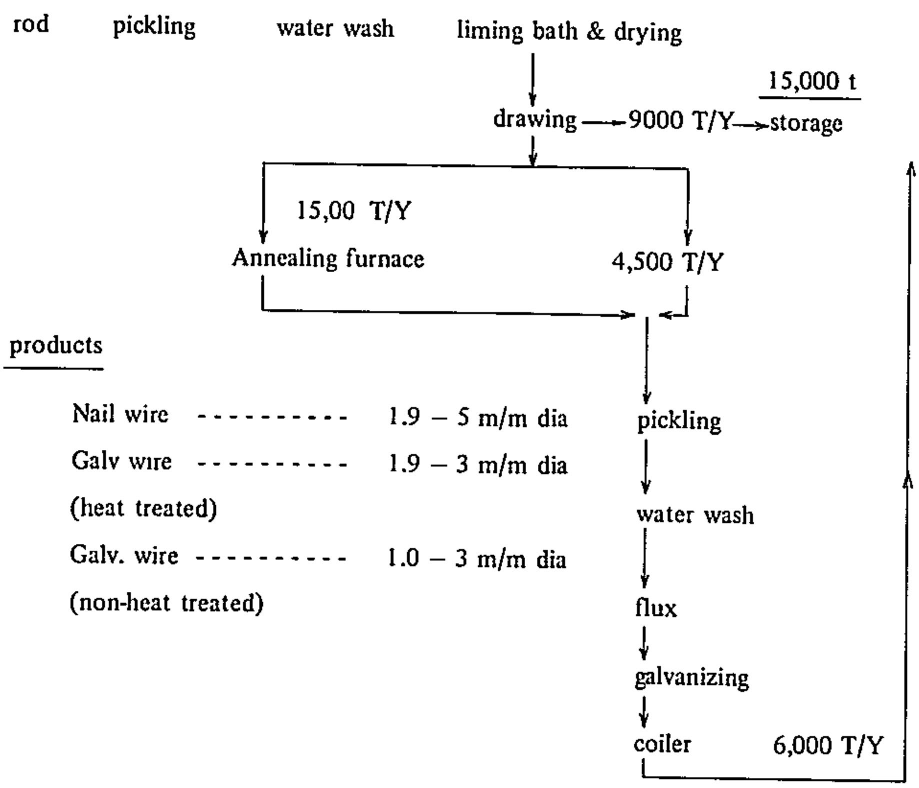
Working hours was assumed to be 8 H x 3 shifts x 30 days x 12 month = 8,640 hours and the break time for the workers was not taken into account for this calculation.

According to the UNIDO data, wire drawing facilities are:

4 machines – 6.5 mm dia max, rod

1 machine – 3.2 mm dia max wire, 0.75 mm dia wire minimum and the capacity is said to be 15,000 T/Y which is considered as the normal facility.

According to this data, the operating process is as follows:



products

Nail wire	----------	1.9 – 5 m/m dia
Galv wire (heat treated)	----------	1.9 – 3 m/m dia
Galv. wire (non-heat treated)	----------	1.0 – 3 m/m dia

(2) Production planning for peak operation (1975)

Merchant Mill (3 shifts)

products	size	outpur
Rounds	10 – 50 m/m	72,000 T/Y (Rounds to Hoops)
Squares		
Hexagons		
Flats	4–12m/m thick, 12-125m/m wide	
Angles	20x20x3-80x80x12m/m	
Hoops	2-3.5m/m thick, 20-50m/m wide	
Wire rods	6-6.5 m/m dia	23,200 "
Wire rods (raw material for plant use)	"	15,300 "
Total		110,500 "

← Imported billet 117,000 T/Y (60,80,100mm square)

→ 15,300 T/Y, 6-6.5 m/m → Wire drawing mill

Wire drawing mill

Nail wire	1.9-5 m/m dia	9,000 T/Y
Galv. wire	1.9-3 m/m heat treated	4,500 "
Galv. wire	1.0-3 m/m non – heat treated	1,500 "
Total		15,000 "

According to UNIDO data, the yield at the merchant mill is said to be 86%. However, the yield could be increased to around 94 % at the full operation with the expected proficiency in technique and increased work efficiency. This goal should also be attained.

(3) Start-up period and production in each phase.

Shown above is the plan of the production at the full operation.

Production tempo and required workers during the start-up period is estimated as follows:

(merchant mill)

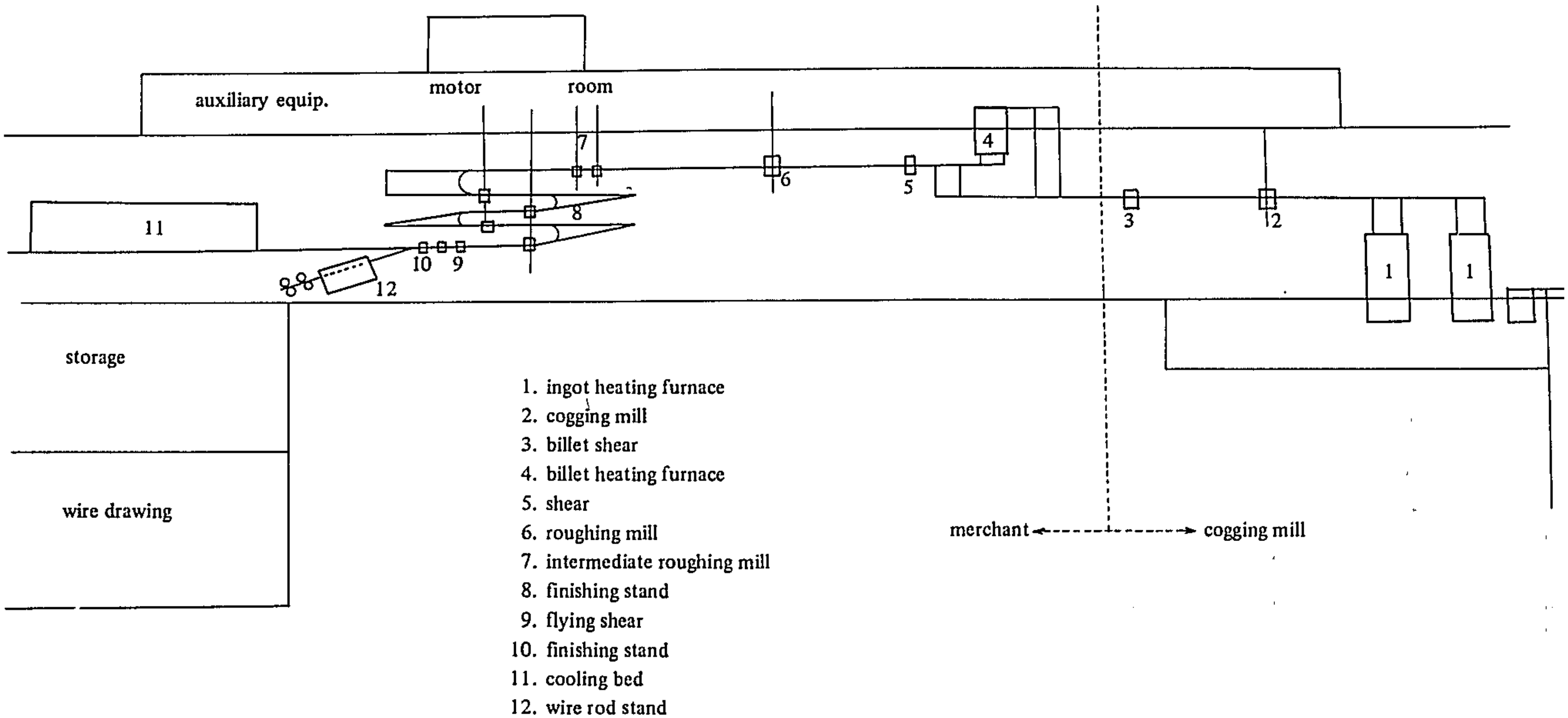
Item \ Year & month		1974 Jan. – Aug.	1974 Sep. – Nov.	1975 (Full operation)
Bar & section		13,400 T (1920 H)	13,400 T (960 H)	72,000 T
Wire rod		17,000 T (1280 H)	17,000 T (640 H)	38,000 T
Total		20,400 T	20,400 T	110,500 T
Working hours		8H x 2 shifts x 25 days x 8 month = 3,200 H	8H x 2 shifts x 25 day x 4 month = 1,600 H	8H x 3 shifts x 30 day x 12 month = 8,640 H
Operators	Engineer		3	3
	Foreman		2	4
	Skilled worker		23	42
	Unskilled worker		125	210
	Total		153	259

(wire drawing mill)

Item \ Year & month		Jan.	Feb.	Mar.	Apr.	May	Jun. – Dec.
Nail wire		50	200	370	750	750	....
Galv. wire (heat)		10	30	50	125	125	....
Galv. wire (non heat)		25	80	150	375	375	....
Total		←—— 965 T ——→			←—— 1245 T/M ——→		
Working hours		10H x 1 shift 25 day x 3 month = 750 H			8H x 3 shifts (drawing) 8H x 3 shifts (annealing galv.) 9H x 1 shifts (pickling)		
Operators	Engineer		2				2
	Foreman		1				3
	Skilled worker		3				7
	Unskilled worker		24				58
	Total		30				70

Fig. 1 Proposed Layout of the Merchant Mill

(size-no scale)



4.2.4 Technical Recommendations

As previously stated, the survey mission was unable to obtain detailed information on the existing facilities of Tjilegon project, therefore the study of the technical aspect had to be made largely on assumption. It is very regretable that the MISSION is unable to make a concrete recommendation on the technical aspect, however some technical problems which the mission has noted during the course of its study may be listed as follows:

(1) Import

Although the length of billet in the plant is said to be 4.5 m, 5.5 m and 6 m, it is considered that the facilities are actually designed to make a shorter billet by shearing after it has been heated in the billet re-heating furnace.

With this process, however, it is expected that some temperature drop occure on the rear pieace of sheared billet while it is waiting for rolling, thus affecting the quality of billet. It is desirable therefore to import billet of pre-determined length in the future import of billet. However, the decision on this matter should be made after a study has been made whether the billet re-heating furnace is designed to treat a short billet.

(2) Improvement of profitability

Although the profitability of the project from a financial stand point will be discussed at a later stage, the first consideration, in the reactiviation of the facilities of Tjilegon, must be given as a matter of course to the improvement of the working ratio and the productivity of the facilities as has been repeated previously because of comparatively expensive construction cost required for the installation of these facilities.

(a) Operator should become proficient in technique as early as possible. Effort should be made to improve the working ratio of the facilities, to increase production and to minimuze miss rolling.

(b) By minimizing miss rolling, it is possible to improve the yield.

(c) To be proficient in techniques, it is necessary for each worker to have positive willingness to acquire necessary technique in receiving the instructions from advanced countries.

(d) Training program should be implemented progressibly in order to disseminate acquired technique to all employees.

These technical training program along with those in (3) and (4) must be well planned and implemented prior to commercial operation.

As to the increase in the production, a space has been specially provided in item 3 for further discussion.

(3) Increase in the production

As previously stated, increase in the production is not only an absolute requirement for the improvement of profitability but also the desire of the nation as it is evident that the demand for steel bars in Indonesia is far greater than the capacity of the Tjilegon.

For this purpose:

(a) A thorough review should be made and necessary measures should be taken on the working conditions and working days in order to secure maximum working hours. That is, to make a positive effort to attain the objective of 24 hours x 30 days x 12 month = 8640 hours through the year by making an efficient use of low labor cost and by securing adequate manpower so that the employees are able to take holidays and breaks alternately.

(b) It is necessary to make periodic checks from time to time on the facilities and operating method for the improvement of them.
The improvement in these fields has not only a direct bearing on the increase in the production but also has an influence on the improvement of the yield. Generally speaking, not the facility or the operation of original plan is always successful, but always leaves room for additional effort for further improvement, therefore it is necessary to take a positive measure for their improvement.

(4) Future increase in the production of steel bars

Even with the measures discussed in the preceeding paragraphs 2 and 3, large increase in the production above a certain level can not be expected, for the basic layout has already been determined and the facilities have been arranged accordingly. For further increase in the production, the following measures may be considered appropriate.

(a) Major remodelling plan for existing bar mill.
To materialize this plan, it is necessary to review many problems as a whole for final solution such as additional installation of roughing stands, increased output of mill motor, increase in the mill speed, change in the overall equipment arrangement, and also the replacement of mill, expansion of cooling table, and the review of billet size, capacity of heating furnace and the space for the storage of billet and the products, etc.

(b) New merchant mill project at the Tjilegon
Although the construction of a new mill may be the easiest way to increase production, there must be a careful consideration given to available space and equipment layout so that it will be the best advantages to the overall arrange-

ment of the Tjilegon facilities if this method is to be employed. Construction of a new mill is considered very advantageous because of the availability of existing facilities such as water supply system, repair shop, etc and low cost required for the installation of these facilities if they are to be installed newly and also because of the availability of acquired techniques and current strength of manpower. In this case, however, there should be a thorough study of the requirements described in paragraph 5 below.

(c) New merchant mill project at the location other than Tjilegon.
This project requires comparative review with other proposed plans under items (1) and (2) above from the standpoint of cost and in this case, the requirements described in paragraph 5 below should also be reviewed thoroughly.

(5) Precautions to be taken on expansion projects described in the preceding paragraph 4.

The existing merchant mill at Tjilegon is a multi-purpose plant designed for the production of all types of light section.

It will be necessary to determine whether the new mill should be of multi-purpose type with less production capacity, or the one specializing bar only, or the one designated for the production of shapes and round bars only, or the one such as the rod mill designed for the production of special items, according to the prevailing demand and also after a thorough review of profitability.

As a result, it may be necessary to convert existing mill at Tjilegon to the several small mills for the production of specialized items.

Our discussion had to be metaphysical partly due to lack of detailed information as has been mentioned previously. For the purpose of providing necessary information as a guide to the study of construction or alteration of a mill in the future, a merchant mill plan is attached to the following paragraph.

Under this plan, the scope of facilities are considered on the basis of the trend of demand in Indonesia. The construction cost for the facilities having a production capacity of 156,000 T/Y is estimated at US$7.2 million and the unit cost is estimated at 46 $/T. (with the future increase in the working ratio, the unit cost matching with the demand for approximately 200,000 T/Y in 1980 will be 36 $/T). On the other hand, our estimated unit cost for the Tjilegon plan (the maximum production: 110,000 T/Y, and the total construction cost: US$12.37 million) is 112 $/T, leaving the productivity of the Tjilegon as low as less than 30 %. Based on the above analysis it is expected that the operation of the Tjilegon will involve a major problem. We sincerely hope that the date we have furnished will be a help to the future study by the Indonesian Government.

C.4.3 An example of a typical merchant mill reflecting the trend of demand in Indonesia.

4.3.1 Introduction

In the past, our discussion was centered on the merchant mill (including wire drawing) based on the reactivation of the existing Tjilegon facilities. It was unfortunate for us that many assumption had to be made in the course of our study due to lack of adequate information. It is conceivable therefore, that our study also lacks completeness to some extent. Nevertheless, the impression, the survey mission gained was that in general the construction cost, particularly the cost of imported mechinery and equipment was comparatively high and that there could be no hope for the plant whose annual production capacity is about 100,000 tons from the standpoint of profitability under the existing circumstances. (Facilities of the Tjilegon is estimated at ¥3,280 million for imported items and ¥1,170 million for construction work, a total of ¥4,450 million, with the exception of open hearth furnace, cogging mill, power plant and water pipe line for outside the plant.) The mission tried to clearly indicate the approximate size and the construction cost of a plant equivalent to the one at Tjilegon on the assumption that the plant is to be constructed in Japan. In this task the mission considered the trend of demand in Indonesia. It hopes that this study in profitability will provide information and the recommendations for the parties concerned.

4.3.2 Layout

Layout of a standard merchant mill is divided into three specialized plants due to the reasons described in the following table.

Camparison between specialized plants and a multi-purpose plant

No.	Item	Specialized plants	Multi-purpose plant
1	Total construction cost	Low cost can be expected finally since the order of construction is adjustable to domestic demand	Low cost can be expected only when demand and production come to a same level
2	Progress of construction	Construction work can be promoted step by step (corresponding with the demand) and is highly adaptable same as above	Equipment installed are not fully utilized at the initial stage. Moreover, even when demand increased, the loss of equipment will still remain, waiting for the completion of next project.
3	Productivity	Because of less requirement for changing caliber rolls, improvement of working ratio is possible Loss time for changing roll is comparatively short. Loss time until the smooth operation after the change of roll can be minimized.	Because of wide difference between the minimum size and the maximum size for each type of products, requirement for changing caliber rolls inevitably increases, thus deteriorating productivity.
4	Unit consumption	Increase in the working ratio will in turn decrease all unit consumption. Roll planning will become easier and waste in roll grouve guide can be eliminated.	Unit consumption increases because of loss time. Unit consumption is particularly high for the production of small size.
5	Proficiency of worker	Because of simplification in the type of products (in each plant) proficiency of workers including that of new employes can be accomplished in a short period.	Proficiency of workers can not be easily attained because of small production of various items.
6	Equipment	Because of simplication in the type of product: Simplification of equipment is also possible. Rationalization is easily attained.	Rationalization can not be easily attained because of small production of various items.
7	Yield	Because of simplification in the type of products, occurrence of failure immediately after the change of caliber roll is less frequent and the yield increases accordingly.	In many cases, the product is changed to another type when both operators and equipment have at last familiarized themselves with. This causes frequent mishandling and as a result, yield decreases accordingly.
8	Operating personnel	Division of plant requires increase in the number of workers by 50 to 60% compared with multipurpose plant.	Operation of one system plant requires less number of workers for the time being, until the completion of next project.

Layout of equipment is shown on the attachment.

Comparison list of product size and production capacity between Indonesia's proposed multi-purpose plant and model plant consisting of several specialized mills.

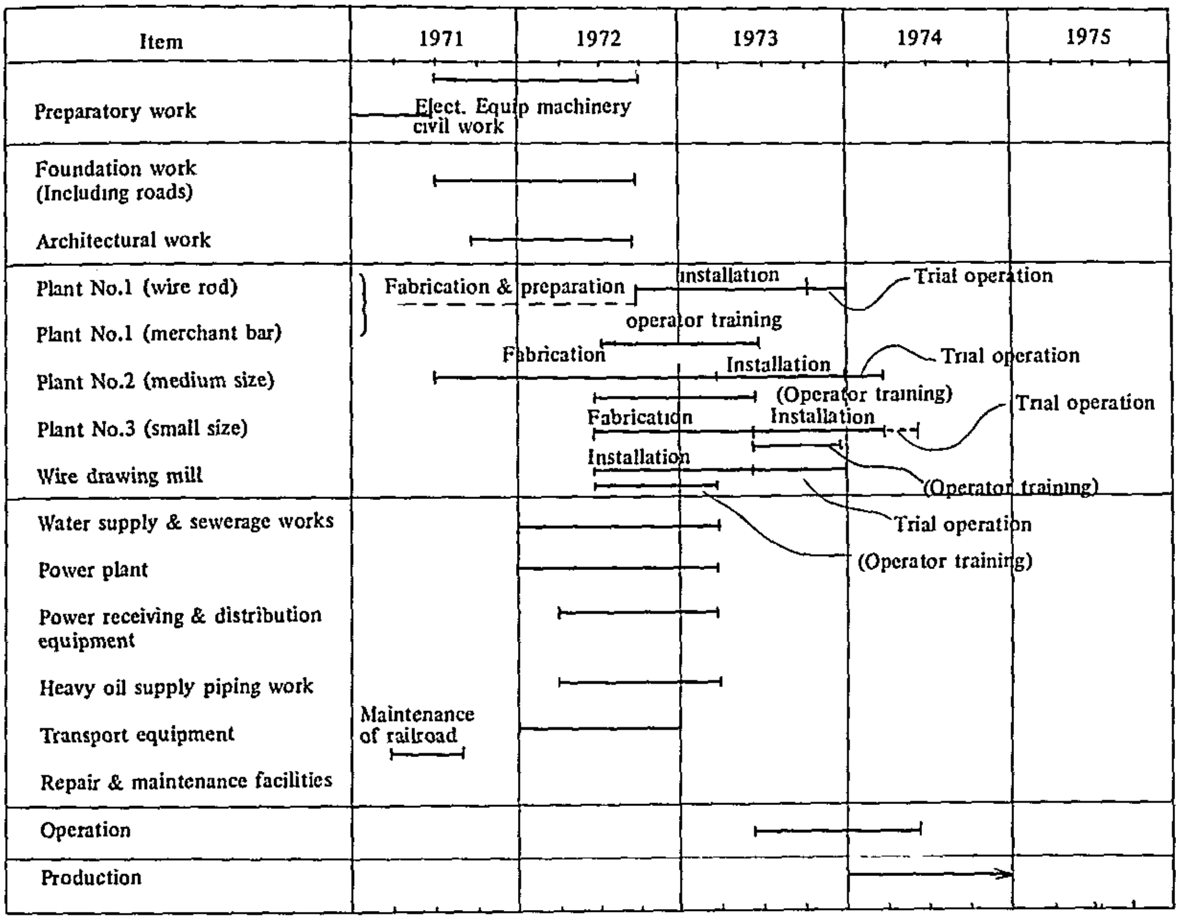
Products	Specialized plant			Multi-purpose plant
	Mill No. 1	Mill No. 2	Mill No. 3	
Wire rod	6 – 6.5 ϕ (Capacity) with 2 pieces of 6ϕ, 21m/sec, 660T/day x 60% working ratio = 400T/day			6 – 6.5 ϕ (Capacity) with 2 pieces of 6ϕ, 21m/sec. 660T/day x 60% working ratio = 400T/day
Round bar	9,10,13ϕ (Capacity) with 2 pieces (1/2 pieces in actual) of 10ϕ, 10m/sec, 600T/day x 53% working ratio = 315T/day	Large size 22–50ϕ (Capacity) 240T/day x 50% working ratio = 120T /day	Medium size 16–19ϕ	10–50ϕ (Capacity) with one piece of 13ϕ, 660T/day x 50% working ratio = 330T/day
Square & hexagon bar		Medium size: 22–50ϕ equipment (Capacity) 240T/day x 50% working ratio = 120T/day	Small size: 10–19ϕ equipment (Capacity) 120T/day x 50% working ratio = 60T/day	Equivalent to above (Capacity) same as for round bar
Flat bar		Medium size: (3–12 thick) x (45–125 wide) (Capacity) same as for round bar	Small size: (3–12 thick) x (12–38 wide) (Capacity) same as for round bar	(4–12 thick) x (12–125 wide) (Capacity) same as for round bar
Angle		Medium size. 50 x 5 – 80 x 80 x 12 (Capacity) same as for round bar	Small size: 20 x 20 x 3– 45 x 45 x 5 (Capacity) same as for round bar	20 x 20 side x 3 thick – 80 x 80 side x 12 thick (Capacity) with 1–2 size per month, around 300T/day
Hoop				(2–3.5 thick) x (20–50 wide)
Production comparison trial calculation (Note: In the case of specialized plant working ratio leaves room for further improvement)	Wire 400T/day x 8 days = 3,200 T/Month Round bar: 315T/day x 17 days = 5,300T/M Heating furnace: 16T/H x 1 unit improved to 20T/H in the future	Medium size: 120 T/day x 25 day = 3,000T/month Heating furnace 8T/H x 1 unit	Small size: 60T/day x 25 day = 1,500 T/month Heating furnace 5T/H x 1 unit	Wire: 400T/day x 7 days = 2,800T/month Flat & bar: 300 x 14 = 4,600 Shape: 300 x 4 = 1,200
	Total 13,000T/month = 156,000T/Year Space for future alteration or additional installation to be secured for all the furnaces.			Total 8,600T/month = 103,000T/Year

Reasons for not planning for the production of hoop are as follows:

1. Demand for hoop is considered to be very low.
2. Hoop is expected to be replaced by hot coil slitter product in the future.
3. Requirement for special equipment (such as vertical roll stand, high pressure water scale breaker, special coiler, etc) must be expected.

4.3.3 Construction plan and production planning to meet the increase in demand in Indonesia.

No. 1 Construction schedule



Under this plan, wire drawing process will be inaugurated first (latter part of 1973). Production of wire rod for use as wire drawing material will begin in 1974 and production of round bar with remaining capacity of the mill will also begin in the same year.

Production of square, hexagon, flat bar and angle will begin first with the small size (60 sq billet sheared in half will be used).

No.2 Production planning

Note: Figures in the column for "Demand (required production)" do not include 20,000T/Y of merchant bar, which has hitheto been considered as the capacity possible in Indonesia.

Year	Demand (Required production)	Mill No. 1		Mill No.2 Mediumsize	Mill No.3 Small size	Total	Counter Measures
		Wire rod	Round bar				
1974	Wire rod 36,000 T/Y	T/M				T/M	
Jan.	(3,000 T/M)	300	–	–	–	300	
Feb.	Merchant bar 91,000	400	–	–	–	400	
Mar.	(7,580)	500	100	200	–	800	
Apr.	Shape (18,000)	700	300	500	–	1,500	
May	(1,500)	900	500	700	1 shift	2,100	
Jun.	Total (145,000)	1,100	800	900	–	2,800	
Jul.	(12,080)	1,500	1,500	1,500	100	4,600	
Aug.		1,500	2,500	1,800	300	6,100	
Sep.		1,500	3,000	1,900	2 shift 500	6,900	
Oct.		2,000	3,500	2,400	800	8,700	
Nov.		2,500	4,500	2,800	1,300	11,000	
Dec.		3,000	5,000	3,000	3 shift 1,500	12,500	
		15,900	21,700	15,700	4,500	57,800	
1975	Wire rod 38,000 T/Y	8 day, 60%				3,160	
	(3,160T/M)	3,160					
	Merchant bar 94,000		17 day 53%	22 day 50%	25 day 50%	7,820	
	(7,820)		5,300	2,600	1,500		
	Shape 19,000						
	(1,580)					1,580	
	Total 151,000 (12,560)					12,560	13,000T/m production is possible within the range of previously mentioned working ratio
1976	Wire rod 40,000	9 day, 60%				3,330	Shortage in calculation is the figure which is to be included in the range of difference between 330 T/M (2.5% total production) and the actual achievement. Also allowing for the previously mentioned working ratio which was determined relatively low, production is considered to be possible with increased working efficiency.
	Merchant bar 10,000		16 day, 53%	25 day, 55%	25 day, 55%	8,330	
	(8,330)		5,050	3,300	1,650		
	Shape 20,000						
	(1,670)					1,670	
	Total 160,000 (13,330)					13,300	

1977	Wire rod 42,000	9 day 60 %				3,500	Reheating furnace at No.1 mill will be expanded (improved) from present 16T/H to 20 T/H. This work can be accomplished on normal maintenance days.
	(3,500)	3,500					
	Merchant bar 106,000		16 day 60%	25 day 55%	25 day 55%	8,830	
	(8,830)		5,630	3,300	1,650		
	Shape 21,000						
	(1,750)					1,750	
	Total 169,000 (14,080)					14,080	
1978	Wire rod 44,000	9 day 62%				3,670	Working ratio in No.1 & 2 mill shall increase to about 62%
	(3,670)	3,670					
	Merchant bar 112,000		16 day 62%	25 day 60%	25 day 55%		
	(9,330)		5,910	3,600	1,650	9,330	
	Shape 22,000						
	(1,830)					1,930	
	Total 178,000 (14,830)					14,830	
1979	Wire rod 46,000	9 day 65%					Working ratio in No.1 & 2 mill will be increased to about 65%
	(3,830)	3,830				3,830	
	Merchant bar 18,000		16 day 65%	25 day 65%	25 day 55%		
	(9,820)		6,190	3,900	1,650	9,820	
	Shape 23,000						
	(1,920)					1,920	
	Total 187,000 (15,570)					15,570	
1980	Wire rod 48,000	9 day 68%					Further efforts should be made to improve the working ratio. Production ratio by product type will be adjusted during the year through the combination of number of working days for each product type.
	(4,000)	4,000				4,000	
	Merchant bar 125,000		16 day 71%	25 day 65%	25 day 55%		
	(10,400)		6,850	3,900	1,650	10,400	
	Shape 24,000						
	(2,000)					2,000	

	Total 197,000 (16,400)					16,400	
1985	Wire rod 62,000 (5,170) Merchant bar 65,000 (13,750) Shape 30,000 (2,500) Total 257,000 (21,420)						Production of wire rod and production of small round bar (3/8" ϕ, 1/2"ϕ) in mill No.1 will be separate after construction of a new mill.

4.3.4 Facilities and equipment (Equivalent price in Japan)

No. 1 For merchant Mill

(Unit: ¥1,000)

	Item	Mill No 1	Mill No. 2	Mill No 3	Remarks
Building	Main buildings	197,280	189,000	189,000	Main bldgs: 10,500m² x 3 690m² x 1
	Auxiliary buildings		23,000		
	Sub total	197,280	212,000	189,000	Offices, locker room, latrine, warehouse, bath house, etc 700m²
Heating furnace	Billet re-heating furnace	(16 T/H)	(8 T/H)	(5 T/H)	
	Billet charging equipment				
	Firing equipment	35,000	20,000	15,000	
	Flue & stacks				
	Heavy oil tank	(35T x 3)	(35% x 1)	(35T x 1)	
		10,000	3,000	3,000	
	Sub total	45,000	23,000	18,000	
Roughing mill	Reducer	6,000	6,000	3,000	
	Fly wheel	2,500	3,000	1,600	
	Pinion stand	4,000	4,000	2,000	
	Mill stand	3,000	7,000	6,000	
	Tilting table	-	5,000	1,500	with chute
	Repeater	-	1,000	1,500	
	Operating floor	-	1,500	1,000	
	Sub total	15,500	27,500	16,600	

Intermediate mill	Reducer	28,000			
	Pinion stand	20,000			
	Mill stand	16,000			
	Repeater or trough	5,000			
	Sub total	69,000	–	–	
Finishing mill	Reducer	15,000	6,000	2,500	
	Pinion stand	12,000	3,000	1,000	
	Mill stand	34,000	10,000	5,000	
	Repeater or trough	1,000	4,000	2,500	
	Sub total	62,000	23,000	11,000	
Finishing equipment	Wire coiler	24,000	–	–	
	Low, high speed conveyor	8,000	–	–	
	Hook conveyor	30,000	–	–	
	Cooling bed	90,000	40,000	30,000	
	Product cutting machine	10,000	3 saw 9,000	2 units 6,000	
	Flying rotary shear	2 units 15,000	–	–	
	Pinch roller	5,000	–	–	
	Bandling	3,000	3,000	4,000	
	Sub total	185,000	52,000	40,000	
Auxiliary equipment	Roller conveyor	3,000	4,000	1,500	Cooling trough included.
	Operating floor	2,000	5,000	3,000	
	End shear	16,000	6,000	5,000	One rotary shear & one alligator shear in wire rod plant
	Casten shear	–	–	1,500	
	Coiler for mis product	500	600	300	
	Straightener	–	10,000	8,000	
	Sub total	21,500	25,600	19,300	
Crane	Electrical equipment	358,000	53,000	43,000	
	Crane, material yard	–	10 T x 1 5 T x 1 20,000	10 T x 1 3 T x 1 20,000	
	Crane, product yard	5 T x 1 7,500	3 T x 2 10,000	3 T x 2 10,000	
	Crane, mill yard	5 T x 1 7,500	–	–	
	Hoist and others	5 T x 1 5,000	–	2 T x 1 2,000	For roll lathe shop
	Sub total	20,000	30,000	32,000	

Other equipment	Truck scale and other scales	–	5,000	–		
	Compressor	–	2,000	–		
	Roll lathe	20,000	15,000	–		
	Other machine tool	–	10,000	–		
	Electric welding equip.	–	2,000	–		
	Gas welding equipment	–	2,000	–		
	Sub total	20,000	36,000	–		
Water supply & sewage system	Deep well	10,000	5,000	5,000		
	Pump and others	5,000	5,000	4,000		
	Piping (water supply)	8,000	3,000	3,000		
	Drainage	10,000	3,000	3,000		
	Water tank	10,000	5,000	5,000		
	Sub total	43,000	21,000	20,000		
Spare parts	Roll	25,000	15,000	10,000		
	Roller guide	5,000	–	–		
	Guides etc.	10,000	10,000	10,000		
	Repeater base	5,000	5,000	5,000		
	Spindle, coupling	5,000	5,000	3,000		
	Resin bearing	5,000	4,000	3,000		
	Spare stand	72,000	–	–		
	Spare bearing	15,000	–	–		
	Sub total	142,000	39,000	31,000		
Erection	Equipment foundation	40,000	20,000	15,000		
	Cost of equipment installation	20,000	10,000	5,000		
	Cost of installation of electrical equipment & wiring	53,000	8,000	6,500		
	Sub total	113,000	38,000	26,500		
	Total	1,291,280	80,100	446,400	Grand Total: 2,317,780 *	
Capacity of electric equipment	6,000 Volt system	Motor 5,680kw	2,200kw	1,200kw	Others 75kw	Total
		MG 500	–	–	Total 9,655 kw	
	380 Volt system	380	300	300	2,700	3,680
	Lighting				400	400
	Total	6,560	2,500	1,500	3,175	13,735 kw

* US$6,600,000

For additional information, following is the result of trial calculation of construction cost of power generating plant:

Normal load	Mill No. 1 120 kwH/T x 34 T/H =	4,000 kw
	Mill No. 2 80 kwH/T x 12 T/H =	1,000 kw
	Mill No. 3 100 kwH/T x 6 T/H =	600 kw
	Related facilities	3,400 kw
	Total	9,000 kw

9,000 kw x 1.5 (Load factor) x 0.8 (diversity) = 10,800 kw

(Unit: ¥ 1,000)

	Diesel generator plan		Turbo-generator plan		Remarks
Boiler		0	Outdoor type 75 T/H 40 atsmss 450°C, 2 units	560,000	
Generator	6,000 KVA 6 KV cos ϕ = 0.85 3 units	480,000	12,000kw 2 sets	720,000	
High voltage panel		14,000		12,000	
In-house electric source	Transformers, batteries and others	10,000	Transformers, batteries and others	10,000	
Heavy oil equipment	Oil tank	30,000	Service tank, heavy oil burner	20,000	
Cooling water tank		6,000		0	
Other related facilities		2,000		4,000	
Building & civil work		50,000		100,000	
Erection		48,000		70,000	
Cable work to rolling mill power room		15,000		15,000	
Total		655,000		1,511,000	

No. 2 For wire drawing mill

(Unit: ¥1,000)

Description of facilities		Quantity	Weight (T)	Amount	Remarks
Acid bath	HCl pickling bath	3	80	5,000	
	Water wash tank	3			
	Liming bath	1			
	Drying furnace	1		5,000	
	Sub total			10,000	
Wire drawing	4 drum type drawing machine	2	20	17,600	Capacity (6.5 ϕ 1.9ϕ) (5.5 ϕ 1.5 ϕ) . . . 15T/day 40HP x 8 units included
	3 drum type drawing machine	2	15	13,200	Capacity (6.5 ϕ 3,2 ϕ) (5.5 ϕ 2.4 ϕ) . . . 30T/day or (6.5 ϕ 4 ϕ) (5.5 ϕ 3.2 ϕ) . . . 42T/day, 40HP x 6 units included
	Coiler for the above	4	8	7,200	600 ϕ ID, 10HP x 4 units included.
	6 drum type drawing machine	1	6	6,000	Capacity (2.4ϕ 1.6 ϕ 1.0 ϕ . . . 3T/day, 7.5 HP x 6 units included.
	Coiler for the above	1	2	1,800	400 ϕ ID, 10 HP x 1 unit included.
	Wire welder	5		1,200	
	Sub total			47,000	
Galvanization	Galvanizing line (large size)	1	150	35,000	6 ϕ (0.09 m/sec) 1.5 ϕ (0.73 m/sec) . . . average 35T/day
	Galvanizing line (small size)	1			Less than 1.5 ϕ . . . 10T/day or less
	Welder for the above	2		500	
	Sub total			35,500	
Others	Packing device	1		1,500	
	Hoist or forklift	2	10	10,000	Over 2 T
	Foundation work			5,000	
	Building work	3,000 m^2		75,000	Acid bath – 240 m^2, wire drawing – 480 m^2, galvanization – 1,320 m^2, material & product storage – 960 m^2, totaling 3,000 m^2.
	Other related facilities	Complete		20,000	Receiving & wiring work for electric equipment having capacity of approx. 600 kw and water supply & sewerage system.
	Sub total			111,500	
	Total		Approx. 300 T	204,000	= US$567,000

4.3.5 Manpower plan

Job site		For merchant mill				For wire drawing mill		
		Mill No.1	Mill No.2	Mill No.3	Remarks	Job site	Operator	Remarks
Heating	Charging	2 men x 3 shift = 6 men	2 men x 3 shift = 6 men	2 men x 3 shift = 6 men	Foremen included	Supervisor	1 man x 3 shift = 3 men	
	Discharging	3" = 9	2" = 6	2" = 6		Acid bath	1 x 2 = 2	
	Sub total	15	12	12				
Rolling	Rough rolling	4" = 12	12" = 36	14" = 42		Wire drawing	5 x 3 = 15	
	Intermediate rolling / Finish rolling	4" = 12	8" = 24	8" = 24				
	Sub total	24	60	66				
Finishing	Coiler & shear / Bandling / Others	20" = 60	6" = 18	15" = 45		Galvanizing	7 x 3 = 21	
	Sub total	60	18	45				
	Crane	3	8	8		Transport	2 x 2 = 4	
Material & product	Material	10	4	12				
	Product	12	6	6				
	Sub total	22	10	18				
Maintenance	Electrical	10	6	3		Electrician	1 x 1 = 1	
	Machining	10	6	6		Repairing maintenance of dies	3 x 1 = 3	
	Welding	8	2	-				
	Sub total	28	14	9				
Inspection & straightening		12	20	18		Inspection	2 x 1 = 2	
	Total	164	142	176	Total 482	Total	51	
Skilled worker		71	94	95	260	Skilled worker	7	
Unskilled worker		93	48	81	222	Unskilled worker	44	
	Total	164	142	176	Total 482	Total	51	
Supervisory personnel	Plant manager	1				Engineer	2	
	Chief, production section	1						
	Staff, production section	4				Clerk	2	
	Chief, engineering section	1						

Staff, engineering section	2		
Chief, administrative section	1	Labor	1
Staff, administrative section	6	Shipping	1
Female employe	8	Female	2
Guard	8		
Total	32	Total	8
Grand Total	514		59

4.3.6 Yield and Unit Consumption

Item	Merchant mill			Wie drawing mill	
	Mill No.1	Mill No.2	Mill No.3	Unit consumption from acid bath to wire drawing	Unit consumption to be added for galvanization
Yield	93.5%	90.0%	90.0%	Over 2 mm ϕ – 97.5% Under 2 mm ϕ – 96.0%)	Average 97.0%
Yield loss (material)	70 kg	110 kg	110 kg		
Return scrap	60 kg	94 kg	94 kg		
Fuel	50 ℓ/T	60 ℓ/T	65 ℓ/T	0.5 ℓ/T	100 ℓ/T
Electric power	120 kwH/T	80 kwH/T	100kwH/T	70 kwH/T	30 kwH/T
Water	12 m^3/min	4 m^3/min	1.5 m^2/min	6(acid bath) + 5 (wire drawing) = 11 m^3/T	10 m_3/T
Roll	1.25kg/T	1.8kg/T	1.5kg/T	-------	------
Tools & consumable supplies	220¥/T	300¥/T	250¥/T	21 + 150 = 171¥/T	845¥/T
Repair & maintenance	250¥/T	400¥/T	300 ¥/T		
Acid bath supplies	---	---	---		
HCl (35% conv.)				12 kg/T	
Lime				1.2 kg/T	-----
Soap				0.5 kg/T	-----
Supplies for galvanization	---	---	---	---	
Lead					2 kg/T
Zinc chloride					1.3 kg/T
Zinc					No.1 Type 10 kg/T No.3 Type 35 – 40 Average: 24 kg/T
Aluminium					Only No.1 type used 0.3 kg/T

Note:

1. Production planning for 1975 is to be used as a precondition.
2. Definition of yield: Yield loss in ton = $\frac{\text{Production}}{\text{Yield}}$ – production.
3. Return = Yield loss x 85%
4. Quantity of water in the column for merchant mill indicates total quantity of water required.
5. Prices shown are those in Japan.
6. Type I galvanization and type 3 galvanization in the column for wire drawing mill are such as:

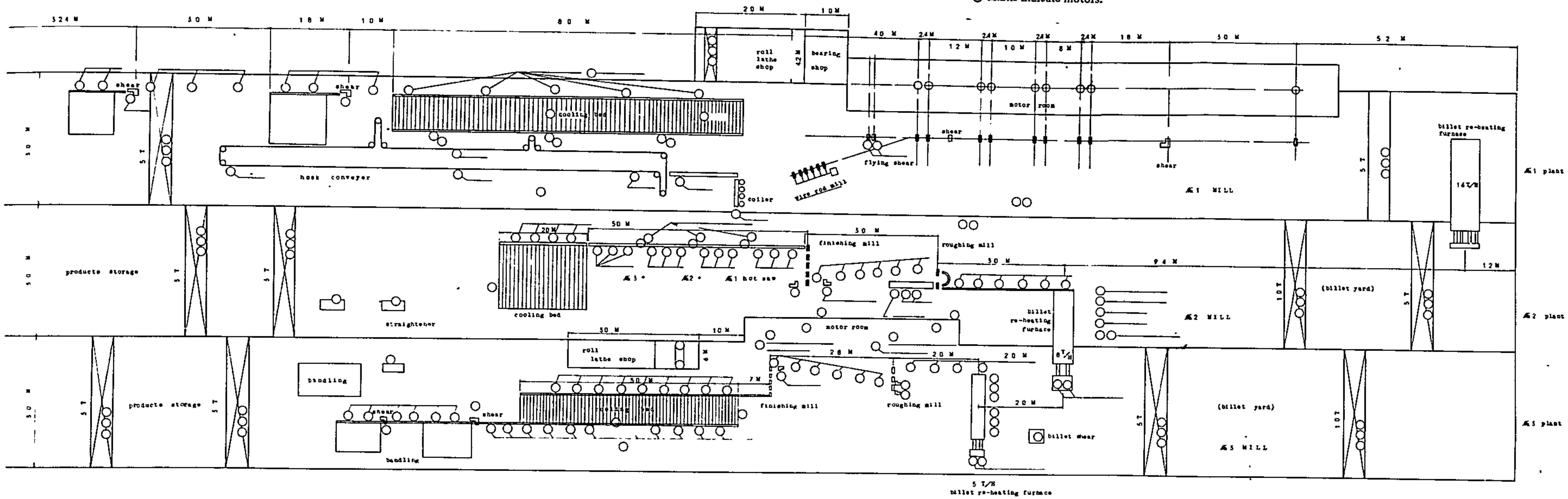
	JIS No.1 type/or low grade	Type 2	Type 3	Type 4
(Example) 4 ϕ	37 gr/m² or more (0.12 ounce)	57 gr/m² or more (0.19 ounce)	153 gr/m² or more (0.5 ounce)	244 gr/m² (0.8 ounce)

SIZE
(NO - SCALE)

total length 350M

Notes:

1. As one opinion, the span of plant No.1 may be expanded by about 2m to accommodate No. 3 plant equipment. For this purpose, the rolling line and the motor room in plant No. 1 will be moved up on the drawing and, the location of wire rod mill, coiler and hook conveyor will also be moved up across cooling bed on the drawing. This provides better access to the wire drawing plant.
2. In the above case, the cooling bed of plant No. 3 locates back to back with the cooling bed of plant No. 1.
3. Roll lathe plant will be integrated into an appropriate location.
4. Space for the future alteration and expansion of reheating furnace must be considered.
5. O Marks indicate motors.



C.4.4 Financial forecast and recommendations

4.4.1 Estimate of production cost (For full operation in 1975)

(Unit: US$)

Product / Expense Item	Bar & Section			Nail Wire			Galv. Wire		
	Quantity	Unit price	Amount /T	Quantity	Unit price	Amount /T	Quantity	Unit price	Amount /T
Out-put	110,500T/Y			15,000T/Y(9,000+6,000)			6,000T/Y		
Yield		94%			98%			100%	
Imported billet	1.063	86.93	92.40	–		–	–		–
Wire rod	–		–	T 1.020	111.65	113.88	–		–
Wire	–		–	–		–	T 1.000	124.03	124.03
Zinc	–		–	–		–	24 kg	0.28	6.73
Returned scrap	T 0.032	40.00.	(-) 1.30	T 1.010	40.00	(-) 0.40	–		–
Scale	T 0.016	16.00	(-) 0.30	–		–	–		–
Sub total			90.80			113.48			130.76
Fuel	60 l	0.017	1.02	0.5 l		0.01	95.5 l		1.62
Power	90 kwH	0.017	1.53	70 kwH		1.19	30 kwH		0.51
Water	25 m^3	0.033	0.83	11 m^3		0.36	10 m^3		0.33
Roll	1.9 kg	672.00	1.28	–		–	–		–
Hydrochloric acid	–		–	12 kg	0.021	0.25	20 kg		0.42
Soap	–		–			0.25	–		–
Lime	–		–	1.2 kg	0.031	0.04	–		–
Lead (P6)	–		–	–		–	24 kg	0.29	0.58
AL	–		–	–		–	0.3 kg	0.56	0.17
Zinc chloride	–		–	–		–	1.3 kg	0.15	0.19
Consumable supplies			2.00			0.50			2.30
Labor	295		1.14	40		1.33	30		2.50
Depreciation			5.97			3.46			3.71
Repair & maintenance			2.53			1.45			1.56
Administrative expenses & others			1.50			1.71			2.02
Sub total			17.80			10.50			15.91
Production cost			108.60			124.03			146.67

Note: 1. Unit price of imported billet includes US$77.00 C & F Djakarta, 4% import charge, 5 % handling charge and 3 US$/T transport charge.

2. Cost (108.60) of bar and section is the average of the costs of wire rod (111.65) and other bar and section (106.97). Its calculation is based on each T/H.

3. Annual escalation of 5 % from the present base is included in the estimate of labor cost.

4. Straight line method with 16 years service life is used for depreciation.

5. Repair and maintenance cost is estimated to be at 2.5 % of capital cost. (Ratio of own repair & maintenance is approx. 50 %)

6. US$1.00 = RP.300 (As of July 1968).

4.4.2 Profitability study and recommendations

(1) Financial Plan

For the success of an Indonesian government's plan to establish a private enterprise in the form of joint venture with the participation of people's capital (100% foreign capital is acceptable for the investment amounting over $2.5 million) for the construction and operation of a merchant will with reactivated Tjilegon facilities, there must be a definite measure for the solution of numerous problems that may be brought up in the course of the following profitability study.

(Unit: US$1.000)

Fund required		Source of fund		
1. Land	150	1. Capital	12,970	100%
2. Estimated cost for the completed portion	9,970	(Indonesia capital)	(9,970)	(76 9)
(Imported machinery)	(9,120)	(Foreign capital)	(3,000)	(23 1)
(Construction cost)	(850)	2. Long-term loans	3.00	
3. Required cost for the completion	2,400	3. Short-term loans	0	
4. Engineering service	400			
5. Training expenses	50			
6. Prestart-up expense	50			
7. Organization expense	300			
8. Interest during construction	400			
9. Working capital	2,250			
Total	15,970	Total	15,970	

Note:

1. Available land space is approximately 50,000 m^2. Estimation of land was made merely on assumption.
2. Engineering service shown includes fee for assistance provided in the field of construction and erection, and in the plant operation by 5 persons for approximately 36 months.
3. Training expenses shown is for 3 engineers, 3 foremen and 26 workers, a total of 33 operators. This is an estimate including living expenses and travel expenses for a 8 month period for merchant mill operators and a 3 month period for wire drawing operators.
4. Prestart-up expense shown is an estimate of cost of raw materials, operation auxiliary materials and wages that are required during prestart-up period.
5. Organization expenses shown include expenses required for the establishment of a corporate, opening of offices and necessary investigations, etc.
6. Interest during construction shown is the interest that occure during construction which is expected to amount to around $3 million for long-term loans at the rate of 6-7/8 % (payment on 12 year installment after the period of 4 years grace.)
7. Working capital is estimated to be the amount equivalent to about two months annual total cost. (manufacturing, selling and administrative).
8. Capital investment by Indonesia sides is tentatively set to be the amount equivalent to the total cost for the completed portion of the project. The remainder of required fund is estimated to be filled by foreign capital and long-term loans on equal terms (fifty-fifty basis).
9. As to the short-term loans, because of uncertainly for its domestic procurement and also due to unstable interest rate under current inflation, no estimate has been made for this financial plan. This matter, therefore, should be given due consideration on a realistic basis.

(2) Estimated profit and loss (For full operation in 1975)

It is rather difficult to make a forecast of sales price of steel products in Indonesia because of present incomplete distribution channel. The majority of steel products in demand have to be imported and the market price is said to be 20 to 30 % higher than C & F price according to government sources.

Breakdown of extra charges is shown below:

Import duties . . . . No tax is imposed except for 5 % duties imposed on nail wire.

Charges	Insurance, B.L.L.D. tax, Bank charge, importers commission, Handling charge	Approximately 10%
Sales tax	A uniform 5% tax on all items except for semi-finished products such as billet, etc.	
Estimated profit	5 – 10 %	Total 20 – 30%

Shown above is the current situation and it is expected that this situation continues to exist in the future if import of products is to continue. However, the construction of a plant in its own country and self-supply of products, though it may be a mere processing of semi-finished product, will result in the saving of foreign currency and at the same time makes it possible to supply domestically produced base materials at low cost (protection by customs duties as a transitional means may be considered), thus greatly promoting the economy of the nation. Therefore, there should be no reason that the current sales price which was formed at the market through the past import of products is to be left intact.

Since the way in which market price was formed in the past is very questionable, the survey mission made the following assumption on future domestic sales price which the mission considers very appropriate under existing circumstances. C & F Djakarta price list for recently imported steel products has already been mentioned, therefore, the average price by size is shown below:

Bar & light section	C & F 120 x 115% = 138 S/T.	
Wire rod	C & F 96 x 115% = 110 S/T.	
Nail wire	C & F 130 x 120% = 156 S/T.	(5% import duty)
Galv. wire	C & F 165 x 115% = 189 S/T.	

Based on the above figures, the total annual sale by the Tjilegon merchant mill is estimated as follows:

Bar & light section	72,000 T/Y x 138 =	9,936	($1,000)
Wire rod	23,200 T/Y x 110 =	2,552	"
Nail wire	9,000 T/Y x 156 =	1,404	"
Galv. wire	6,000 T/Y x 189 =	1,154	"
Total	110,200 T/Y x	15,046	"

Estimated profit and loss

(Unit: US$1,000)

1.	Estimated total sales revenue	15,046 (100%)	Output equals sales
2.	Total cost of production	(-) 12,288	Output x unit cost per ton
3.	Gross profit	2,758 (18.3%)	
4.	General administrative and selling expenses	(-) 301	2% of total sale
5.	Selling tax	(-) 752	5% of total sale
6.	Operating profit	1,705 (11.3%)	
7.	Non-Operating expenses	450	
	(Interest)	(210)	6-7/8% x 3,000 ($1,000)
	(Miscellaneous losses)	(240)	Amortization of deferred assets etc. (even rate for 5 years after initial operation)
8.	Net profit (before tax)	1,255 (8.3%)	
9.	Appropriation of profit		
	1) Corporate income tax reserve	753	Net profit x 60%
	2) Legal reserves	126	
	3) Officers bonuses	20	
	4) Profit available for dividend	356	2.74% against capital

For the appropriation of profit, above US$753,000, an equivalent of corporate income tax reserve, is initially earmarked as a normal procedure. However, with the realization of tax exemption under the law No.1 which came into effect in 1967, profit available for dividend is increased to US$1,109,000 and the ratio to the capital is 8.6% in real term. However, since carry-over of losses incurred during the preceding start-up period prior to the initial phase of commercial operation must be expected as a matter of course and at the same time, appropriation of profit for the 10% dividend on the constant base must also be maintained from a standpoint of commercial base, some measures must be taken to deal with these situations.

Since the capital contribution by the Indonesian Sides in the form of property is the amount equivalent to the total cost for the portion of the project completed in compliance with the original contract and also due to the fact that the amount represent a nominal value and not a real value as shown in the previously mentioned estimate on the standard construction cost, it is appropriate to make some devaluation of the value to around US$6,500,000. This will bring the capital to around $9,500,000 and the ratio to the capital will be 11.7% (after corporate income tax).

(3) Financial Recommendations

As a matter of course, the calculations made so far is based on the premises which included many assumptions, therefore it is risky to draw a definite conclusion from the resultant figures, and the calculations made are not intended for that purpose either. Only intent of the survey mission in mentioning a series of calculation is to clearly indicate what measures are to be considered in advance to make this project a success and where the emphasis should be placed.

(a) Part of the project, such as water supply. power generation and port facilities should be separated from the merchant mill project and should be completed as an independent project under the sole responsibility of the government and the third parties. Arrangements should be made by the government for the supply of power and water to the mill at a reasonable unit price

(b) The details of the terms of credit made by the U.S.S.R. are not available. The new company which will operate and manage the steel plant should not be responsible for the early repayment of loans made by the U.S.S.R. Repayments, if any, should be on a long term basis, after successful operation of the plant.

(c) Private enterprise may come in many forms. It would be appropriate for the government to make a contribution in the form of property other than money, i.e., the merchant mill, including related auxiliary facilities, and possibly entrust the entire management of the company with a private sector It is also necessary to give due consideration for the smooth operation of the project on commercial basis by reducing the capital cost of equipment. Likewise, the real estate should be leased to the company free of charge or at very low cost.

The Indonesian Government has already taken a measure for the encouragement of new enterprises by enforcing the Law No.1 – Foreign Capital Investment – in 1967.

The encouragement given to private enterprises and assistance of the government in setting up steel industry in the country is a step in the right direction

D SINGAPORE

D. SINGAPORE

D.1 Present Situation and Forecast of Demand and Supply of Steel Products in Singapore.

D.1.1 Economic background and present situation of demand and supply of steel product

Singapore has a population of approximately two million, the rate of its increase is about 2.5% annually. Due to the withdrawal of the British Forces, the government has faced two major problems, the turnover of labour and decrease of foreign currency income. To cope with this situation, especially to create employment for labour population, the government has been making serious efforts to develop the national economy by promoting intensive industrialization. The government policy to attract various manufacturing enterprises in the Jurong Industrial Estate and to give them proper protective and fostering measures is a manifestation of this effort. The government has been giving protection and favorable treatment to the industries with the expectations that they will have enough strength to stand international competition.

Table 1. Steel Product Consumption Compared with Gross National Products

	1962	1963	1964	1965	1966
Steel product consumption (A) (1,000 M.T.)	123.2	133.3	157.6	184.3	178.4
Gross national products (B) (Billion S$) (market price)	2.54	2.88	2.96	3.19	3.39
Steel product consumption per Billion S$ (1,000 A/B ton)	4.85	4.63	5.32	5.78	5.26
Population (end of year, Million)	1.73	1.73	1.82	1.86	1.91

Table 2. Transition of Population in Singapore

Estimate	1,000 persons	Ratio to previous year	Annual rate
1962	1,732.8	%	
1963	1,775.2	+2.45	
1964	1,820.0	+2.52	
1965	1,864.9	+2.47	
1966	1,913.5	+2.61	
1967	1,955.6	+2.20	
1967/62	1.129		2.4 (%)

Source: Monthly Digest of Statistics (Singapore) June 1968.

The Singapore government is now reconsidering its economic development plan. The target of development aimed by the Government is rather high.

The Government's effort for economic development has achieved a sound success judging from the growth of the gross national products from 5.8% annually during last 10 years to 7.3% annually during last 5 years.

With these economic development in the background, the demand for steel products has been growing steadily, the rate of growth between 1962 to 1967 being 14.2% annually.

Table 3. Actual Figures of GDP of Singapore (Million S$)

	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	67/57	
GDP *	1.94	2.06	21.2	2.04	2.13	2.43	2.54	2.88	2.96	3.19	3.39	3.61	Annual Com-parison	Annual Rate
Growth rate	—	6.2	2.9	-3.8	4.4	14.1	4.5	13.4	2.8	7.8	6.5	6.5	1.752	5.8

* Market price Source: Economic Survey of Asia and Far East 1967. UN.
(Figures for 1966 and 1967 are obtained by hearing at Singapore)

Table 4. Apparent Consumption of Steel Products (Unit: 1,000 M.T.)

	Actual Figures					
	1962	1963	1964	1965	1966	1967
Finished products	123.226	133.326	157.595	184.357	178.436	239.230
Flat products	62.368	68.452	79.700	106.195	91.344	129.681
Others	60.858	64.874	77.895	78.162	87.092	109.549

	(Ratio classified by Products (Actual figures, %)					
	1962	1963	1964	1965	1966	1967
Finished products	100.0	100.0	100.0	100.0	100.0	100.0
Flat products	50.6	51.3	50.6	57.6	51.2	54.2
Others	49.4	48.7	49.4	42.4	48.8	45.8

Source: EDB data and others, Singapore.

As seen above, the elasiticity to GDP is 1.94. The demand for steel products has been growing at a fairly high rate.

Table 5. Ordinary Carbon Steel Apparent Consumption (Unit: M.T.)

Product		Year	1962	1963	1964	1965	1966	1967
Ordinary carbon steel	Section & Others	Pig iron	6,501	9,574	2,691	7,947	8,216	19,052
		Bloom	4,899	6,951	5,880	15,969	2,948	21,588
		Bar	40,759	36,503	55,652	49,247	44,511	67,451
		Bar products	-144	2,395	5,615	5,822	5,216	17,659
		Shape (over 80 mm)	-1,856	204	3,015	6,390	13,261	9,366
		Shape (under 80 mm)	12,865	16,625	12,712	16,000	16,444	11,941
		Total	51,624	55,727	76,993	76,924	79,432	106,417
	Flat products	Plate (over 4.75 mm)	14,080	18,335	24,563	33,255	29,961	33,283
		Medium plate (3–4.5mm)	4,907	1,863	-763	1,892	4,800	5,624
		Sheet (under 3 mm)	11,303	9,948	24,414	29,340	34,135	48,349
		Hoop (for pipe)	752	916	3,333	9,618	11,764	16,492
		Tin sheet (Prime)	14,273	15,191	17,255	23,479	24,755	22,801
		Galvanized plate	9,460	12,599	8,171	13,369	11,938	11,546
		Coated plate	—	687	1,246	1,840	3,167	439
		Pipe (welded)	3,990	6,668	1,854	12,598	-10,481	19,893
		Total	58,765	66,207	80,072	125,393	110,039	158,427
		Production overlapped	—	—	2,439	21,845	25,401	37,797
		Net consumption	58,765	66,207	77,633	103,548	84,638	120,630

* Production overlapped means black sheets for galvanizing and sheets for piping.
* Net consumption is that excluded production overlapped; apparent consumption is production + import-export.
* Beside above figures, there are high carbon steel products and others (secondary products) which make the figures in above Table 5 inconsistent with those in Table 4.

D.1.2 Forecast of demand for steel products

In order to forecast the steel demand in the future, forecast for the GDP is required. The reliable data for this purpose is not available at the Singapore Government or any other sources.

The estimate of growth of GDP in the future is made by the cross-sectional method utilizing various international economic data, using 1967 as a base year.

Table 6. Estimated GDP in future in Singapore

		1970	1975	1980	1985
G D P	Million S$	3.84	5.11	6.67	85.0
Annual growth rate	%	1967–70 6.5	1971–75 6.0	1976–80 5.5	1981–85 5.0

Basing on this figure and taking account of the record of steel demand in the past, demand for steel products in the future is estimated as follows.

Table 7. Forecast of Apparent Consumption of Steel Products

(Unit: M.T.)

	1970	1971	1972	1973	1974	1975	1980	1985
Finished products	272,000	289,600	308,500	328,600	350,000	373,000	499,000	636,000
Flat Products	141,400	150,592	160,420	172,186	183,400	195,452	274,000	366,000
Others	130,600	139,008	148,080	156,414	166,600	177,548	225,000	270,000

	Ratio by products (estimated %)				Average annual growth rate (Unit M.T)				
	1970	1975	1980	1985	70/65	75/70	80/75	85/80	85/70
Finished products	100.0	100.0	100.0	100.0	8.0	6.5	6.0	5.0	5.8
Flat products	52.0	52.4	55.0	57.5	5.9	6.7	7.0	6.0	6.5
Others	48.0	47.6	45.0	52.5	10.8	6.3	4.9	3.8	5.0

The result of the First Survey Mission, ECAFE, in 1967 is lower than that made by the Second Survey Mission as shown in the following table. The difference between them is due to the fact that in the current survey actual conditions in 1967 and 1968 have been taken into account.

Year	ECAFE First Survey Mission 1,000 M.T.	This report 1,000 M.T.
1970	226	272
1975	309	373
1980	405	499
1985	515	636

D.1.3 Feature of demand for steel products

The feature of steel product demand in Singapore is shown in the aforesaid apparent consumption classified by products growing ratio of flat products in the demand for steel products. The major part of demand for flat products consists of the demand for those of 4 75mm or more in thickness to be used at the Jurong Shipyards, cold rolled sheets for tinning mill, plates or sheets for welded pipes and galvanized sheets for general consumrers.

The hot dipped galvanized sheets produced in Singapore are those of the Japanese Industrial Standard G3302, and the corrugated GI sheets are 8 corrugations, 3" pitched, 752mm (30 inches) wide (before corrugation).

Steel pipes are produced by two plants. The dimensions and weights of pipes produced by one of them, the Simalpan Steel Pipe Co., are shown in the following table.

Table 8–1. Dimensions and Weights in Accordance with B.S. 1387/1957.
(Simalpan Steel)
(British Units)

Nom. Bore. Inches	Approx. Outside Diam.		WALL THICKNESS						Weight per Foot of Black Tube Plain Ends			Number of Threads Per inch
			Light		Medium		Heavy		Light	Medium	Heavy	
	Inches	mm	Inches	mm	Inches	mm	Inches	mm	Lbs.	Lbs.	Lbs.	
1/2"	27/32	21.4	0.080	2.0	0.104	2.6	0.128	3.2	0.640	0.822	0.977	14
3/4	1.1/16	27.0	0.092	2.3	0.104	2.6	0.128	3.2	0.944	1.06	1.27	14
1	1.11/32	34.1	0.104	2.6	0.128	3.2	0.160	4.1	1.35	1.64	2.00	11
1-1/2	1.11/16	42.9	0.104	2.6	0.128	3.2	0.160	4.1	1.73	2.11	2.58	11
1-1/2	1.29/32	48.4	0.116	2.9	0.128	3.2	0.160	4.1	2.19	2.43	2.98	11
2	2.3/8	60.3	0.116	2.9	0.144	3.6	0.176	4.5	2.76	3.42	4.14	11
2-1/2	3	76.2	0.128	3.2	0.144	3.6	0.176	4.5	3.90	4.38	5.31	11
3	3.1/2	88.9	0.128	3.2	0.160	4.1	0.192	4.9	4.58	5.69	6.76	11
4	4.1/2	114.3	0.144	3.6	0.176	4.5	0.212	5.4	6.64	8.14	9.71	11

All weights per foot are those established by the International Standard Organization.

Table 8–2. Weight Range in KGS/FOOT (Simalpan Steel)

Size/Thickness		3.00mm	3.25mm	4.06mm	4.90mm	5.40mm	6.35mm
6"	I/D	3.504	3.802	4.774	5.793	6.404	7.577
	O/D	3.369	3.643	4.527	5.432	5.967	6.971
8"	I/D	4.649	5.043	6.325	7.664	8.466	10.001
	O/D	4.514	4.884	6.077	7.303	8.029	9.395
10"	I/D	5.795	6.283	7.875	9.535	10.528	12.426
	O/D	5.659	6.125	7.627	9.174	10.091	11.820
12"	I/D	6.940	7.524	9.425	11.405	12.590	14.850
	O/D	6.805	7.366	9.177	11.044	12.153	14.245
14"	I/D	8.086	8.765	10.975	13.276	14.652	17.275
	O/D	7.950	8.606	10.728	12.915	14.215	16.670
16"	I/D	9.231	10.006	12.526	15.147	16.714	19.700
	O/D	9.096	9.847	12.278	14.786	16.277	19.094
18"	I/D	10.376	11.247	14.076	17.018	18.776	22.124
	O/D	10.241	11.088	13.828	16.657	18.339	21.518
20"	I/D	11.522	12.488	15.626	18.889	20.838	24.549
	O/D	11.386	12.329	15.378	18.528	20.401	23.943
22"	I/D	12.667	13.729	17.177	10.759	22.900	26.974
	O/D	12.532	13.570	16.928	20.398	22.463	26.368
24"	I/D	13.812	14.969	18.727	22.630	24.962	29.398
	O/D	13.677	14.810	18.479	22.269	24.525	28.792

The correct information of weight range from 26" up to 40" and the pressure table from 6" up to 49" will be given on request.

Comparative test pressures to comply with the following specifications are:

B.S.S.	534:3601	692 lbs per square inch.
B.S.S.	1387	700 lbs per square inch.
		783 lbs per square inch. Grade A pipe.
A.P.I. Std. SL		800 lbs per square inch. Grade A pipe.

The Malaysia Steel Pipe produces medium and small dia. pipes. Those of less than 4" dia and not galvanized are used mainly for furniture making and those galvanized for construction works (for water and gas pipes).

Generally speaking, the demand for flat steel products increases with the progress of industrialization promoted by the economic development policy, and it is anticipated that in early 1970's, when the new shipbuilding yard will start its operation and expansion of the existing Jurong Shipyard will be completed, the demand for flat products will certainly increase.

The weight of sections in the total demand for steel products decreases as one general feature of economic development. This feature may continue in the future.

The main part of demand for sections is for bars to be used in building and civil engineering works. Demand for wire rods is gradually increasing due to the development in secondary products. As large projects such as port and other construction works are increasing, consumption of shapes is also steadily growing.

Most of the round bars for various uses are produced by the National Iron & Steel Mills, Ltd.

The varieties of its products and prices in domestic market are as follows:

Table 9. Domestic Market Price on Products of the National Iron & Steel Mills Ltd.

Products	Size	Singapore Dollar Long Ton
Mild Steel Round Bar (B.S. 785)	1/4"	365.0
	3/8"	325.0
	1/2"	320.0
	5/8" 3/4" 7/8" 1"	315.0
	1-1/8	320.0
High Tensile Deformed Bar (SINGACON–B.S. 114, ASTM–A15)	3/8"	378.5
	1/2"	363.5
	5/8" 3/4" 7/8" 1"	353.5
	1-1/8"	363.5
	1-1/4"	383.5
Mild Steel Flat Bar	3/16" x 5/8"	330.0
	3/16" x 3/4"	330.0
Mild Steel Square Bar	9 mm^2	325.0
	12 mm^2, 15 mm^2	320.0
Mild Steel Angle Bar	6 x 50 x 50 mm	330.0
	6 x 63 x 63 mm	330.0
	6 x 75 x 75 mm	330.0

Source: EDB data as of July 1968.

D.1.4 Forecast of demand for Cold Rolled Sheets

As it is impossible to know the apparent consumption by the statistical data available in the country, estimate is made from the statistics on the export of cold rolled sheets to Singapore from 9 countries in the world by the Japan Iron and Steel Federation (JISF). The apparent consumption of cold rolled sheets is calculated by reducing the amount of re-export from the total amount of export to Singapore.

The estimate for the amount of re-export is calculated from the ratio of the amount of re-export to the total amount of import of sheets (less than 3 mm) (statistics are available in Singapore).

The apparent consumption of cold rolled sheets estimated by the JISF is given below.

Table 10. Actual Figures of Apparent Consumption of Cold Rolled Sheets

		1962	1963	1964	1965	1966	1967
Actual Figures	Import of Cold Rolled Sheets (1,000 M.T.) (A)	7.3	9.4	14.8	23.5	28.5	38.0
	Import of Sheets (under 3 mm) (B)	12.0	12.9	24.9	31.1	35.5	48.7
	Export of the same (C)	1.0	3.1	0.9	2.3	1.9	1.2
Estimate	C/B	1/12	31/29	9/249	23/311	19/355	12/487
	Export of Cold Rolled Sheets A x D (re-export)	0.6	2.4	0.6	2.0	1.0	0.5
	Apparent Consumption of Cold Rolled Sheets (A – E)	6.7	7.0	14.2	21.5	27.5	37.5

1.4.1 Demand classified by Market

(1) For G I Sheets

Currently, there is The Singapore Galvanizing Industry Ltd. (SGI – a joint-venture with Japan) which has annual production capacity of 15,000 tons (one hot dipped line) but turns out only 8,000 tons annually due to a severe competition with other countries.

About 8,000 tons of coiled galvanized steel is imported annually. This makes a large increase of production almost impossible unless some protective measures including restriction of import is enforced.

(2) For tin plate

No tinning plant nor the construction plan existed as of August 1968.

(3) For other use

There are two steel pipe plants, namely the Malaysia Steel Pipe and the Simalpan Steel Industries. Both of them are joint ventures of Singapore and Japan. The amount of demand (cold rolled sheet) for their products is unknown.

Demand by the medium and small manufacturers in the Jurong Industrial Estate for the production of furniture and cans, and the demand from the Jurong Sipyard are growing remarkably.

Table 11. Actual Figures of Consumption of Cold Rolled Sheets
Classified by Use in Singapore

(Unit: 1,000 M.T)

	1962	1963	1964	1965	1966	1967
G I sheet	–	–	–	6.0	7.5	7.5
Others	6.7	7.0	14.2	15.5	19.5	29.5
Total	6.7	7.0	14.2	21.5	27.0	37.0

Note: The Singapore Galvanizing Industry was put in operation in February, 1965.

1.4.2 Estimates of Demand for other Uses made in Correlation with GNP and of Demand for Base Sheets to be used for G I Sheets

(1) For other uses (exclude use for G I sheet)

Estimate made by the analysis correlated with the GNP is as follows:

Table 12. Demand for Cold Rolled Sheets to be used for other than
Base Sheets for G I Sheets

	1967	1970	1971	1972	1973	1974	1975	1980	1985
Demand for Cold Rolled Sheets (1,000 M.T.)	29.5	37.0	40.0	42.0	46.0	50.0	52.0	70.0	90.0

(2) For G I sheets

The present production capacity in full operation is 18,000 ton/year which makes the demand for base sheets approximately 17,000 ton/year.

The B.R.C. Woldmesh Ltd. is producing dock plates, koystone plates, etc. using 1,500 tons of GI sheet coils annually. Several other similar plants are also operating. With these plants in operation, demand for coiled GI sheets (made by electrolytic line) will be kept fairly high. But, so far no program for expansion or construction of GI sheet plants has been disclosed.

Table 13. Forecast of Demand for Cold Rolled Base Sheets
for GI Sheets

(Unit: 1,000 M.T.)

	1967	1970	1971	1972	1973	1974	1975	1980	1985
Demand for Cold Rolled Sheets	5.7	8.0	10.0	14.0	15.0	16.0	17.0	21.8	29.0

For 1980–85, estimate is made with the same growth rate as flat product.

(3) Forecast of total Demand for Cold Rolled Sheets

The results mentioned above can be sumarized as follows:

Table 14. Forecast of Sumarized Demand for Cold Rolled Sheets

(Unit: 1,000 M.T.)

Use for	1967	1970	1971	1972	1973	1974	1975	1980	1985
GI sheets	7.5	8.0	10.0	14.0	15.0	16.0	17.0	21.8	29.0
Others	29.5	37.0	40.0	42.0	46.0	50.0	52.0	70.0	90.0
Total	37.0	45.0	50.0	56.0	61.0	66.0	69.0	91.8	119.0

D.1.5 Forecast of Demand for Billets

1.5.1 Demand for billets in Singapore

At present, the National Iron & Steel Mill and Malaysia Iron & Steel are operating as bar mills. The former is producing 106,600 M.T. of bars from its own ingots (80 kg and 205 kg), imported billets and ship breaking scrap in 1967. It is planning to construct continuous casting machine. The import of billets will decrease when it is completed.

Table 15. Rolling Capacities Classified by Billet Using Co. and Mill (as of July, 1968)

(Unit: M.T.)

Company	Mill	Mill	Current Production Metric ton (3 Shift)	Rated Capacity Metric ton (3 Shift)
Billet using Mill	National Iron & Steel	No.1	81,000	122,000
		No.2	24,000	36,600
		No.4	Under Planning	61,000
	Malayan Iron & Steel	No.2	6,100	36,600
	Sub-Total		111,100	256,200
Re-rolling Mill	National Iron & Steel	No.3	8,100	12,200
	Malayan Iron & Steel	No.1	9,700	9,700
	Sub-Total		17,800	21,900
Grand Total			128,900	278,100

Source: Economic Development Board.

Note: 1. Among the billets used, the sizes of those imported were 80 mm x 80 mm x 20 and exporting countries were mainly Australia, West Germany and India. The price was US$70.00 per long ton CIF Singapore.

2. Production is the annual rate in July 1968.

Table 16. Transition of Production of Merchant Bar, Light Section and Wire Rod

(Unit: M.T.)

	Year	Production (M.T.)	Remarks
Actual figures	1913	5,080	
	1964	48,770	NISM in operation
	1965	55,883	
	1966	69,091	
	1967	111,562	
Estimate	1968	132,000	
	1970	152,400	

Source: E D B data

Estimated demand for bars, sections, and other products for the period up to 1985 is made. Demand for bars and sections can be estimated by reducing the amount of demand for others from the total amount as in Table 17 below.

Table 17. Forecast of Demand for Bars and Sections Creating Demand for Billets

	1970	1975	1980	1985
Demand (1,000 M.T.)	121	163	207	247

Table 18. Trend of Steel Making Capacity in Singapore

(Unit: M.T.)

		Capacity
1967	Electric Arc Furnace	120,000
1968	Electric Arc Furnace	144,000
1971	Electric Arc Furnace	144,000
Ingot output (Capacity x 80%)	1967	96,000
	1968	115,200
	1971	115,200
Output in bars & sections equivalent (Ingot x 94%)	1967	96,200
	1968	108,300
	1971	108,300

The future steel making capacity in Singapore can only be estimated from the anticipated expansion of facilities of the National Iron & Steel Mill (NISM), except the Government's project. The expansion program of the Malayan Iron & Steel (MIS) has not been disclosed so far.

The NISM has the annual ingot making capacity of 144,400 tons as of 1968 and its capacity will continue for some time. Basing on the assumption that the ratio of products to ingot making capacity is 80%, the output of bars can be estimated at 108,300 tons. But, practically, the amount of products made from the imported billets should be added to the above figure.

Table 19. Trend of Demand, Products and Production Capacity of Bars and Sections

(Unit: M.T.)

		1967	1970	1975	1980	1985
Demand for bars & sections		106,000	121,000	163,000	207,000	247,000
Total products of bars & sections		112,700	134,100	182,100	.....	.....
Products of NISM (A)		106,600	128,000	176,000	(250,000)	.....
	%	100.0	100.0	100.0	...	...
By own ingot (B)		90,200	108,300	120,000	.....	.....
	%	84.6	84.6	68.2		
By ship breaking scrap & imported billets A – B = C		16,400	19,700	56,000	.....	.....
	%	15.4	15.4	31.8	...	...
$C \times \frac{100}{94}$ Converted to billets		17,500	21,000	60,000	.....	.....
Products of MIS		6,100	6,100	6,100	.....	.....
By ship breaking scrap & imported billets (D)		6,100	6,100	6,100	.....	.....
$D \times \frac{100}{94}$ Converted to billets		6,500	6,500	6,500	.....	.....
Total in terms of billets		24,000	27,500	66,500	.....	.....

Note: Estimations are made for the years up to 1970 basing on EDB data and ECAFE First Missions estimate for steel making capacity: for 1975, NISM's steel making capacity was modified by informations got at Singapore; for NISM's 1980 by UNIDO data and others. NISM's definite production plan has not been decided.

Concerning the production in 1975, if NISM's No.4 Rolling Mill (billet using) has been completed and put into operation, the capacity of all billet using mills of NISM is estimated at 220,000 M.T., and, assuming the ratio of product to capacity is 80%, the amount of bars and sections is 176,000 M.T. To this, 6,000 tons of MIS's output (production capacity is presumed to remain at the same level as of August, 1968) is to be added and the total products of bars and sections is to be 182,000 tons.

In NISM's output, 120,000 M.T. is considered to be made from the ingot of its own production (based on First Survey Mission's estimation with some modification) and 56,000 M.T. is from the ship breaking scrap and imported billets. The MIS's production capacity and output is considered to remain at the same level as of August, 1968.

As for the product in 1976 and later, it is difficult to estimate since the NISM's production program is unknown and the new steel project of EDB has not been formulated definitely.

1.5.2 Latent Demand for Billets of Six Countries

The forecast of demand for both domestic and imported billets by the six regional countries is attended with great difficulties, because it has close and complicated relations with the Government's way of dealing with semi-finished products in its steel industry policy, as well as comparison of cost between the billet and the ship breaking scrap, etc.

Therefore, in the demand estimations for bars and sections, those wide flange beams, large size shapes, etc. which require, for their production, high technical standard and large scale equipments are excluded in presumption that the demand for them will be met by import, and estimate of demand for billets by the six regional countries (tentatively call this as the latent demand) is made tentatively as shown in the table 20, taking into account various countries steel bar and section consumption classified by products, the future pattern of demand prospected by macro economy approach, informations gathered in the countries, etc. It must be stressed, however, that these figures in the table is estimated purely on assumption and thus can fluctuate in wide range due to the circumstances explained above.

Table 20. Tentative Latent Import Demand for Billets in Six Countries

(Unit: 1,000 M.T.)

Year / Countries	1970	1975	1980	1985
Singapore	28	67	90	100
Malaysia	60	100	140	140
Thailand	110	180	240	250
Taiwan (China)	100	100	100	100
Philippines	150	150	150	150
Indonesia	–	160	210	273
Total	448	757	930	1,013

D.2 Present Situation of Iron and Steel Industry in Singapore

D.2.1 Policy on Iron and Steel Industry of Singapore Government

The Government of Singapore aims to bring up the iron and steel industry, as the axis of its industrialization policy, the strategic industry endowed with enough strength to stand the international competition. The Government is now deliberating the new steel project taking due account of the proposed integration plan of the National Iron and Steel Mill.

Concerning the new steel project, the Government has revealed its policy to give various favorable treatments to it and also to take positive measures to introduce foreign capital.

There have been discussions on an integrated steel mill, but no irrevocable conclusion has been reached.

D.2.2 Outline of Situations of Enterprise and Mill

Following is the outline of the iron and steel makers now operating in Singapore. Other than these makers, the Malayan Iron & Steel is turning out about 6,000 M.T. of round bars annually.

2.2.1 Bar mills

(1) National Iron & Steel Mill Ltd.

This mill was established several years ago at the earnest wish of the then Government of State of Singapore to have a steel mill in Singapore. The Government, approving in principle the recommendation by U.N. (cf. Note) to set up an iron and steel mill in Singapore presented by the United Nations, authorized, complying with the recommendation, the establishment of the mill and rendered necessary assistance and guidance.

The mill was set up on August 12, 1961, designated as the pioneer industrial enterprise in 1962, construction works started on September 1, 1962, laid foundation on September 16, 1962, turned out its first steel on August 2, 1963, held inangural ceremony on January 31, 1964 and on the same day started operation of the rolling mill, by this time the first stage of its construction was completed.

It was the first plant operated in the Jurong Industrial Estate, with the area of plant site of 27 acres. It has developed to be a representative steel mill in Singapore, turning out more than 100,000 tons of bars and rods in 1967. Under the management staff of excellent ability, the mill has been operating soundly.

It has 479 employees (as of the end of 1967), authorized capital being S$50 million, paid-up capital S$12 million and pays dividend of 12.5% per year (after tax).

(a) Capital and Officers (as of the end of 1967)

Its authorized capital is S$500,000,000, paid-up capital S$12,000,000, the breakdown of them being as follows:

Authorized Capital		
Officers shares	(face value S$1)	3 million shares
Preferential shares	(face value S$1)	3 million shares
Ordinary shares	(face value S$1)	44 million shares
Total		50 million shares
Paid-up Capital		
Officers shares	(face value S$1.00)	3 million shares
Ordinary shares	(face value S$1.00)	9 million shares
Total		12 million shares

The shareholders are composed of Singapore Economic Development Board having 2,400,000 shares, officers 662,605 shares and others 8,937,395 shares (as for paid-up capital at the end of December, 1967).

Note: * Report of the UN Technical Assistance Survey Mission. Early in 1960, the Singapore Government first began to consider the construction of a steel mill in Singapore, and in March 1960, Sir Alexander Macfar Rpahar, Representative in Far East of UN Technical Assistance Commission, asked the UN, in compliance with the request made by the Singapore Government, to send a survey team to conduct feasibility study on the matter. The survey team headed by Philippe Schereshewsky, French Engineer, was dispatched by the UN. The team, after surveying the tentative plan on the steel mill construction presented by the Singapore Government, submitted a report, the gist of which was as follows:

(i) In the first phase, two rolling mills, the one furnished with an electric furnace for scrapmelting, the other to roll the ship breaking scrap, total capacity of production of the mills being 30,000 tons in the first year of operation and later to be expanded to 5 – 60,000 tons in 3 shifts, be set up.

(ii) In the second phase, an electric furnace to make pig iron (from iron ore) and steel be connected with the rolling mills constructed in the first stage.

(iii) In the third phase, the blast furnace of more than 500,000 ton steel making capacity be set up as a part of integration program. At this phase, cooperation with foreign large steel maker should be considered.

(b) Outline of the facilities

The plant is located in Jurong Industrial Estate, the area of plant site being 27 acres. The dimensions of each shop are as follows:

Melt shop	44,900 sq. feet
Scrap yard	39,000 sq. feet
Merchant bar mill No.1	29,500 sq. feet
Merchant bar mill No.2	20,718 sq. feet
Merchant bar mill No.3	8,287 sq. feet
Plate yard No.1	12,431 sq. feet
Motor room	9,450 sq. feet
Workshop and testing room	4,050 sq. feet
Finished products storage No.1	17,331 sq. feet
Finished products storage No.2	23,600 sq. feet
Warehouse	10,752 sq. feet
Foundry shop	2,628 sq. feet
Weighing and gate house	630 sq. feet
General office	3,495 sq. feet
Canteen	3,969 sq. feet

(i) Steel making equipment

It has two electric furnaces which use as material 10 – 20% of imported pig iron and remaining 80% of ship breaking scrap and other scrap, the ratio between the ship breaking scrap and other scrap being 6 to 1. The furnaces are operated in 3 shifts a month.

(ii) Rolling equipment

It has 3 rolling Mills from No.1 to No.3, each of which being operated very efficiently.

1. No.1 merchant bar mill

It is operated on 2 shifts a day, 1 shift 8 hours, producing 150 – 200 tons, 5 days a week. The products are round bars of 3/8" – 1" dia and high tensile bars of less than 1.5" dia. The workers of 1 shift are 18 persons.

2. No.2 merchant bar mill

Operated on 10 shifts a week, one shift 8 hours and 60 – 80 ton output, producing 6/8" – 12 mm high tensile deformed bars (brand name SINGACONS), flat bars and round bars.

3. No.3 merchant bar mill

Material to be used is supplied by the No.1 mill. Operated on 10 shifts a week, output capacity being 10 – 12 tons a shift.

The rolling capacities of above 3 mills are as follows:

No.1	6,300 –	8,400 M.T.	Monthly production on 10 shifts a week operation. Construction of No.4 mill is now under consideration.
No.2	2,500 –	3,000	
No.3	420 –	540	
Total	9,220 –	11,940	

The production in 1967 was 104,818 longtons. The items of products are: square bars of 6 mm – 30 mm, flat bars of 3 mm x 15 mm – 25 mm x 75 mm, high tensile deformed bars (SINGACON) of B.S. 1144 and ASTM–A15 C/8 – 1.5 , angle bars of 1/8" x 1" x 1" – 1/4" x 3" x 3" and round bars of B.S. 785 1/4" – 1.5".

(c) Program for expansion

The expansion program of the mill takes the course basically from the first phase to the second phase in the recommendation of the UN. However, with the development of the new steel project of the Government, the program would require re-examination from the view point of business management.

According to the annual report of 1968, installation of 350 ton Lindeman Sheer (for scrap cutting) to increase productivity of electric furnace, expansion of general storage, rolled product store yard, wire-rod store yard, electric apparatus and general machine repairing equipment and office rooms have been completed.

(d) Subsidiary companies

It has three subsidiary companies.

1. National Shipbreakers Limited
2. Eastern Industries Limited
3. Singasteel Sdn., Berhad

The first supplies ship breaking scrap to the NISM, the second deals with selling and the third produces related goods (output in 1967 was about 6,000 tons) having 40 employees.

2.2.2 Pipe mills

(1) Simalpan Steel Industries Ltd.

It was designated as the pioneer industrial enterprise on February 14, 1962. The mill, located in the Jurong Industrial Estate and having the plant site of 80,000 square feets, total ground area owned by the mill being 9.5 acres, has authorized capital of 4,575,000 Singapore dollar (US$1.58 millions) of which 30% is owned by Japanese firms, 18% by the Doriam Sosiete Anonyme of Switzerland and remaining part by native capital. It has 125 employees (in which 103 are operators). The mill started its operation in 1964 and since then has been developing smoothly in output and sales, though once suffered from narrowed market caused by the separation of Malaysia and Singapore.

The problem of marger with the Malaysia Steel Pipe Mfg. Company, also a joint venture of Singapore and Japan, is under consideration.

Facilities of it are as follows:

(a) Electric welded pipe equipment

High frequency welding LSU120, dia 1/2" – 4", monthly output 1,800 tons, operation started in June, 1964.

(b) Spiral pipe production equipment

1. SRE 30, dia 6" – 48" , one shift, monthly output 250 tons, operation started in June 1964.

2. SRU 1,200, one shift, monthly output 500 tons, operation started in December 1964.

3. Others

Beside the above, it has wrapping and lining facilities which have capacity of 14 – 16 units per hour and pipe galvanizing capacity of 4 tons per hour and 1,000 tons monthly.

The store room capacity is 1,000 tons.

The office is located at 3, De Souza Street, Singapore and the mill at Japan Gudang, Jurong Industrial Estate.

(2) The Malaysia Steel Pipe Mfg. Co.

The company, designated as the pioneer industrial enterprise on August 28, 1963 and started operation in January 1965, is a joint venture of Singapore and Japan. At the account settlement in June 1968, it was revealed that company's financial situation had a favorable turn, and accumulated loss was made up. The company is now running smoothly

The authorized capital is 15 million Singapore Dollars, paid-up capital 2.25 million S. dollars, the ratio of capital ownership is 60% by Japanese firms and local investors 40%.

It has 2 lines of electric welder and pipe galvanizing equipment is also furnished.

1/2" – 2"	electric welder	1
4/4" – 6"	electric welder	1

The total output of both is 800 tons monthly, of which 500 tons are sent to galvanized pipe. The monthly amount of sale is 300 tons of black pipes and 450 tons of galvanized pipes. When compared with its production capacity of 1,200 tons a month, the amount of sale is considerably small. To use its production capacity more efficiently, the mill is operating galvanizing work at a charge. As Malaysia Government raised, on July 25, 1968, its customs tariff for the pipes of 1/2" – 4" to M$125 per ton or 25% of its imported value to protect its domestic pipe mills, export of pipes to Malaysia has become difficult. The company, therefore, is now making efforts to increase demand for black pipe in the domestic furniture making field and for galvanized pipes in water and gas supply industries.

The number of employees is 86 persons including operatives of 71 and clerical staff of 15. The plant locates in the Jurong Industrial Estate.

The propose question of merger with the Japanese-Singapore joint venture Simalpan Steel Industries Ltd. is now under consideration.

2.2.3 Galvanized Sheet Mills

(1) Singapore Galvanizing Industries Ltd.

This is a joint venture of Singapore and Japan and the only galvanized sheet mill in Singapore. It was designated as the pioneer industrial enterprise on August 28, 1963. The mill, located in the Jurong Industrial Estate, has a line of hot dipped galvanizing equipment with yearly capacity of 12,000 tons. The area of plant site is 6,955 acres (300,564 square feet), plant building 39,396 square feet, office building 3,087 square feet and recreation building 1,416 square feet.

The authorized capital is 5,000,000 S. dollars and the paid-up capital 1,500,000 S. dollars. 80% of shares are held by Japanese firms and 20% by local capital.

The products are plain and corrugated galvanized sheets with the width of 2.5 and 3.0 feet, length 6 – 10 feet and gauge BWG 24/26/32 and USG 35/37.

2.2.4 Wire Rod Mills

(1) Eastern Wire Manufacturing Co., Ltd.

A joint venture of Singapore and Japan, established on January 19, 1965, designated as the pioneer industrial enterprise (No.138) on October 21, 1965, authorized capital 3 million S. dollars and paid-up capital 200,000 S. dollars.

The composition of shareholders is as follows:

Hong Leong Co., Ltd.	27.8%
Sin Hock Hin Co., Ltd.	17.8%
(including Ong Lin Yock)	(0.9%)
Japanese firms	54.4%

Production facilities and products are shown below.

It started operation on August 1, 1967 and held opening ceremony in September, 1967. The mill is now almost in full operation.

The monthly production capacity, in 3 shifts, is 750 tons of hard drawn wire, nail wire, and black annealed wire and 750 tons of galvanized iron wire. Its area of mill site is 16,160 m^2 and of building 3,960 m^2.

D.3 Feasibility of Establishment of Billet Mill in Singapore

D.3.1 General conditions for establishment of iron and steel plant

Generally speaking, when feasibility of construction of an iron and steel plant is examined, the final decision should be made by how far following conditions are satisfied.

It may safely be said that whether or not a steel mill can produce steel products economically or at a price which can compete with others can almost be decided by its favorable conditions of location, though, of course efforts made in the productive stage of the enterprise must be taken account of.

(1) Availability of material at low price

It is desirable that the sources of iron ore and coal for material be available in its country or in a place not far from the mill site.

At present, however, it is rather rare in the industrialized countries that steel mills are located in the favorable conditions. Locational disadvantages, high cost of material due to transportation are reduced by establishing a mill at seaside and using large vessels.

(2) Land and port

A steel plant requires an extensive industrial ground for the facilities of huge equipments, yards for materials and products, storehouses and an efficient system of transportation for smooth operation of the plant.

The site of the plant should have solid ground foundation to support heavy equipments and also the location should be such as facing a harbour with excellent facilities to secure the convenient transportation of enormous volumes of materials as well as products.

(3) Sources of energy

The steel plant consumes massive volume of energy. Above all, availability of electric power and water supply in large amount at low prices is an indispensable condition.

(4) Labour and technical skill

The steel industry is one of the nucleus of all industries of a country which requires a large amount of labour with high standard of technical skill.

For the smooth running of a steel plant, it is essential to have excellent engineering abilities in the field of metallurgy, machinery, electricity, civil engineering, metrology, etc., and also knowledge of latest business management techniques.

(5) Correlating industries

For the economical operation of a steel mill, it is desirable that various industries closely related with the steel industry exist nearby.

The industries including construction, repairing, machinery, chemical, oil refining, etc are necessary in the well developed conditions. Without some of the above, the plant would have to import necessary machines, materials, services, etc which will burden the plant with disadvantage in the phase of management and production cost.

(6) Demand for products and scale of the plant

The steel industry is a typical large capital investment industry To cope with this situation, efforts are made to reduce the production cost by operating the facilities in full as much as possible.

There is a clear tendency that the larger the scale of a plant, the less the capital cost per unit product.

From the point of material aspect, in order to get main materials including ore and others at low prices, it is advantageous to purchase them in a long term contract in a large quantity from a mine of large scale with ample shipping ability and carry them by large size ships. To keep the high quality of pig iron, ores of varied ingredients must be well blended as materials For a small steel plant, it will be difficult to operate by this method.

The recent trend in the steel making industry in the world is toward a larges scale plant and equipment, and, at the same time, in order to produce as much a quantity of product as possible by these mammoth sized plants, efforts are being exerted to make the steel production automatized and to realize high speed operation.

D.3.2 Study on the scale of the plant

As mentioned above, the scale of the plant has a great effect on the price of steel products. However, it is very dangerous to attempt to set up a large-scaled steel plant without a fair prospect of demand for its expected production. Decision of the plant scale must be made basing on a careful and accurate forecast of demand in the future.

The Second Survey Mission has estimated that, when forecast is made for domestic demand of Singapore for steel bars and sections and demand of Indonesia for steel bars, at the time of 1975 – 80, there will certainly be a demand for 250,000 tons a year of billets, as the material of steel bars and sections. In this estimation, the demands of other countries in the Sub-Region were put out of consideration as the uncertain factors since their extent of steel self-supply is unknown.

However, when comparison is made between the prospected demand for and planned capacity to supply steel bars and sections in the whole region, there exists a gap of more than 1,000,000 tons between the demand and supply. Supposing that there is a close cooperation among six countries and that mutual understanding is reached that the shortage of supply be eliminated by producing them in Singapore concentratedly, it is possible to set up a steel plant with the production capacity of 1,000,000 tons of mainly billets and steel bars and sections in Singapore.

Such being the situation, the Second Survey Mission has set up four models of steel plants. of following cases and studied on their necessary equipments expenses, cost of products, payability, etc.

(1) The billet mill of 250,000 ton capacity per year

(a) Blast furnace, converter, blooming mill process (Model I)

(b) Electric pig iron furnace, converter, blooming mill process (Model II)

(c) Electric steel furnace, small sized ingot process (Model III)

(c.f. Annex 2) Commentary on the continuous casting method

(2) The bar mill of 1,000,000 tons capacity per year

Blast furnace, converter, blooming mill, bar mill process (Model IV)

D.3.3 Prerequisites to the construction of steel plant in Singapore

In studying the models of steel mills, following informations obtained by the current survey are taken as prerequisites.

(1) Ground

The location should be in Jurong District in the southwest of Singapore Island. In the district, the Government is conducting a large scale land exploitation extending 17,000 acres as a part of Singapore Economic Development Program.

The ground has proper solidity and the site of the plant can be secured at the sea-side area facing the deep sea. It is quite suitable for a steel plant site.

The area of the site required is, when the plant capacity is 250,000 ton/year, about 380,000 m^2 and, when 1,000,000 ton/year 1,000,000 m^2, the lease rental of the ground being S$1.81/$m^2$/year.

(2) Material condition

(a) Iron ore ..... Iron ore can be obtained from India and Malaysia at low prices. Though it has some faults in chemical and physical aspects, it should be utilized as much as possible so as to keep the product price low.

Table 21. Prospected Price of Iron Ore

		EF (%)	Price (US$/T)		
			FOB	Freight	C & F
Malaysia	(fine)	59–61	6	2	8
	(lump)		8.50	2	10.50
India	(fine)	62–63	5.50	3	8.50
	(lump)		8	3	11
Australia	(fine)	63–65	8	3	11
	(lump)		9.50	3	12.50

Composition classified by sources

250,000 T/year		1,000,000 T/year	
Malaysia	30%	Malaysia	10%
India	30%	India	10%
Australia	40%	Australia	80%

Ratio between fine ore and lump ore:

fine ore 60% lump ore 40%

(b) Coke..... It is better to import all the cokes because no material coal resources are available in the country and construction of medium or small scale coke ovens being rather high in cost, less efficient and difficult to utilize profitably by-products obtained in the course of calcination. As there is no major coke supply sources in neighbouring countries, supply must depend on Australia or Europe. The price may be approximately S$32, CIF.

(c) Other steel making materials ..... In order to reduce the production cost, low price materials must be utilized. In this connection, iron sand in Indonesia is worthy of note.

Those ashes, dust, slag scale, etc. produced as secondary products should be utilized profitably.

(d) Scrap ..... At present, scraps including disbanded ship scrap can be obtained locally at comparatively low prices, though limitted in volume. When demand exceedes a certain quantity, it must rely on import.

Approximate price of scrap are 30–35 US$/T.

(e) Heavy oil ..... Singapore has one of the best seaports in the world which has developed as the center of communication and transportation between the East and the West since old days. Hence, the international oil companies have been operating the oil refining shops, and there is no uncertainty about the supply of heavy oil. And, as it is a free port, oil can be obtained at rather low prices.

(3) Availability of energy and water

(a) Electric power ..... All the electric power is supplied by the oil burning thermal power station, the capacity of which is at present 460,000 KW. When the additional 480,000 KW facilities now under construction be completed, the present minimum price of 2.7 sc/KWH for major consumers will be reduced to 2.0 sc/KWH. The steel plant will be better to buy all of required power without having its own independent station.

(b) Water supply ..... An integrated steel plant requires a large volume of sea and fresh water for plant operation and clean water for boilers and drinking. Sea water can be pumped up easily when the plant is located at seaside. Fresh and drinking water has to depend on the supply from Johol, Malaysia. From the view point of demand and cost, stress should be put on the efficient recovery of water so as to save the purchase of water as much as possible.

According to the data supplied by the EDB, the cost of water is as follows: For industrial use 4.4 sc/m³. For drinking 33 sc/m³.

D.3.4 Study on economic features of proposed steel plant

Construction Plans

(1) Billet mill of 250,000 ton capacity/year

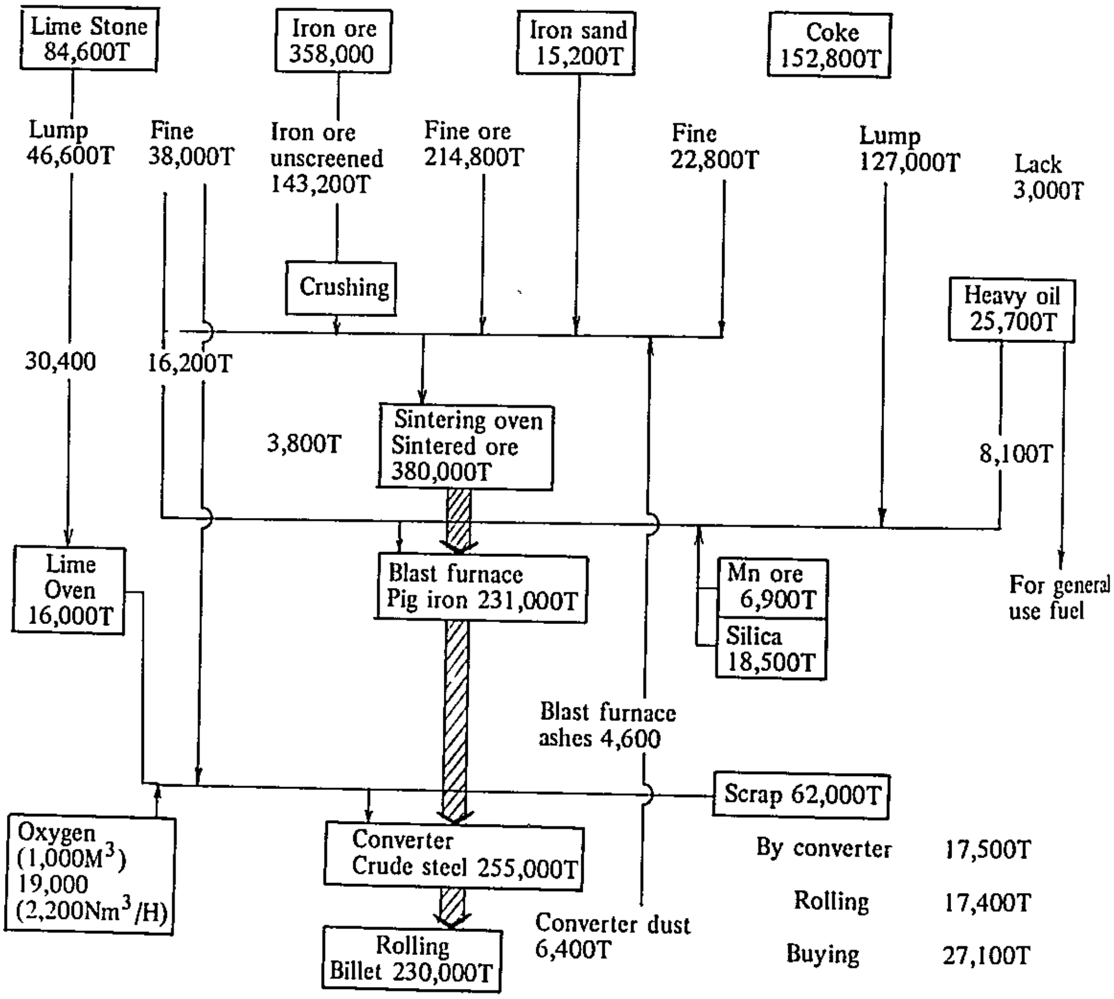
(a) By blast furnace process (Model 1)

This process has the longest history and the primary method to produce the pig iron, although several new pig iron making processes have been developed.

(i) Outline of the process

The outline of the amount of products, materials required, etc. are shown in the following flow sheet.

Table 22. Process Flow Sheet (Figures shown yearly amount)



(ii) Construction cost

Contents of the equipment and cost of construction required are shown in the following Table 23.

Table 23. Equipment and Construction Cost of Model 1

Item	Cost of construction (1,000 $)	Equipments
Material loading & unloading equipment	1,305	Material yard, conveyer, stacker, wheel loader, crasher, etc.
Sintering equipment	1,889	1,050 T/D DL Sintering machine x 1
Blast furnance equipment	6,778	460 m^3 (H.D. 5.5 m) Blast furnace x 1 heating oven, blower, etc.
Lime calcinating equipment	236	
Converter equipment	4,000	25 T/ch Furnace body changeable x 1
Blooming, rolling equipment	7,778	Heating furnace 2 Hi 3,000 Kw Roughing Roller 2Hi 2,500 Kw continuous finishing roller
Oxygen generating equipment	1,500	2,200 Nm^3/H generator x 1
Other power equipment	1,072	Gasholder, boiler, electric receive-distributing equipment etc.
Water supply equipment	1,539	Pool, water recovery and sea water pumping equipment
Harbor, road, rail	2,900	(-12 m – 7.5 m) 360 m quay etc.
Transport vehicle	1,064	
Maintenance, workshop equipment	833	
Others	661	
Total	31,555	

(iii) Personnel required

The personnel required is shown in Table 24 below.

Table 24. Personnel Required of Model 1

	Worker	Foreman	Total
Sintering	25 person	3	28
Blast furnace	62	5	67
Lime oven	7	0	7
Converter	228	12	240
Blooming & Rolling	133	3	136
Total	455	23	478
Auxiliary	539	37	576
Clerical, technical			200
Total	954	60	1,254

Note: Labour cost per capita

Worker	200 SS/M
Foreman	300 SS/M
Clerical, technical	600 SS/M

(iv) Cost of production

The estimated cost of billet basing on above factors is as follows:

Table 25. Cost of Model 1

Item		Monthly expenses: Quantity	Monthly expenses: Unit price	Monthly expenses: Sum	Per billet ton	Remarks
Material cost		T	$/T	(1,000 $)	$ /MT	
	Iron ore	29,800	10.19	303,628		
	Coke	12,700	32.00	406,400		
	Scrap	2,300	35.00	80,500		
	Others			94,722		
	Total			885,250	46.10	
Operation cost	Labour cost	1,254 person	89.53$/capita	112,267		
	Ingot case	318T	139 $/T	44,167		
	Brick			64,778		
	Roll			16,000		
	General material			62,011		
	Repairing cost payable			65,047		
	Electric power	5,750 (1,000KWH) Industrial	0.67 ₵/KWH	38,333		
	Water supply charge	205 (1,000 m^3) Drinking 26	1.47 ₵/m^3 11.00	5,867		
	Land cost	380,000 m^2		19,089		
	Depreciation	Equipment Cost		156,136		by fixed installment method Useful life 16 years scrap value 5%.
	Miscellaneous cost	31,555 (1,000 $)		53,722		
	Total			637,417	33.20	
	Product cost			1,522,667	79.30	
Sales cost & others	Commission			53,900		Sales x 3%
	Packing & Handling	19,200T	3.00$	57,600		
	Interest			162,500		Loan 25,600$ Average rate 7.6%
	Total			274,000	14.30	
	Cost of sales			1,796,667	93.60	F.O.B.

Table 26. Cost of Production Classified by Production Stages

Stage Classification	$/T
Sintered ore	14.50
Pig iron	50.90
Steel ingot	67.50
Billet	79.30
Cost of sales	93.60

(Reference)

At present, the distribution price of billet in Southeast Asia is 70–80$ (CIF). Therefore, the products by this process are considered unfit to export at payable prices.

(b) Comparison of pig iron costs between electric iron making (Model II) and blast furnace process (Model I)

The detailed explanation on the electric iron making method was made in the Commentary (Part I). Estimation for the cost of pig iron produced by the electric iron making mill of 250,000 ton capacity is made and compared with that of authodox blast furnace method (Model I), the result being shown in Table 27. Regarding the electric method, the process in which ore is reduced preparatorily by the rotary kiln is presumed.

Therefore, in the table 27, the figures of the blast furnace process include those of sintering furnace and blast furnace, and those of the electric iron making process include those rotary kiln and electric furnace.

Table 27. Comparison of Pig Iron Cost between Blast Furnace Process and Electric Iron Making Process

Item	Unit price	(Model I) Blast furnace		(Model II) Electric Iron making process		Remarks
		Original unit	$/P.T.	Original unit	$/P.T.	
	* Iron ore					* Purchasing unit price
Main material	10.54 $T	1,649 kg	16.74	1,649 kg	16.74	10.19$
Tempering cost					2.41	Crushing, etc 0.35$
Sub-material			1.35		1.35	
Total			18.09		20.50	
Coke	*33.00 $	649	21.42	–	–	* Purchasing unit price 32.00$
Hard coal	17.00	–	–	400	6.80	shortage rate 3%
BF gas blowing			1.91	–	–	
Heavy oil	13.33	39	0.52	65	0.87	
Electric power	* 0.81	70	0.56	1,053	8.49	* Purchasing unit price 0.67 cont
Electrode		–	–	2	0.19	Receiving & distributing cost 0.14 cont
Total			24.41		16.35	
Labour cost			0.34		0.35	
Depreciation			2.26		2.31	
Miscellaneous cost			3.34		4.40	
Overhead cost			3.51		3.51	
Excluded (BF gas &others)			-1.03			
Total			8.42		10.57	
Cost of pig iron			50.92		47.42	

As shown above, in the current production conditions in Singapore, the cost of production by the electric iron making method is a little lower than that of the blast furnace process. In the future, however, there may be a possibility that the above relation will accelerate due to the fall of electric power price caused by introduction of moe efficient power generator, development of atomic power generation or development of more economical coal materials.

(c) Economic Advantages of Electric Furnace Method Using Scrap (Model III)

At present, Singapore is supplied with scrap locally and from the neighbouring countries at comparatively cheap prices. By melting and refining these scraps with the electric arc furnace, it has been producing small size steel ingot and rolled steel products (bars and sections) at internationally competitive costs.

However, there is some anxiety for the future scrap supply in Singapore among these concerned with the steel industry. In this connection the mission has a rather optimistic view on the international long term scrap supply.

As the steel making method by oxygen converter system using molten pig iron as the material is coming in world-wide use, the wide-range and frequent fluctuations in prices of scrap due to the changes in demand and supply of scrap, as was often seen in the past, will probably not occur in the future, and the price standard is likely to have a downward tendency.

Under such circumstances steel mills adopting electric are furnaces arc increasing in many steel making countries. Even if the price of scrap is assumed as US$35, the cost of small ingot would be about US$70· which is lower than the aforementioned cost of billet made in Model I by about $10.

Table 28. Estimated Cost of Small Ingot Produced by Electric Arc Furnace

	Item	Basic unit	Used unit cost	$/T	Remarks
Material Cost	Scrap	1,054 K	35.00 $/T	36.54	Use recovery 1,087 Kg 33 Kg
	Ferro-alloy etc.			2.84	
	Total			39.38	
Operation Cost	Electric power	550 KWH	0.81¢/KWH	4.43	
	Electrode	5 Kg	0.56 $/Kg	2.78	
	Labour			1.16	
	Brick			3.61	
	Other material			3.19	Ingot cast, etc.
	Depreciation			1.78	
	Miscellaneous			8.56	Repairing cost, etc.
	Overhead cost			4.67	
	Total			30.18	
	Cost of small ingot			69.56	

The result of study on the Model I, II and III shows that a small scale integrated steel making plant with blast furnaces, shown in Model I would not be profitable.

On the other hand the electric arc furnace system, shown as Model III, which uses scrap as raw material can produce small ingot, if scrap is available at about $30, the cost of which can compete with that of the billet produced from molten pig iron by the large scale integrated mill.

(Reference) Concerning the adoption of continuous casting method, there are following merits in adoption of this method.

1. Cost of equipment is comparatively lower than that of blooming-rolling method.
2. Operation environment can be improved greatly than in blooming rolling method.
3. Number of workers can be lessened.
4. A large increase of yield can be expected (billet/molten steel ration: Blooming method 82–84%, Continuous casting method 92%).
5. Though detailed explanation is excluded herewith, by adopting this method, billet cost can be reduced by $4–5 compared with the bloom-rolling method.

However, some technically unsettled problems accompany with this method at present, namely:

1. It is difficult to make small section products.

   According to the survey of demand made by the ECAFE mission, about a half of demand for billets in this region will be for small sized products of 50 mm square.
2. By the present techniques, production of rimmed steel and alminium killed steel is impossible.

   Considering these facts and production scale of the mill in question as well as varieties of its products, it is not proper to adopt this method right now.

(2) Bar mill of million ton annual capacity

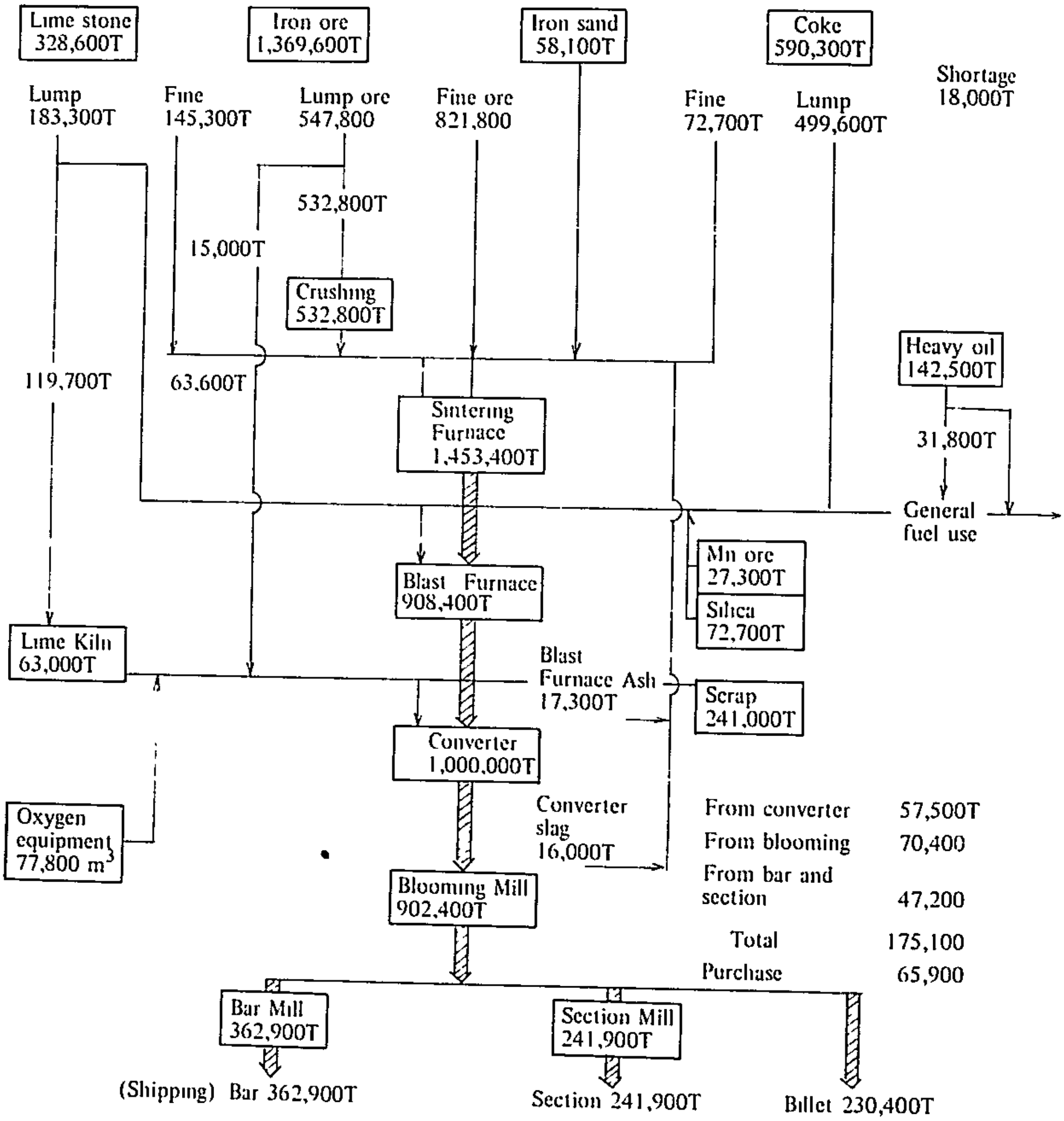
As mentioned in the preceeding paragraphs, if a small scale integrated steel mill should commercially compete with international big scale steel mills, it must have exceptionally favorable conditions including location or direct connection with special products as material. Generally speaking, these are difficult to realize.

And, operation of a steel mill requires huge amount of capital investment which makes fixed expenses such as interest and depreciation expenses extremely large. When the mill produses only such products as billets which requires little processing, the burden of fixed expenses becomes too heavy. Therefore, in the operation of a mill, it is rational that, besides the billets, production of finished goods which have bigger ability to stand the expense be done.

Considering above mentioned situation and from the market survey of this region, the mission presents the economic feasibility of the proposing intergrated steel mill of bars and sections with the production capacity of one million tons a year.

(a) Outline of Operation Process

Table 29. Operation Flow Sheet



(b) Construction cost

Equipments and construction cost are shown in Table 30.

Table 30. Construction Cost

Equipment	Contents of equipment	Construction cost (1,000 $)
Material loading & unloading	Conveyer, yard, stacker, wheel loader, crusher	4,697
Sintering	2,100 T/D x 2	4,511
Blast furnace	Inner measurement 900 m^3 1,250 T/D x 2	19,456
Lime kiln	70 T/D x 3	906
Converter	Inner measurement 60 m^3 50 T/ch x 3	15,294
Blooming & rolling	Soaking pit 5, 2 Hi Roughing roller & continuous finishing roller	26,281
Bar rolling	Heating furnace 1, continuous roller	9,722
Shape rolling	Heating furnace 1, continuous roller	6,944
Blast furnace blower	5,300 Kw x 3	2,858
Oxygen generating	4,500 Nm^3/H x 2	5,244
Power	BF gas holder & piping, boiler, others	983
Electricity receiving distributing	Transforming equipment	864
Water supply	Water pool, recovery, sea water pumping, piping, others	4,267
Rail		1,750
Carrying machine	Diesel locomobile, torpede-car, slag-car, billet-car, others	3,556
Port & harbour	Quay material unloader, product loading LLC	4,431
Maintenance	Machines & tools	1,378
Testing	Analyzing & testing apparatus	558
Office		408
Total		114,108

(Breakdown of procurement)

Imported equipment machine cost	87,081	
Locally procured construction materials	7,830	
Locally procured construction cost	1,917	
Total	96,828	(Unit: $1,000)

Note: Imported equipment cost is estimated presupposing imported from Japan.

(c) Personnel Required

The number of required personnel is shown in Table 31.

Table 31. Number of Persons Required for One Million Ton Steel Mill

Section	Worker	Foreman	Managing staff	Total	Remarks
	person	person		person	
Sintering	36	1		37	
Blast furnace	114	6		120	
Lime kiln	9	–		9	
Converter	271	12		283	
Blooming	164	3		167	
Bar rolling	240	6		246	
Shape rolling	160	6		166	
Total	994	34		1,028	
Material transporting	107	3		110	
Power & water supply	92	6		98	
Maintenance	373	24		397	
Harbour	276	3		279	
Analyzing & testing	36	–		36	
Total	884	36		920	
Clerical & Technical	–	–	400	400	
Total	1,878	70	400	2,348	

Note: Wage level of each job category is same to that in Model I.

(Reference) For information, comparison of productivity of land, equipment capital and labor, three elements of production, between 250,000 T/Y mill, namely Model I, and this Model IV is made as follows:

Table 32. Comparkson Between the Models

Article		Model I (1,000 T)	Model IV (1,000 T)	Remarks
Quantity of production of billet	(A)	255	1,000	
Land	(B)	380,000 m^2	750,000 m^2	(Whole Model IV)
A/B		(1,000 $)		1,000,000 m^2
Equipment capital	(C)	31,555	1.33 T	114,108 (1,000 $)
C/A		124 $	97 $	
Personnel	(D)	1,254 person	1,836 person	114,108 (1,000 $)
A/C		203 T	545 T	2,348 person

Note: To make the conditions eq''al, calculation is made by excluding the figures of bar and section rolling processes from Model IV.

(d) Main Power and Fuel Balance

The necessary volumes of main energy, water, fuel, etc. in this plan are shown in the following tables.

Table 33. Balance of Electric Power

Section	Production/M	Basic unit	(1,000) KWH/M	Remarks
Sintering	121,100 T	25 KWH	3,027	Note:
Blast furnace	75,700	15	1,135	Electric power buying price 0.67₵/KWH
Lime kiln	5,200	20	104	Electric unit price at use 0.79₵/KWH
Converter	83,300	10	833	Unit price at use includes depreciation expenses, labour cost and cost of power substation
Blooming	75,200	60	4,512	
Bar rolling	30,200	70	2,114	
Section rolling	20,200	70	1,414	
Oxygen	1,000m^3 6,480	800	5,184	
Water	Industrial 1,008	160	1,668	
	recovered 4,031	280		
	sea water 1,893	200		
Others			3,818	
Total use			23,809	
Loss			736	
Required Volume of Purchase			24,545	

Table 34. Balance of Water

Table 34–1 Industrial Water

Section	Production/M	Basic unit	1,000 m^3/M	Remarks
Sintering	121,100T	1 m^3	121	Industrial water price 1.47¢/m^3
Blast furnace	75,700	7	530	Industrial price at use 1.15¢/m^3
Converter	83,300	12	1,000	
Blooming	75,200	15	1,128	Recovery rate in plant is 80%
Bar rolling	30,200	25	755	Price at use includes labour cost, depreciation of water supply equipments, and electric power expense for pump
Section rolling	20,200	25	505	
Others			1,000	
Total use			5,039	
Required water supply		(20%)	1,008	

Table 34–2 Service Water

Section	Production/M	Basic unit	1,000 m^3/M	Remarks
Boiler	53,745T	1.25m^3	67	Note: Service water price 11¢/m^3
Others			30	
Total			97	

Table 34–3 Sea Water

Section	Production/M	Basic unit	1,000 m^3/M	Remarks
Elast furnace	75,700T	25 m^3	1,893	Note: Unit price at use 0.48¢/m^3

Table 35. Balance of Steam

Section	Production/M	Basic unit	T	Remarks
Sintering	121,100T	1 kg	121T	Note: Unit price at use 1.90 $/Steam T
Blast furnace	75,700	40	3,028	
Converter	83,300	7	583	
Blooming	75,200	15	1,128	
Bar rolling	30,200	30	906	
Section rolling	20,200	30	606	
	(1,000Nm^3)			
Blower	109,770	220	24,149	
Others			20,000	
Total use			50,521	
Loss		(6%)	3,224	
Required volume			53,745	

Table 36. Balance of Oxygen

Section	Production/M	Basic unit	1,000Nm^3/M	Remarks
Converter	83,300T	60 m^3	4,998	Note:
Others			834	Unit price at use
Total Use			5,832	1.32¢ /Nm^3
Loss		(10%)	648	
Required volume			6,480	4,500Nm^3/H x 2

Table 37. Balance of B.F.G.

Section	Production/M	Basic unit	1,000Nm^3/M	Remarks
Generation	Blast furnace 75,700T	1,800Nm^3	136,260	Note: Unit price at use 1.05¢/1,000m^3
Loss		3%	4,088	calculated by calorie
Effective gas volume			132,172	conversion basing on heavy oil price
Hot stove	Blast furnace 75,700	700	52,990	700 Nm^3 800 (1,000 k cal.)
Boiler	53,745	850	45,684	850 Nm^3 680 (1,000 k cal.)
Total use			98,674	
Radiation			33,498	

Table 38. Balance of Blowing Air

Section	Production/M	Basic unit	1,000m^3/M	Remarks
Blast furnace	75,700T	1,450m^3	109,770	Note: Unit price at use 0.75 $/1,000 m^3

Table 39. Balance of Heavy Oil

Section	Production	Basic unit	T/M	Remarks
Sintering	121,100T	2.5 kg	303	
Blast furnace	75,700	35	2,649	Note:
Lime kiln	5,200	180	936	Purchase price 13.33$/T
Blooming	75,200	70	5,264	
Bar rolling	30,200	50	1,510	
Section rolling	20,200	50	1,010	
Others			200	
Total			11,872	

Table 40. Balance of Coke

Section	Production	Basic unit		Remarks
Sintering	121,100T	50 kg	6,055	Note:
Blast furnace	75,700	550	41,635	Purchase price 32 S/T
Total use			47,690	Unit price to use 33 S/T
Shortage		3 %	1,475	(Shortage rate 3%)
Quantity to buy			49,165	

(e) Cost of production

Basing the preceding conditions, cost of production of each stage is calculated as follows:

Table 41. Sintered Ore (Production 121,100 T/M)

Item		Basic unit	Unit price	S/T	Remarks
Material Cost	Iron ore	932kg	11.43S/T	10.66	Purchasing unit price 11.13S/T
	Iron sand	40	6.00	0.24	Crushing expense, etc. 0.30
	Lime stone	100	2.50	0.25	
	Coke	50	33.00	1.65	Purchasing price 32.00S/T Shortage rate 3%
	Other materials	28	3.00	0.08	
	Sub-Total			12.88	
Operation Cost	Personal expenses	W· 36 person F 1		0.02	
	Electric power	25KWH	0.78₵/KWH	0.19	
	Heavy oil	2.5kg	1.33₵/kg	0.03	
	Consumption articles			0.17	
	Repairing			0.28	
	Depreciation			0.18	
	Miscellaneous expenses			0.11	
	Sub-Total			0.98	
	Total			13.86	
	Product cost			14.62	Management expense 5.5%

Table 42. Pig Iron (Production 75,700 T/M)

Item		Basic unit	Unit price	$/T	Remarks
Material Cost	Sintered ore	1,600kg	13.86$/T	22.17	
	Coke	550	33.00	18.15	
	Heavy oil	35	13.33	0.47	Mn ore, silica, lime stone
	Other material			0.94	
	Sub-Total			41.73	
Operation Cost	Labour cost	W 114 persons F 6		0.11	
	BF Gas	700m³	$/1,000Nm³ 1.05	0.74	
	Blowing	1,450m³	$/1,000Nm³ 0.75	1.09	
	Other power & water			0.39	
	Consumption articles			0.36	
	Repairing			0.69	
	Depreciation			1.27	
	Miscellaneous cost			0.56	
	Sub-Total			5.21	
By-product deduction				-1.17	BFG. blast furnace slag
Total				45.77	
Product cost				48.29	Management expense 5.5%

Table 43. Steel Ingot (Production 83,300 T/M)

Item		Basic unit	Unit price	$/T	Remarks
Material Cost	Pig iron	990kg	45.77$/T	41.60	
	Scrap	241	35.00	8.44	
	Other materials			2.22	
	Sub-Total			52.26	
Operation Cost	Labour cost	W 271 person F 12		0.23	
	Oxygen	60m³	1.32¢/m³	0.79	
	Ingot case	12kg	139$/T	1.67	
	Brick			3.05	
	Repairing			2.08	
	Depreciation			0.91	
	Miscellaneous cost			0.70	
	Sub-Total			9.43	
By-product deduction				-2.06	Scrap, dust
Total				59.63	
Product cost				62.91	Management expense 5.5%

Table 44. Billet (Production 75,200 T/M)

Item		Basic unit	Unit price	$/T	Remarks
Steel ingot		1,111kg	59.63$/T	66.25	
Operation Cost	Labour cost	W 164 persons F 3			
	Electric power	60KWH	0.78¢/KWH	0.47	
	Other power			0.20	Water, steam
	Heavy oil	70kg	1.33¢/kg	0.93	
	Roll			0.83	
	Repairing			0.56	
	Depreciation			1.73	
	Miscellaneous cost			0.56	
	Sub-Total			5.43	
By-product deduction				-2.73	Scrap
Total				68.95	
Product cost				72.74	Management expense 5.5%

Table 45. Bars and Sections (Production 50,400 T/M)

Item		Basic unit	Unit price	$/T	Remarks
Billet		1,111kg	68.95$/T	76.60	
	Labour cost	W 400 persons F 12		0.55	
	Electric power	70KWH	0.78¢/KWH	0.55	
	Other power			0.35	
	Heavy oil	50kg	1.33¢/kg	0.67	
	Roll			0.56	
	Repairing			0.83	
	Depreciation			1.64	
	Miscellaneous cost			0.69	
	Sub-Total			5.84	
By-product deduction		78kg	35.00$/T	-2.73	Scrap
Total				79.71	
Product cost				84.09	Management expense 5.5%

Table 46. Cost of Sales

Item		Billet	Bar. Shape	Remarks
	Product cost	72.74 $/T	84.09 $/T	
Sales cost & others	Packing & handling	3.00	3.00	
	Commission	2.58	2.97	3% of gross cost
	Interest	7.75	8.95	
	Total	13.33	14.92	
	Cost of sales	86.07	99.01	FOB Singapore

Reference
Production classified by stages of Model I (250,000 T/Y) and Model IV.

Comparative cost studies of Model I with production capacity 250,000 ton per year and this Model IV in stages are given in Table 47

Table 47. Comparison of Costs

Stage Classification		Model I	Model IV	Difference
Production cost	Sintered ore	14.50 $/T	14.60 $/T	-0.10 $/T
	Pig iron	50.90	48.30	2.60
	Steel ingot	67.50	62.90	4.60
	Billet	79.30	72.70	6.60
	Bar & section	–	84.10	–
Cost of sales	Billet	93.60	86.10	7.50
	Bar & section	–	99.00	–

(f) Monthly Total Expenses

Table 48. Monthly Total Expenses

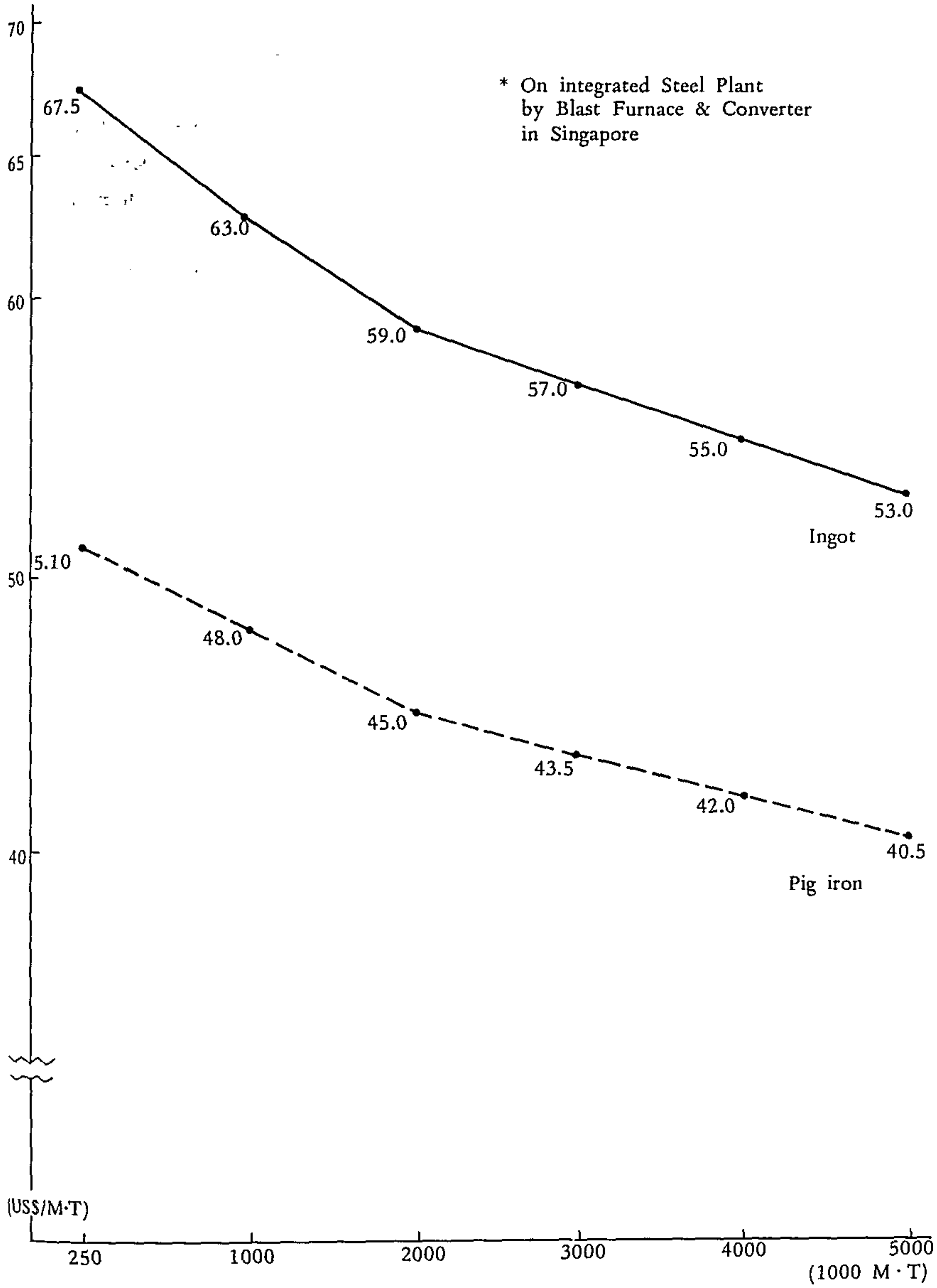
Item		Amount	Unit price	Sum (1,000 US$)	Remarks
Material cost	Iron ore	114,100 T	11.13 $/T	1,270	
	Iron sand	4,800	6.00	29	
	Mn ore	2,300	20.00	46	
	Silica	6,100	2.00	12	
	Lime stone	27,400	2.50	69	
	Scrap	5,500	35.00	192	
	Ferro-alloy			70	
	Converter flux			46	
	Coke	49,200	32.00	1,573	
	Heavy oil	11,900	13.33	158	
	Total			3,465	

Item		Amount	Unit price	Sum (1,000 US$)	Remarks
Operation cost	Labour cost	2,328 person	91.07$/ person	212	
	Ingot case	1,000 T	139 $/T	139	
	Brick			255	
	Roll			91	
	Other materials			236	
	Repairing cost payable			297	
	Electric power charge payable	(1,000KWH) 24,500	0.67₵/KWH	164	
	Water supply charge	Industrial 1008 (1,000 m³)	1.47₵/m³	25	
		Service water 97	11.00		
	Depreciation	Equipment expense (1,000$) 114.108		564	5% scrap value useful life 16 years, fixed installment method
	Land cost	1,000,000m²		50	1.81 S$/m²/year
	Miscellaneous cost			156	
	Total			2,171	
Product cost				5,636	
Sales cost & others	Packing & handling	69.600T	3 $/T	209	
	Commission			199	3% of gross cost (1,000$)
	Interest			600	Loan 94,800 average rate 7.6%
	Total			1,008	
Cost of sales				6,644	

Table 49. Financial Balance

Fund Required		Fund Raised	
	(1,000 US$)		(1,000 US$)
Construction expenses	114,000	Capital	63,200
Construction interest	12,000	Loan	94,800
Business expenses & others	8.000	ADB (7/8 %)	1/3
Operation fund	24,000	EDB (7 %)	1/3
		Others (9 %)	1/3
Total	158,000		158,000

Cost Curve by Production Scale



D.4 Recommendations

Singapore is located approximately at the center of the six countries in the sub-region. It possesses good deepwater weather harbours. It is considered as the most suitable place to construct a steel making plant producing semifinished products such as billets. The amount of billets in demand in the six countries is estimated variously according to the calculating method. However, the size of demand is an important factor for the construction of plants in the iron and steel industry. Such a construction requires a large and intensive capital investment. This indicates a danger in risking in the construction based on inaccurate estimates. The construction of a billet center in Singapore to supply the billet requirements of the six countries under the aegis of the common market is recommended by this mission.

The project must be based upon reliable data and estimate on the future demand for billets in the subregion. The plant should be built in stages.

(1) First stage – electric arc furnace steel making plant using domestic and imported scrap as raw material. This initial production will supply only the market for Singapore and Indonesia of about 250,000 tons annually.

(2) Second stage – additional electric arc furnaces to supply together with the first stage units about 500,000 tons of small ingots and billets. The integration of this proposed plant with the National Iron and Steel Mills, Ltd. is suggested.

(3) Third stage – it is recommended that if the trend of demand would warrant the expansion of this plant, a careful study should be made in the selection of the type of machinery and equipment to meet this expansion. Iron and steel industries of the world have not decided whether to expand their blast furnace facilities or electric arc furnaces. The comparative advantages and disadvantages of the electric steelmaking and the blast furnace processes should be evaluated in this study.

It is assumed that the international scrap prices would be stabilized at certain amount in a decade or so. Whatever would become of the international scrap price and type of facilities to be expanded, they should be carefully analyzed by those responsible for the billet center project. The mission recommends that the third stage should be executed considering those factors.

E MALAYSIA

E MALAYSIA

E.1 Present Situation and Forecast of Demand and Supply of Steel Products in Malaysia

E.1.1 Economic background and present situation demand and supply of steel product

Malaysia consists of three districts: Saban, Sarawak and West Malaysia and 85 per cent of its population live in West Malaysia.

Malaysia is currenty carrying out its First Malaysia Plan 1966 – 70, in which the target of average growth rate of Annual Gross Domestic Products for five years is fixed at 4.8 per cent.

The rate of economic growth set in the plan seems rather low comparing with 6.3 per cent, the actual record of annual growth during the period from 1960 to 1965.

However, the economic condition in Malaysia has been improved steadily along with the line of the Government's development policy. The ratio of manufacturing as well as construction industries to the Gross National Products is increasing gradually and expected gain the importance in the national economy as shown in the First Malaysia for a Plan.

With these economic growth for a background, the demand for steel products has been growing steadily. For example, during 5 years from 1962 to 1967 the growth of steel products consumption was 14.7% on average, annual growth rate of 5.4% for the Gross National Products recorded in the same period. The elasticity of the steel product consumption against the GNP was 2.7.

Table 1. Transition of Population and its Regional Distribution

(Unit: 1,000 person)

Year		Malaysia as a whole	West Malaysia	Sabah	Sarawak
1962		8,644	7,377	489	778
1963		8,815	7,611	505	799
1964		9,155	7,814	523	818
1965		9,421	8,039	544	838
1966		9,725	8,298	565	862
1967		10,071	8,580	588	903
		100 0(%)	85.0(%)	6.0(%)	9.0(%)
67/62	Annual ratio	1,165	1,163	1,202	1,161
	Annual rate (%)	3,1	3.1	3.8	3.0

Table 2. Malaysia:

Gross Domestic Product by Sector of Origin, 1965–70

(M.$ million)

	1965 (preliminary)	1970 (target)	Annual growth rate (%)
Agriculture, Forestry & Fishing	2,005	2,435	4.0
Rubber planting	1,015	1,115	1.9
Agriculture & livestock	715	910	5.0
Forestry	120	205	10.9
Fishing	155	210	6.0
Mining & Quarrying	600	475	-4.6
Manufacturing	665	1,070	10.0
Construction	360	530	8.0
Electricity, Water & Sanitary Services	125	2,200	10.0
Ownership of Dwellings	305	370	4.0
Wholesale and retail trade	1,100	1,370	4.5
Public Administration & Defence	425	515	4.0
Other Services	1,230	1,645	6.0
Gross Domestic Product at Factor Cost	6,815	8,615	4.8

Source: First Malaysia plan 1966 – 70

Table 3. West Malaysia. Industrial Origin of Net Domestic Product

	Total	Agriculture Forestry	Mining	Manufacturing	Construction	Transportation Communication	Whole-sales & Retail Trade	Civil Housing	Public Facilities Defence	Other Services
1960	100 0(%)	37.8(%)	5.9(%)	8 7(%)	3.0(%)	5 0(%)	15 6(%)	4 7(%)	6.5(%)	12.8(%)
1961	100.0	34.9	7.2	8.1	3.6	5.1	16.2	4 8	6.3	13 8
1962	100.0	33.1	7.1	8.5	4.3	5.2	16.3	4 8	6.2	14.5
1963	100 0	31.5	7.1	9.0	4.6	5.2	16.6	4.7	6.3	15.0
1964	100 0	29.5	8.0	9 7	4.6	5.3	16.4	4.6	6 8	15.1
1965	100.0	28.4	8.7	10.3	4.6	5.5	16.1	4.3	7.2	15 0

Table 4 Transition of Gross Domestic Products

(Unit: Thousand Millions M $)

	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	67/62 Annual Growth Rate
GDP	4508	4528	4731	4978	5388	5702	5994	6255	6700	7075	7419	5.4%

* 1964 Base year Constant Market Price

Source: UN, Monthly Bulletin of Statistics, September 1968 pp 188

Table 5. Records of Apparent Consumption of Steel Products

(Unit: M.T)

	1962	1963	1964	1965	1966	1967
Finished Steel Products	167.841	195.246	227.367	275.226	284.909	333.331
Flat Products	66.024	75.928	87.317	100.415	115.447	132.798
Others	101.817	119.318	140.050	174.811	169.432	200.533

Ratio Classified by Items

(Actual Record %)

	1962	1963	1964	1965	1966	1967
Finished Steel Products	100.0	100.0	100.0	100.0	100.0	100.0
Flat Products	39.3	38.9	38.4	36.5	40.5	39.8
Others	60.7	61.3	61.6	63.5	59.5	60.2

Table 6. Steel Product Consumption Compared with G N P

	1962	1963	1964	1965	1966	1967
Steel Product Consumption (1,000 M.T.) (A)	167.8	195.2	227.4	275.2	284.9	333.3
G D P (B) (1964 Thousand Million M$)	5702	5994	6255	6700	7075	7419
Steel Product Consumption per Thousand Million M$	0.029	0.032	0.036	0.041	0.040	0.045
Population (Mid-year, 1,000 person)	8644	8815	9155	9421	9725	10071

E.1.2 Forecast of Demand for Steel Products

Based on the actual record of the steel products consumption, the forecast of demand was made by comprehensively examining the results of estimations made in correlation with the GDP, and the Government's data and with the use of cross-sectional method, the result of which is shown in Table 7.

Table 7. Forecast of Demand for Steel Products

(Unit: M.T)

Year	1970	1971	1972	1973	1974	1975	1980	1985
Finished Steel	437.650	484.040	535.350	592.100	654.860	726.410	910.000	1,195.000
Flat Products	187.650	207 653	229.665	284.208	314.333	348.677	438.000	575.600
Others	250.000	276.387	305.685	307.892	340.527	377.733	472.000	619.400

Ratio Classified by Items

Year	1970	1975	1980	1985
Finished Steel	100.0 (%)	100.0 (%)	100.0 (%)	100.0 (%)
Flat Products	42 9	48.0	48.1	48 2
Others	57.1	52.0	51 9	51 8

Table 8 Actual figures of GDP and the forecast

(Unit Thousand Million M$)

Year	1957	1958	1959	1960	1961	1962	1963	1964	1964	1965	1966
GDP	4508	4528	4731	4978	5388	5702	5994	5994	6255	6700	7075

Year	1967	Forecast	1970	1971	1972	1973	1974	1974	1975	1980	1985
GDP	7419		8777	9259	9768	10305	10872	10872	11471	14637	18238

* 1964 Base Year Constant Market Price

E.1 3 Forecast of Demand for Cold Rolled Sheets

Since it was difficult to estimate actual result of consumption of the cold rolled sheets with the data available in Malaysia, the data prepared by the Japan Iron and Steel Federation (JISF) shown in Table 9 below was used to see the amount of sheets imported into Malaysia

Table 9. Actual Figures of Import of Cold Rolled Sheets

(1,000 M.T)

	1961	1962	1963	1964	1965	1966	1967
Import of Colled Rolled Sheets	3.1	8.3	20.0	35.5	34.4	41.7	44.6
GI Sheet Plant Operation			Aug. 1962, FIW operation started			Feb. 1965 SIW operation started	1967 MGIW operation started

Source: JISF and Information obtained in Malaysia

The use of these imported sheets is divided into for GI sheets and others, the breakdown of which is shown in Table 10 below, the present state of the GI sheet plants now under operation.

Table 10. Present Capacity, Production and Future Capacity of GI Sheet Plants

(Unit: M.T)

	In Aug. 1968		In 1971	
	Capacity	Production (1967)	Capacity	Production
Federal Iron Works (FIW)	24,000	16,000	24,000	18,000
Southern, Iron & Steel Works (SIW)	12,000	7,200	12,000	10,000
Malaysia, Galvanized Iron Works (MGIW)	14,000	8,000	24,000	15,000
Total	50,000	31,200	60,000	43,000
Demand for Base Sheet		30,000		41,000

Of these plants, the FIW started operation in August, 1962, SIW in February 1965, it is operated on 12,000 ton annual production base after June 1965, and MGIW in 1967. With the time of their first operation and the increased amount of import of cold rolled sheets, one can tell the breakdown of the use of sheets for GI sheets and others.

Table 11. Imported Cold Rolled Sheets by Use

(1,000 M.T)

	1961	1962	1963	1964	1965	1966	1967
GI Sheets	...	4.0	15.0	25 0	20.0	25.0	25.0
Others	3.1	4.3	5.0	10 5	14.4	16.7	14.6
Total	3.1	8.3	20.0	35.5	34.4	41.7	44.6

Above is a presumed breakdown of the use of imported cold rolled sheet. The demand for black sheets in 1971 is estimated at 41,000 tons (based on the pace of expansion of capacity of the GI sheet plants). The demand for cold rolled sheets in 1971 for the use other than GI sheets is estimated at 223,000 tons against the growth of GI sheets in 1971 and 1967 considering the elasticity between the growth rates of GI sheets and other items from 1963 to 1967.

Table 12. Forecast of Demand for Cold Rolled Sheets by Use

(1,000 M.T)

Use	1967	1968	1969	1970	1971	71/67	
						Ann. ratio	Ann. Growth rate
GI Sheet	30.0	35.0	38.0	40.0	41.0	1.4	8.8
Others	14.6	16.1	17.7	19.5	22.3	1.5	10.5

* The use for others for 1968 – 70 was estimated from the average annual growth rate in 1967 and '71, while that for the GI sheets by the pace of expansion of production capacity of the plants.

Estimate for the years after 1972 was made based on estimate of demand for flat products.

Table 13. Demand for Cold Rolled Sheets

(1,000 M.T)

	1967	1970	1971	1972	1973	1974	1975	1980	1985
Demand for Cold Rolled Sheet	44.6	59.5	63.3	71.7	81.5	92.5	105.0	132.0	173.0

E.1.4 Forecast of Demand (Import) for Billets

In Malaysia there are several makers of bars and sections and they are represented by the Malayawata which create demand for billets.

Table 14. Production Capacity of Two Representative Steel Bar and Section Makers

	As of August 1968	
	Capacity	Production
Malayawata Steel Mill (MSM)	84,000 ton	72,000 ton
* United Malaysia Steel Mill	9,600 ton (In the end of 1968, capacity be raised to 36,000 tons. 2 electric furnaces be installed.)	9,600 ton (Operation will start in the end of 1968)
Total	93,600 (129,600)	81,600

* Billet is partially used as material.

The Government of Malaysia issued a proclamation in the Government Gazette on August 1, 1968, starting that the import of semi-finished steel products would require Government permissions. The policy was adopted for the purpose of protecting the Malayawata Steel Mill and the permission will be given after the consultation with the MSM. Billets were included in the items which require the permission.

In the near future, when the Malayawata and other makers operating electric furnaces have raised their supply capacities of the ingot (billet) to the extent that will meet the whole demand, the import of billets amounting to about 7,000 tons will be stopped.

Further, even when the Malayawata can not expand its facilities fast enough to meet the expected demand for steel bars and sections in the future, the Government will not authorize other makers import semi-finished products to produce these items, and the shortage will be covered by importing finished products. Consequently, there will be practically no possibility of importing billets, by other makers. (In case, the finished products are to be imported, they will in the light of the Malaysia Protection of Pioneer Industries Ordinance (P10) those not compete with the products of the Malayawata.

Under these circumstances, it might be concluded that there is a great possibility that the import of billets will lose its ground in the future. However until the time when the Malayawata and other makers will complete their expansion program, it may continue as it is now.

E.2 Present Situation of Steel Industry in Malaysia

E.2.1 Government's policy on steel industry

In the First Malaysia Plan 1966 – 70, the Government fixed the target of annual growth rate of industrial production at 10%, and for the steel industry, at least 10% of growth was estimated.

The economic development policy of the Malaysia Government aims at a balanced progress of national economy in general, and in carrying out the plan stress is being placed on fostering the Malayawata Steel Mill to meet the domestic demand for steel products.

The Government of Malaysia enforced on August 1, 1968, a policy of broad restriction of import on the steel products and as a result strengthened its control over illegal import of steel products through strict customs surveillance. The Government has been taking every possible means to protect and develop the industries by virture of the Pioneer Industries Ordinance. It intends to make the Malayawata Steel Mill the axis of Malaysian steel industry performing the role of supplier of semi-finished products and pig iron to the domestic makers

The Government is also positively promoting a policy of industrialization of the nation in consideration of the stagnation in natural rubber market and uncertainty in the future of tin resources, both of which have been the major export goods. Under these conditions, the development of steel industry with the Malaywata Steel Mill as its nucleus will have an important position.

E.2.2 Outline of present situations of steel makers and mills

The present situations of major steel makers are summarized as follows:

2.2.1 Malaywata Steel Mill (Integrated Iron and Steel Plant)

The mill was founded in 1960 by native capital and became a joint venture of Malaysia and Japan in Aug , 1950. It is a unique integrated iron and steel plant with charcoal furnace in Southeast Asia designated by the Malaysia Government as the Pioneer industrial enterprise. It has authorized capital of M.$250 million and paid-up capital of M.$31.10 million, the composition of which being 61% of Malaysia and 39% of Japan at the end of 1967, including the capital participation by the MIDFL (51%) in July 1967 and the International Financing Corporation (IFC) 10% in August 1967.

The mill is located at Prai, at the opposite shore of the Penan Island, occupying the area of 45 acres.

(1) Selection of Prai as the location of mill

The reason why Prai was selected as the location of the mill may be (1) the Government had designated the area as the important regional development area for heavy industries and took measures for development and the area is backed by a large market for steel products, (2) it is favorably located for acquiring raw materials because the Keda Iron Mine is in 80km distance to north and the Ipo Iron Mine and the lime stone mine 176 km south, (3) water of the River Prai can be used as industrial water and the electric power can be steadily supplied by the nearby national thermal power station (started power supply in 1966 with least lost in transmission, (4) it is close to the pier of Prai Port, efficient ore shipping port when expansion of facilities is completed and (5) it is conveniently located to acquire rubber goods as the material of charcoal to be used in the charcoal furnace.

(2) Outline of the facilities

The layout of the whole equipment of the mill is made thoroughly from the raw material to the finished products, and it may be one of the most rationalized design for a plant of this scale in the world.

The amount of capital investment underation is 75 million Malaysia dollars (including 55 million M. Dollars for the purchase of equipment). And survey of the site was made in August 1965 and ground clearing followed. The construction work of the mill started in March 1966. The rolling mill was put in operation on May 20, 1967, the Blast furnaces and the LD converters were commissioned in August of the same year.

Outline of the Facilities

Facilities	Equipments		Contents
Blast furnace	Furnace	1	Charcoal furnace, inner volume 145 m^3, 170 M.T/day
	Hot stove	3	
	Gas cleaning facility	1	line 20,000 N m^3/H
	Ore preparation facility	1	line 60 T/H
Sintering	Sintering plant	1	13 m^2 260 T/D Main ventilator 350 kW
Lime kiln	Lime kiln	2	10 T/D Main air blower 22 kW 10 T/D Main air blower 22 kW
Converter	L.D. Converter	2	12 T/CH Furnace body removable vessel type
	Mixer	2	Ladle type, 80 T
Rolling	Reheating furnace	1	25 T/H
	Roughing mill	2	High AC 75 kW
	Intermediate mill	4	2 High AC 1,000 kW
	Finishing mill	6	2 High AC 1,200 kW
Auxiliary	Oxygen generator	2	500 N m^3/H
	Boiler	2	1 5 T/H
	Power sub-station	1	1 1/3 3 kV, 4,500 kV x 2
	Others		

Among these equipment, the blast furnace and the LD converter have specific features. The blast furnace is a charcoal furnace which utilizes mainly the rubber woods.

To supply charcoal to these furnaces ever since the Mill was put in operation, the Malaywata Charcoal Co., Ltd., a subsidiary of the Malayawata Steel Mill, has been producing 4,000 tons of charcoal a month a month by 18 charcoal kilns, each having a capacity of 12 – 18 tons (monthly) located in 7 kiln-centers in a radius of 35 miles from Prai. This charcoal company was merged to the Malayawata Steel Mill in July 1968 and is now operating as the charcoal Division of the Malayawata Steel Mill.

The converter has adopted a new method of furnace body change-removable system, which greatly contributed to the improvement of operation efficiency.

(3) Expansion Programme

At the end of 1968, the Mill will see the start its 2nd expansion plan, which was originally scheduled to start in April 1968 but was delayed for some reasons. The plan was worked out in line with the Malaysia Government's policy to provide practical protective measures for the Malayawata Steel Mill (restriction of import of competitive products and strict surveillance through customs office for illegal import. The expansion plan calls for the installation of a new blast furnace of 170 ton (145 m^3) a day capacity and a large size rolling mill, stand, and the enlargement of ingot storage yard, etc. It aims to raise the production capacity of the mill over 110,000 tons in terms of steel products as early as possible so that the cost of production may be reduced by mass production. The Pla mill also realize a well balanced installation of equipments and enable the supply of steel products of good quality at low price.

With regard to the operation of the blast furnace, expansion of sintering equipment was excluded from the plan since it produces sintered ore instead of 100% sintered ore material used in the past. After practical test of the equipment, they had confidence in successful use of it.

As a result of growing diversity in demand, various kinds of products will be added to the present product of round bars

(4) Others

For the construction and operation of the Malayawata, The Yawata Iron and Steel Co. of Japan is offerring extensive cooperation. Arrangements between the two companies provide that the Yawata is to provide technical assistance, general equipment and technicians, etc. The Yawata is providing assistance and maintaining close cooperation with the Malayawata in the phases of plant construction and the operation of mill in such fields as management, planning, purchase of equipments, transportation, etc.

2.2.2 Galvanized Sheet Mills

(1) Federal Iron Works

This is a joint venture of the native Chinese capital (Yew Lian, Ltd.) and Japanese firm, designated by the Malaysia Government as the Pioneer industrial enterprise on June 11, 1960, and produces hot dipped galvanized sheets. The mill, located in the industrial estate in Pataling Jaya, started its operation in August 1962 and has a production capacity of 24,000 tons on the average of two consecutive years.

(2) Malaysia Galvanized Iron Works Ltd.

This, like the Malaysia Galvanized Iron Pipes, Ltd., located next to it in the industrial estate at Petaling Jaya, is a subsidiary of the Soon Seng & Co. (12-A Jalan Tandang, Petaling Jaya, Selangor). It was established in 1965 with a locally invested capital of US$330,000 (¥120 million). It's monthly production capacity is 1,200 tons of hot dipped galvanized sheets of No.25 and No.35. Though the mill has two galvanizing lines (3 feet wide and 4 feet wide respectively), only one 1 line of 3 feet wide is now in operation.

(3) Southern Iron and Steel Works Ltd.

Located 20 miles south of Prai, on the opposite shore of Penang Island in West Malaysia, the mill is capitalized at M.$1 million and produces galvanized sheets and round bars. The mill is under the guidance of the Sumitomo Metal Industries, Ltd. of Japan for operation.

(a) Galvanized sheet Division

Annual Production capacity is 12,000 tons (Hot Dipped). The machine, manufactured by the Tanisaka Iron Works of Japan to treat the sheets ranging from No.26 – No.39 was first put in work in 1965 and is now producing mainly No.35 sheets.

(b) Bar Division

Its facilities consist of a heating furnace of 3 – 7 tons/hourly one stand of 2 high 8-1/2" x 20' roughing mill and 6 stands of 2 high 8-1/2" x 16' finishing mill to produce 5-1/4" – 1" bars with a monthly capacity of 6,000 tons in 3 shifts.

2.2.3 Steel Pipe Mills

(1) The Steel Pipe Industries of Malaysia, Ltd. (Under Construction)

It was established in April 1968 as a joint venture of the Japanese firms and the Hong Leong, Hong Bee and Kim & Co. of Malaysia, the share of 40% of the joint capital being possessed by the Japanese firms and 51% by three other local firms. Annual production of 14,000 tons electric welded pipes is being planned for the proposed mill.

The mill is now under construction with the work schedule calling for the completion of piling of the mill site by the end of November 1968, closing of bid for building construction (biders will be native contractors only) by the end of 1968, completion of building by January 1969, completion of installation of electric welded pipe mill and auxiliary equipments by March 1969, and the commencement of operation in May 1969.

The site of the mill is expected to be on the opposite shore of the Penang Island (B' worth).

(2) Malaysia Galvanized Iron Pipes, Ltd.

It is a subsidiary of the Soon Sen & Co., one of the leading financial trust in Malaysia. It produces electric welded pipes, and operate purely on local capital of US$ one million at the end of July 1968. The mill site is in Petaling Jaya industrial estate and the head office, at 23, Jalan Melaya, Kuala-Lumpur.

It has a high frequency induction welded line in operation to produce 1/2" – 4" pipes with a monthly capacity of 2,500 – 3,000 tons and an equipment (monthly capacity 1,000 – 1,500 tons) for the production of pipes less than 2", which is at present not in operation.

Its products conform to the B S Standard. The area of the mill site is 4.5 acres, the building floor area being 60 feet x 540 feet. 80% of its selling is the galvanized pipes and 20% black pipes.

As to the equipments for tinning, it has 4 tinning lines and one high pressure steam cleaner.

The customs tariff for the imported goods competing with products of this mill is set very high to protect the mill and this impressure has been proved to be a success

(3) K. G. Boon & Cheah Steel Pipe, Ltd.

It was set up on June 12, 1962 as a Government designated Pioneer industrial enterprise. The old name of the company was C & E Morton (Malaya) Ltd.

As a subsidiary of the K. G. Boon & Cheah Co., Ltd., a leading civil engineering and construction concern in Malaysia, it produces electric welded pipes. Though it has monthly production capacity of 1,000 tons, actual record of production has been around 500 tons a month.

The location of the mill is Site No.2, Industrial Estate, Ipoh, Perak.

2.2.4 Bar Mills

(1) Dah Yung Steel Mfg. Co., Ltd.

Located in the subrubs of Kuala Lumpur, the mill produces 18 tons of bars a day per shift (360 tons monthly), operating 20 days a month. The sizes of the products are from 9 mm to 20 mm. The equipment is one line of 22 high 14" x 27" 2 stand rolling mill, one line of 3 high 14 inches 1,200 mm 2 stand mill, a heating furnace of 2 ton/hour and 2 electric arc furnaces, the capacity of which being 3 tons and 4 tons at a charge respectively.

(2) United Malaysian Steel Mill

It is a round steel bar maker operating electric furnaces, located in the industrial estate of Petalin Jaya in the suburbs of Kuala Lumpur. Formerly it was a reroller of round bars using the ship breaking scrap and was named the Sincere Rolling Steel Mill. The mill had been closed for sometime after the conflict of views between the management and the shareholders on the expansion program of the mill and was reopened in July 1966 under the present name. It produces 800 tons of round bars by operating 8" – 7 stand cross-country mill. Additional electric furnace and rolling mill are now under construction with the investment of 3 million US dollars of its own fund. Installation of the rolling mill was completed in April 1968 (a second hand rolling mill which had been stored at Hong Kong was imported) and the electric furnace, in September 1967.

The newly equipped rolling mill has 2 stand 14" roughing mill and 8 stand 2 high 10" intermediate finishing mill, with a monthly capacity of 2,500 – 3,000 tons on 2 shifts. This mill is to be used for the production of small size pipes of 3/8" – 5/8".

The specification for his electric furnace, made by the Ushio Works of Japan, calls for 6 – 8 ton capacity, 2,500 kW, top-charge type and with oxygen blowing apparatus. The oxygen is supplied by the Malaysian Oxygen Co.

(3) Southern Iron & Steel Works, Ltd. (See above V-2, b) ii 3)

E.3 Malaysia's Iron and Steel Making Facility Plan

E.3.1 Results of a Study of the Recommendation Presented by the ECAFE First Survey Mission on the Possibility of Hot Strip Mill Construction

The Malaysia Government has reaffirmed that it will continue its policy for the development of national steel industry with the Malayawata Steel Mill as its center. Therefore, it may be said that the problems concerning the hot strip mill have close relations with the future of the Malayawata. We made a study on the matter by giving due consideration to the Malayawata and come to the following conclusion.

In Malaysia there is the Malayawata Steel Mill at Proi District, the unique integrated steel mill in Southeast Asian countries, which is now in favourable operation producing mainly round bars. The mill consists of a small sized charcoal-blast furnace, a LD converter of vessel-exchangeable type and a bar mill. The blast furnace is unique for its of charcoal made from the waste rubber woods in the nearby rubber plantations to reduce iron ore The cost of pig iron production is of the such level as that of modern large blast furnace. The converter which adopted the newest technique of exchanging vessel has excellent efficiency. However, only one blast furnace is currenty in operation, for the converter is forced to be in idle operation because of limited quantity of pig iron. The bar mill, though it has potentiality to double its production capacity with a new addition, is not in full operation as yet. As a result, the interest and depreciation expense per ton of ingot and bars run high and in turn, the production cost of steel bars will have to be rather high.

To cope with this situation, a plan is being worked out Under the plan another blast furnace of same capacity as the one now in operation will be installed and a portion of the rolling mill will be expanded so as to double and balance production of each facility from blast furnaces to bar mills. If this plan is carried out successfully, a large reduction in the production cost can be expected. Even when two blast furnaces are in operation, the Malayawata's integral iron and steel making system will have no reserve capacity to produce items other than bars and sections.

It is said that in 1967 when the Malayawata made a study on the feasibility of construction of the tin plate mill and the reverse mill, a conclusion was made that cold sheets and hot coils, the main base materials, would have to depend on the import.

The First Survey Mission, ECAFE had an idea to make a study on the possibility of erecting a hot strip mill in Malaysia (Malayawata). The idea was based on the thought that the next stage of the Malayawata's development program should be in the field of flat products

However, a hot strip mill should have a minimum annual production capacity of 1,000,000 tons to operate economically. It will hardly be able to expect its normal operations on economical scale due to the shortage in domestic demand at this moment.

By the way the demand for cold rolled sheets in Malaysia in 1980 is estimated at abou 132,000 tons and the demand for hot coils, products of hot strip mill, including hot rolled sheets will amount to 330,000 – 350,000 tons. And even in 1985 the demand will be only 450,000 tons, which is far less than half of annual production capacity of hot strip mill.

The quality of pig iron produced by the charcoal furnace of the Malayawata is too good to be used as raw material for ordinary steel such as marchant bars. Effort should be made to make high quality products such as special steel bars by taking into consideration the future trend of demand in the community.

E.3.2 Study on the Possibility of Constructing an Electrolytic Tinning Plant in Malaysia

3.2.1 Background of the Proposal

In view of the present demand and future prospect of demand for tin plate and the existence of tin ore as the natural resources in Malaysia, construction of the tinning plant is deemed appropriate.

The Government on its part has a positive intention to set up such a tinning plant. Under these circumstances, it may be said that there is great possibility of for the construction of an electrolytic tinning plant in the future.

All the demand for tin plate in Malaysia is being met by import.

Amount of Import of Tin Plate in Malaysia:

Year (C.Y.)	1961	1962	1963	1964	1965	1966	1967
1,000 M.T.	7.0	10.7	7.3	16.4	15.4	24.2	25.9

Note: (1) Figures for 1967 are based on the estimate.

(2) Includes the tin plates of WAST. If only the tin plates of Prime is to be culculated, the figure will be less than the above.

Source: Japan Iron & Steel Federation

As shown above, Malaysia's demand for the plate in 1966, nearly all of which is for electrolytic tin plate, was about 2,000 M.T per month, and the demand has been steadily growing at the rate of 70% annually. However, it must be said that such demand alone is not enough to make the project feasible, and it would take approximately 10 years before the construction of the electrolytic tinning line is possible. The demand in 1975, 1980 and 1985 is estimated at about 3,700 T/M, 5,150 T/M and 7,250 T/M respectively.

Fortunately, Malaysia as a major tin producing country, is in a favorable position to obtain tin at the low price. The proposed tinning plant will have a production capacity of 5,000 tons per month in the initial operation around 1980 and eventually 10,000 tons in the future.

3.2.2 Plan for Production Facilities of the Electrolytic Tinning Line.

(1) Stages of construction

In principle, the facilities should be expanded according to the growth of demand. In the proposed plan the phase of construction is divided into the following two stages, setting the initial capacity of the tinning line, the major equipment, at 5,000 t/month and later expanding it to 10,000 t/month.

– First Stage –

Coil preparation line	1 set	15,000 T/month
Tinning line	1	5,000 "
Shearing line	1	8,000 "
Recoiling line	1	6,000 "
Packing line	(one set each for coils and sheets)	

– Second Stage –

Tinning line	(expansion)	10,000 T/month (Capacity after expansion)

The timing of the second stage will be decided according to the growth of demand. The foundation work should be completed in the first stage so that the period of suspension of operation of lines caused by expansion works may be limited to about one week.

(2) Main equipment

(a) *Coil preparation line*

Weight of coil:	10 tons
Thickness of coil:	0.1 – 1.0 mm
Width:	457 – 1,067 mm (before side trimming)
Feeding speed:	30 m/minute

(Note) Since this line is used for rejecting faulty coil and for coil-trimming, this line can be disposed of when pre-treated coil is supplied.

(b) Tinning line

No. of plating tank:	7 (14 after expansion)
Weight of plating:	(for each area) 2.8 – 11.2 gr/m^2
Tinning speed:	244 m/minute
Size of products	
Thickness	0.1 – 0.6 mm
Width	457 – 965 mm (18" – 38")
Weight of coil	10 T
Width of coil	max. 1,016 mm

(c) Shearing line

Size of strip	
Thickness	0.1 – 0.6 mm
Width	450 – 1,050 mm
Weight of coil	10 T
Size of products	
Width	449 – 1,021 mm
Length	457 – 1,105 mm
Line speed	107 – 380 m/minute

(3) Budget for Equipments

Expense for plant site is excluded.

First stage	(Unit: US$)
Coil preparation line	469,444
Tinning line	4,168,666
Shearing line	1,388,888
Recoiling line	588,889
Packing line (2 lines)	347,222
Crane (5)	208,333
Building and equipment foundation	2,611,111 (including offices)
Auxiliary facilities	638,888
Power facilities	1,472,222
Water supply and drainage	361,111
Others	180,555
Total	12,434,329

(If the coil preparation line excluded: minus US$638,890)

Second stage	(Unit: US$)
Tinning line (expansion)	1,555,555
Building (expansion)	125,000
Power, etc. (expansion)	250,000
Total	1,930,555
Grand Total	14,364,884 (13,725,994)

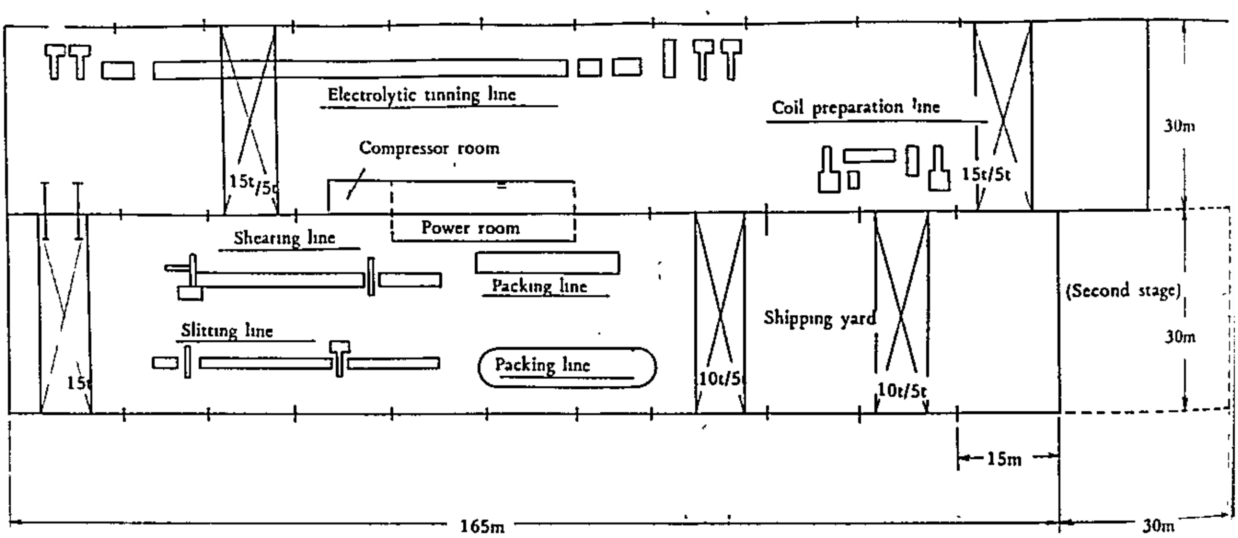
The layout of the plant is shown at the end of the report.

(4) Technical Recommendation

As the production of electrolytic tin plates requires extremely high technical skill and circumspect care in operation, thorough training must be given to the operators for a long period of time. Therefore, before the plant is put into operation, it is hoped that a number of engineers and operators be sent to the industrialized countries including Japan to obtain necessary knowledge and skill. In a series of processes, if a slight error is made or material or products treated roughly, the product yield of the plant will be reduced greatly, which in its turn endaangers the profitability of the plant.

Generally speaking, it is desirable to operate continuously the tinning line; if operated in an intermittent way, the yield of products will decline. It is recommended, therefore, the construction of this equipment must wait till the time comes when there becomes sufficient demand to enable the plant operate in its full capacity.

Layout of the Electrolytic Tinning Plant



F THAILAND

F. THAILAND

F.1 Present Situation and Future Prospect of Demands for Iron and Steel in Thailand

F.1.1 Economic background and present demands for iron and steel

In recent years Thai economy has been continuing a high level growth. Its annual average growth rate during the period of 1958 – 1968 is 7.8%, and the percentages of the manufacturing and construction industries in GDP are increasing. Also the foreign currency reserves have maintained a level nearly matching the payments for annual imports.

Table 1. Gross Domestic Products in Thailand (1968–'68)

(10^3 Million Baht)

Year	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968
G D P	48.7	53.8	59.4	62.0	65.3	71.7	76.8	82.9	90.0	96.4	103.6
Growth Rate	0.6	10.5	10.4	4.4	5.3	9.8	7.1	7.9	8.6	7.0	7.5

Source: U.N. Monthly Bulletin of Statistics, March 1968 PP189, however, it is presumed that the increase in 1967 was 7.0% over 1966, and the increase in 1968 was 7.5% over 1967.
(National and Social Development Plan Revised Copy BC 2511 (1968) Office of the National Economic Development Board November 1967. PP 9).

Note: 1962, Base Year Constant Price
Thousand Millions of National Currency Unit.

Table 2. Industrial Origin of Domestic Products

	Total	Agriculture & fishery	Mining	Mfg.	Construction	Transport & communications	Wholesale & retail	Housing	Public facilities & defense	Other public services
1960	(100.0)	38.9	1.4	10.5	3.6	7.5	17.3	4.6	4.8	11.4
1961	(100.0)	38.6	1.5	11.1	3.6	7.2	17.2	4.5	4.9	11.4
1962	(100.0)	37.2	1.5	11.4	4.2	7.4	17.7	4.4	4.6	11.6
1963	(100.0)	36.4	1.5	11.4	4.9	7.2	17.5	4.4	4.8	11.9
1964	(100.0)	33.8	1.9	11.7	5.0	7.8	18.7	4.4	4.7	12.0
1965	(100.0)	32.7	2.3	12.4	5.1	8.0	18.6	4.3	4.6	12.1
1966	(100.0)	33.4	2.4	12.8	4.8	7.8	18.3	4.1	4.3	12.1

Source: U.N. Economic Survey of Asian and the Far East 1967 PP 149

Table 3. Consumption of Steel in GDP

Year (CY)	1962	1963	1964	1965	1966	66 / 62 Annual ratio	66 / 62 Annual rate	Remarks
Steel consumption (1,000M.T.) (A)	289.1	355.9	385.5	442.3	515.0	1.781	155	Elasticity of growth of steel consumption to growth of GNP is 1.85
GNP (B) 1962: 1,000 mil. bahts	65.3	71.7	76.8	82.9	90.0	1.378	8.4	
Steel consumption (1,000 M.T.) per 10,000 mil. bahts	4.43	4.96	50.2	5.34	5.72	1.291	6.6	
Population: - millions at end of year	28.0	28.9	29.8	30.7	31.6	1.128	3.1	

Table 4. Tendency of Increases in Imports and Foreign Currency Reserves

		Foreign currency	Gross imports
Year (CY)		Million US$	
1964		649	681
1965		632	736
1966		900	884
1967		985	993
67/64	Annual ratio	1.518	1.458
	Annual rate	14.9	13.4

Sources: I M F, International Financial Statistics

Table 5. Actual Value of Capital Formation

(Unit: 10,000 mil-bahts)

	1960	1961	1962	1963	1964	1965	1966	1967
Actual value	9.3	10.6	12.7	15.2	17.3	18.9	20.2	22.4

Source: National Economic and Social Development Plan Revised copy B.E. 2511 (1968) PP15

Note: Current price

Of the gross domestic production (GDP), the growth of capital formation, is most closely related to the consumption of steel, has continued at an average annual rate of 13.4% during the seven years from 1960 to 1967. It is due to such a remarkable economic development that the steel consumption has been increasing at a rapid pace. The steel consumption growth during the 4-year period of 1962 – 1964 was at a rate of 15.5%, while the growth of GNP was at 8.4%. Thus the elasticity of the steel consumption growth against the growth of GNP was 1.85.

Table 6. Growth Tendency of Apparent Demands for Steel During Past 5 Years

(Unit: 1,000 M.T.)

Kind of steel	Year	1962	1963	1964	1965	1966
Flat products	Universal steel plates, sheet	19.2	22.7	27.8	36.6	37.6
	Gold rolled plate	64.3	78.5	105.7	80.2	118.0
	Hoop	0.9	0.9	2.1	2.5	5.1
	Tin plate	14.6	13.1	18.0	20.9	30.9
	Galvanized sheet (GI sheet)	60.8	69.6	79.9	90.2	108.8
	Steel pipe	18.5	30.3	26.5	37.7	43.0
	Sub-Total	178.3	215.1	160.0	268.1	344.4
	Duplicated production	-60.0	-70.0	-85.0	-117.0	-155.0
	Total of steel plates	119.0	145.0	175.0	151.0	190.0
Sections & others	Bar	114.6	128.4	143.5	187.5	231.6
	Shapes	12.8	18.4	21.5	24.8	34.6
	Wire and wire products	44.7	44.9	50.2	55.6	34.7
	Sub-Total	172.1	192.2	215.2	267.9	300.9
	Duplicated production	-5.0	-6.0	-7.0	-7.2	-7.2
	Total of sections	167.1	186.2	208.2	261.7	293.9
	Others	3.0	24.7	2.3	29.6	31.3
Grand total		289.1	355.9	385.5	442.3	515.0

Note: Duplicated production of steel plates refers to tin plates, material plates for galvanized sheet and material plates for welded steel pipes; and that of sections to secondary processed wire products.

F.1.2 Forecast of demands for cold rolled sheet

1.2.1 Present situation and general picture

For the five years from 1962 to 1966, the apparent demand for cold rolled sheets increase and an annual growth rate of about 13%. The principal factor for this increase was the demand for the base sheets for GI sheets and tin plates, which accounted for about 70% of the overall demand. Other factors are the fact that galvanized sheet. (GI sheet) mills entered a full scale operation in 1962 and that the protective import duty of 2,000 bahts (US$100) per ton have been enforced.

The greatest part of the demands for galvanized sheets was for No.35 corrugated products and a great variety of No.14 to No.35 plain GI sheets. The average purchase price of base sheets (on mill delivery) is 3,210 bahts per ton. Most of thick sheets are used for the manufacture of water tanks.

As for coated sheets, those of 0.6 oz/ft^2 2.5 ft x 6 ft, 3 ft x 6 ft and 2.5 ft x 8 ft are major products. The percentage of these in corrugated sheets is 70%. The wholesale price of GI sheets of 2.5 ft in width is 1.88 – 1.90 bahts/foot (No.35). The custom duty for No.35 black plate is 100 bahts per ton, that for zinc 10% of C & F, that for GI sheets 2,000 bahts per ton.

Tin plates are largely demanded in 75 – 107 pound products for the manufacture of tabacco and oil containers, and demands for the manufacture of milk cans are also increasing recently. The demand season for GI sheets is the period of June to September.

1.2.2 Present situation of GI sheet and tin plate mills, and expansion plans

At present Thailand has a total of four GI sheet and tin plate mills.

GI Sheet Mill as of Aug. 1968

Company name	Rated Capacity	Production
Thailand Iron Works (T.I.W.)	60,000 (5 units)	38,235 *3
Sangkasi Thai *2	70,000 (5 units)	53,652 *1
Galvanizing (S.K.T.)	24,000 (2 units)	16,113
	154,000	108,000

Tin Plate Mill as of Aug. 1968

Thai Tin Plate Co. (T.T.P.)	24,000 (hot dip 5 units)	8,000 (2 units operating)*3

Note: *1 Excluding annual production of 1,200 t of colored, coated sheet.
*2 An additional line with annual production of 12,000 t is now under construction
*3 Production began in 1967

1.2.3 Prediction of capital formation with GDP as a premise

In order to make a prediction of the demands for cold rolled sheet in connection with the country's capital formation in GNP, computation of their future values is necessary. As to the future values of GNP and CF (capital formation), the following method was employed:

(1) GDP

The forecast was made on the basis of the actual values up to 1966, the Thai Government's data for 1967 and 1968 and the Thai Government's Second Economic Development Plan, information directly derived from officials interviewed and other sources for 1969 and after.

Table 7. Forecast of GDP in Thailand (1969 – 1985)

(10,000 mil. bahts)

Year	1969	1970	1971	1972	1973	1974	1975	1980	1985	70/66	85/70
G D P	111.6	120.2	129.2	138.9	149.3	160.5	172.5	241.9	335.3	1.335	2.789
Growth rate	7.7	7.7	7.5	7.5	7.5	7.5	7.5	7.0	6.75	7.5	7.1

Source: Based on actual results and by referring to:

1) Report of the Survey Mission on the Development and Expansion of the Iron & Steel Industry in South - East Asia.

2) The Second National Economic and Social Development Plan (1967–1971), information directly given & data of Japan Iron & Steel Federation.

(2) Capital formation (C.F.)

Based on data of Thai Government and United Nations (up to 1967); the Second National Economic Development Plan and information directly derived from officials concerned.

Table 8. Presumed Values of Capital Formation

	1968	1969	1970	1971	1972	1973	1974	1975	1980	1985
Presumed value	24.4	26.5	28.8	31.2	33.1	35.4	37.9	40.5	51.7	64.4

Source: National Economic and Social Development Plan Revised copy B.E. 2511 (1968) PP9–15

Note: (1) Current Price

(2) Based on data of the Second National Economic Development Plan and information directly given by officials concerned.

1.2.4 Forecast of demands for steel plates and GI sheets and Tin plates

The demands for steel plates in 1970, 1975 and 1985 was analyzed by correlating the values of the expected future GDP and CF, and GDP's correlation value which indicated, through intra-polaration, a value approximate to the past actual results, was taken.

Result is as follows:

Table 9. Apparent Demand for Steel Plates Presumed by GDP Correlation

(Unit. 1,000 M.T.)

	1970	1975	1980	1985
Demand for flat	260.7	388.3	557.6	785.5

	70/66	75/70	80/75	85/85
Annual growth rate	8.2	8.3	7.5	7.1

*Reference: Values of demand, actual and presumed by Thai Government

For flat products	1,000 M.T.
1965	150
1966	200
1967	300
1975	480

Note. Information was given by concerned officials

Forecast of consumption of GI sheet and tin plates, made on basis of actual sale record of various companies.

The actual sale results have followed the tendency as shown below:

Table 10. Actual Consumptions of GI Sheets and Tin Plates

	B.I. Sheet, tin plates sale tendency						Cold rolled sheet
	SKT	TIW	FEW	Sub-Total	TTP	Total	(imported)
61	22.0	18.5	–	40.5	N. A.	N.A.	49.6
62	32.4	29.0	–	61.4	7.0	68.4	64.3
63	31.0	31.0	–	62.0	7.0	69.0	72.5
64	41.0	31.0	10.0	82.0	7.0	89.0	105.7
65	41.0	33.0	15.0	89.0	7.5	96.5	80.2
66	39.1	31.0	15.0	85.1	7.5	92.6	118.0
67	53.7	38.2	16.1	108.0	7.5	115.5	153.9

Note: The sale volume in 1961 – 1967 was attained on the basis of spot hearing, but TTP's was attained from its capacity and production.

As shown above the apparent consumption of GI sheets produced from cold rolled sheet sometimes exceeded the actual import volume of cold sheet. This is due to the fact that in those years their inventories were counted out. The exports and imports of GI sheet being unavailable, it would be appropriate to presume the consumed value on the basis of the sales by a company producing them. Such figures on sales considered approximate to the production value. The estimated consumption values of GI sheets on the basis of GDP and CF are approximated to the actual past values by the intra-polaration of the forecast correlation equation, the one correlated with CF has more appropriateness than that with GDP. The calculated values on CF are taken for the forecast of the consumptions of GI sheet as follows:

Table 11. Forecast of Consumption of GI Sheets on Basis of CF

(Actual basis of sale volumes)

(Unit: 1,000 M.T.)

1961	40.5	1965	89.0	1975	181.2
1962	61.4	1966	85.1	1980	230.5
1963	62.0	1967	108.0	1985	286.4
1964	82.0	1970	129.7		

Note: Actual results up to 1967.

As for the production of tin plates, Thailand's sole producer, Thai Tin Plate Co. has so far produced them at a level of 7,000 – 8,000 tons a year. Even if it increases production by 300 tons a month in anticipation of orders for tin plates for metal boxes, the manufacture of which is expected to start in 1970 – 75, its annual production will be only about 12,000 tons.

Meanwhile, the apparent consumption of tin plates in 1966 reached 30,900 M.T., and a considerable amount of tin plates, largely electrolytic tin plates, were imported that year.

Against this 30,900 M.T., the above Thai Tin Plat's production percentage is 27%. If this is adopted as the percentage of the domestic production of hot dipped tin plates in the forecast for apparent consumption of tin plates, the future production of the plates becomes as follows:

Table 12. Prospects of Consumption and Production of Tin Plates

(1,000 M.T.)

	1965	1966	1970	1975	1980	1985
Gross consumption	20.9	30.9	39.0	49.0	63.0	80.0
Production	7.5	7.5	12.0	12.0	17.0	21.6
Import	13.4	23.4	27.0	37.0	46.0	58.4

Table 13. Overall Prospects of Consumption and Production of GI Sheets, Tin Plates

(1,000 M.T.)

	1966	1967	1970	1975	1980	1985
G. I. Sheet	85.1	108.0	129.7	151.2	230.5	286.4
Tin plate	7.5	7.5	12.0	12.0	17.0	21.6

1.2.5 Demand for cold rolled sheets in fields other than the manufacture of tin plate and GI sheet.

Cold rolled sheets for other than tin plates and GI sheets are also needed for manufacturing steel pipes, furniture, drums, etc.

The articles which are produced from such imported cold sheets are classified as follows

Table 14. Classification of Uses of Imported Cold Rolled Sheet (in 1967)

Use for		Imported cold sheets	Weight %
For mfg. of steel pipes		8,000 M.T.	5.2
As base plates	for GI sheets	103,000	66.9
	for Tin plates	7,000	4.5
Others		35,900	23.4
Total		153,900	100.0

Note: (1) Imported: Jan. to Dec. 1967; the percentages of imported cold sheets by use are calculated on the basis of imports from April 1967 to March 1968. (source: The Japan Iron & Steel Federation's data.)

(2) Quantity of imported cold rolled sheets is not identical with the consumption quantities by use due to inventory condition, etc., so that only the percentate of weight were adopted.

On the basis of the above figures, the amount of cold rolled sheets used for pipes was attained from their weight percentage in 1967, and that after 1980 inclusive was attained from the past tendency by correcting the weights as shown in Table 15.

Table 15. Forecast of Related Articles Causing Consumption of Cold Rolled Sheet*

Use for	1967		1970		1975		1980		1985	
	1,000 M.T.	%	1,000 M.T.	%	1,000 M.T.	%	1,000 M.T.	%	1,000 M.T.	%
G.I Sheet	108.0	66.9	129.7	70.0	181.2	65.0	230.5	60.0	286.4	55.0
Tin Plate	7.5	4.5	12.0		12.0		17.0		21.6	
Others	46.2	28.6	60.7	30.0	104.0	35.0	165.0	40.0	252.0	45.0
Total	161.7	100.0	202.4	100.0	297.2	100.0	412.5	100.0	560.0	100.0

Note: (1) The consumption amounts of GI sheets and tin plates for 1970 – 1985 are those assumed from the actual consumption amounts of these articles.

(2) The cross section method for investigating the trend of iron and steel consumption by kind among iron & steel manufacturing countries was employed on the basis of Japanese exports to Thailand in 1967 of the steels classified by kind.

1.2.6 Forecast of demand for cold rolled sheets

On the basis of Table 15, calculation was made on yields in order to grasp the consumption of cold sheets. The results are shown in Table 16.

Table 16. Forecast of Consumption of Cold Rolled Sheets

(1,000 M.T.)

	1967	1970	1975	1980	1985
C.I. Sheet	102.8	123.5	172.5	219.4	272.7
Tin Plate	7.7	12.4	12.4	17.5	22.3
Others	49.1	64.6	110.7	175.7	268.4
Total	159.6	200.5	295.6	412.6	563.4

	70/67		75/70		80/75		85/80		85/67	
	Annual ratio	Annual rate	Annual ratio	Annual rate	Annual ratio	Annual rate	Annual ratio	Annual rate	Annual ratio	Annual rate
Consumption of cold rolled sheets (%)	1,256	7.9	1,474	8.1	1,396	6.9	1,365	6.4	3,530	7.2

*Backwardation yields

G.I. Sheet ⟶
Tin Plate ⟶
Welded Pipe - - ⟶
Welded Pipe ⟶
Others ⟶

} Cold rolled sheet { x 95.2% / x 103.1% / x 107.5% / x 106.0%

Incidentally, the minimum values of the demand for cold rolled sheets calculated by various methods are 250,000 M.T. in 1975, 32,000 M.T. in 1980 and 410,000 M.T. in 1985.

F.1.3 Forecast of demand for billets

Billets are demanded in the productions of bars, shapes and wire rods. To forecast the demand for billets requires to know what kinds of articles the billets are needed for.

By converting these forecast results to yields, the amount of demand for billets is calculated. The amount of supply corresponding to that of demand can be obtained by dividing it into the amounts of domestic production and imports.

To grasp the actual demand for billets from the demand by reroller and electric furnace makers, the former's demand was attained by dividing billets into cutter billets of ship breaking and those produced from steel ingots.

1.3.1 Present situation of apparent consumption of bars, shapes, wire rods and wires & prospects

Apparent consumptions of these products can be obtained by the equation "production + import-export (in quantity)". In the case of calculating the consumption of wires, its duplication with wire rods should be avoided. After determining the actual consumption, the forecast was made by analyzing the correlation between GDP and CF. The result thus obtained was checked through intra-polaration to the actual value and GDP's correlation.

(1) Features of current consumption of sections, etc., and its general picture.

Demand for structural concrete bars (round bars) is overwhelmingly large and rapidly growing with the advance of Thailand's economic development.

As regards shape steels, those called angles and shapes, are chiefly needed for construction and also as beem and girder materials.

As regards wires and wirerods, such secondary wire products as plain and barbed wires occupy a major part of their demands.

A review of the growth of demand for bars during the past five years indicates that the demand for shapes increased about three-fold, that for bars 2.5-fold, and that for wire rods and wires showed no marked increase.

Table 17. Apparent Demand for Sections

(1,000 M/T)

		1962	1963	1964	1965	1966
Sections	Bars Shapes Wire & wire rods	114.6 12.8 44.7	128.4 18.4 44.9	143.5 21.5 50.2	187.5 24.8 55.6	231.6 34.6 34.7
	Total	172.1	192.2	215.2	267.9	900.9
	Duplicately produced portion between wires and wire rods	-5.0	-6.0	-7.0	-7.2	-7.2
	Total of sections	167	186	208	261	294

(2) Forecast of future demand for sections

The estimate of the future demand for sections was made on GNP correlation and CF correlation using actual values. Then, referring other data, the GDP correlation was adopted, as shown in Table 18.

Table 18. Forecast of Demands for Sections Calculated by GDP Correlation

Year (C.Y.)	1964	1965	1966	1970	1975	1980	1985
Bar	143.5	187.5	231.6	359.0	590.0	950.0	1,324.0
Shapes	21.5	24.8	34.6	54.0	84.0	144.0	200.0
Wire rods and wires (duplicated production excluded)	43.2	58.4	27.5	43.0	66.0	76.0	100.0
Total	208.0	261.0	294.0	456.0	740.0	1,170.0	1,624.0

1.3.2 Present situation of production of sections and prospects

The top maker of bar steel in Thailand is G. S. Steel Co. It is producing 100,000 tons or so annually and endeavoring to expand this scale.

Siam Iron & Steel Co. is also expanding its mill and anticipating to possess a great production capacity sometime in the future. This company expects to begin the operation of a new mill now under construction by 1975, at the latest.

Besides, there are many rerollers and some of them have already had programs to set up electric furnaces for carrying out throughout operation to manufacture bars from the steel making furnace.

The production capacity of steel makers with their own steel-making furnaces and their potential capacities upon the completion of the expansion program are complied in Tables 19 and 20.

Table 19. Transition of Steel Production Capacities in Thailand, Malaysia and Singapore

(Unit: M.T.)

		Thailand	Singapore	Malaysia
1967	Electric furnace	30,000	120,000	
	Open hearth	12,000		
	LD & Bessemer converter	1,500	120,000	120,000 (LD)
	Total	43,500	120,000	120,000
1968	Electric furnace	+96,000	+24,000	+48,000
	Open hearth			
	LD & Bessemer converter			
	Total	139,000	144,000	168,000
1971	Electric furnace	+190,000		
	Open hearth			
	LD & Bessemer converter			
	Total	329,500	144,000	168,000

Production amount of steel ingots (Capacity x 80%)	1967	34,800	96,000	96,000
	1968	111,600	115,200	134,400
	1971	263,600	115,200	134,400
Amount in terms of sections (Steel ingot x 94%)	1967	32,700	90,200	90,200
	1968	104,900	108,300	126,300
	1971	247,700	108,300	126,300

Thailand as of August 1968, had no shape and angle factories but had bar and wire factories.

Regarding the bar factories, there are many re-rollers. Available production capacity and current production by company are listed in Table 20.

Table 20. Current and Future Production Capcity of Thai Bar Mills

	As of Aug. 1968		Future		Remarks
	Capacity	Production	Capacity	Year	
G.S. Steel	120,000	90,000 M.T.	110,000 M.T. 150,000	1970 1975	With electric furnace
Siam Iron & Steel Co., Ltd	9,000	7,500	130,000 170,000	1970 1975	With electric furnace
Bangkok Steel Industry Co., Ltd.	24,000	22,000	22,000 34,000	1970 1973	Re-rolled iron electric furnance to be set up in 1972
Bangkok Iron & Steel Co., Ltd	24,000	20,000	50,000 80,000	1971 1974	With electric furnace
Thailand Steel Industry (1960) Co., Ltd.	3,000	3,000	3,000	1970	Re-rolled iron
Others re-rolled iron makers	10,000	7,500	10,000	1970	
Total	190,000	142,500	275,000	1970	
Electric re-roller	153,000	110,000	290,000 435,000	1971 1975	
Re-rolled iron maker	37,000	32,500	35,000 12,000	1971 1975	

As wire rod-processing makers, Sinthani Industry and Thai Tin Plate must be considered, the former producing annealed wires, wire and barbed wires, and the latter wire nails.

Table 21. Wire Mills

Sinthani Industry Co., Ltd.

Production	Aug. 1968		Remarks
	Capacity	Production	
Iron wire	15,000 M.T.	12,000 M.T.	Producing annealed wires, and barbed wires on iron wires from 1968

Thai Tin Plate Co., Ltd

Production	Aug. 1968		Remarks
	Capacity	Production	
Wire nails	9,600 M.T	7,200 M.T.	Producing nail wires

* The above two makers' demands for materials are met by imports and domestic supplies. Both are included in the apparent demands for the convenience of calculation.

1.3.3 Forecast of demand for billets

Forecast of the production of sections by the type of section makers on the basis of the demand for and supplies of sections reviewed above is given in Table 22.

Table 22. Forecast of Sections Production by the Type of Factory

	Year	Consumption & Production
Apparent consumption of section (A)	1967 1968 1971 1975	330,000 M.T. 360,000 490,000 740,000
Bar production by factories with steel furnaces (B)	1967 1968 1971 1975	32,700 104,900 247,700 348,000
Production by all sections makers (C)	1967 1968 1971 1975	130,000 142,500 250,000 360,000
Production by re-rollers (C–B) (makers without steel furnaces)	1967 1968 1971 1975	97,300 37,600 12,300 12,000

From the above, it can be said that the makers with steel-making furnaces will not have the capacity to supply the domestic re-roller with their own produced billets until 1975 at the earliest. Demand for sections being larger than the production, if such makers have extra capacity to make billets or small ingots, they would direct it to the production of bar. So, for some portion of the material for re-rolled products, the re-rollers must look upon the imported billets.

The investigation conducted in August 1968 found that the percentage of billets for re-rolled steel was produced from such scraps 20% and billets 80% on the basis of which the demand for billets are presumed as shown in Table 23.

Table 23. Forecast of Demands for Imported Billets

	1967	1968	1970	1971	1975
Production by re-rollers (bar) (A)	100,000	74,500	40,000	35,000	12,000
Production from billets A x 80% (B)	80,000	38,000	32,000	28,000	9,600
Demand for billets $B \times \frac{100}{94}$	85,100	40,420	34,040	29,800	10,213

Note: Of the production of billets, it is presumed: 20% from cutter billets; 80% from billets

As for billet production after 1976 inclusive, forecast is difficult to make because the various maker's expansion programs are not clear. It is presumed that demands for imported billets will continue at the size 10,000 M.T.

Table 24. Overall Prospect of Demands for Steel Products

	1966		1970		1975		1980		1985	
	1,000 M.T.	%	1,000 M.T.	%	1,000 M.T.	%	1,000 M.T.	%	1,000 M.T.	%
Total of finished products	515.0	100.0	775.0	100.0	1,285.1	100.0	1,892.4	100.0	2,661.0	100.0
Flat products	190.0	36.9	260.7	33.6	388.3	30.2	557.6	28.9	785.5	29.5
Sections & others	3.250	63.1	514.3	66.4	896.8	69.8	1,344.8	71.1	1,875.5	70.5

	70/66		85/70	
	Annual ratio	Annual rate	Annual ratio	Annual rate
Total of finished products	1,505	10.7	3,433	8.5
Flat products	1,372	8.2	3,013	7.6
Sections & others	1,582	12.1	3,647	9.0

F 2 Present Situation of Iron and Steel Industry in Thailand

F.2.1 Attitude of the government toward the development of iron and steel industry

The iron & steel industry of Thailand is represented by G.S. Steel located in the suburbs of Bangkok, 27 kilometers away, with an electric furnace which began operation around the end of 1967 and the Siam Iron & Steel (formerly the Steel Division of the Siam Cement) located 120 kilometers north of Bangkok. Besides, the country has two pipe mills, three GI sheet mills, one tin plate mill and some secondary wire-rod processing mills and re-rolling mills.

The policy of the government is to leave the industrialization in the country to the private sectors, and the government itself to place to emphasis on the development of infrastructures and to leave the development of iron and steel industry to the private sectors by giving assistance through the "Industrial Investment Promotion Act" enacted for replenishing the external economy Along this policy line, the Board of Investment of the Thai Government has already approved the establishment of several mills by taking into consideration the balance between the merit of free competition and the advantages of economies of scale.

F.2.2 General picture of iron & steel manufactures in Thailand by enterprise and mill

An outline of the status of principal iron and steel makers in Thailand, already operating or going to begin operation are described below.

2.2.1 Bar steel mills:

(1) G.S. Steel Co., Ltd.

Established on August 26, 1963, this company, designated by the Thai Government Board of Investment under the Industrial Investment Promotion Act, was the first to be a proper Thai-Japan Joint venture.

The mill is located 27 kilometers from Bangkok, and 100 m by way of a channel from the Chao River.

Construction of the mill began in March 1966 and was completed in November 1967, and its test operation was conducted on the 4th of the same month.

The site occupies an area of 50 Rais including 17 Rais for buildings.

Capitalized at 40,000,000 Baht (fully paid), 60% of its shares are possessed by the Japanese firms.

The mill facilities comprise:

(a) Steel-making equipment

Two 20-ton electric furnaces (cap. 7,000 KVA each)

Two sets of Lectromelt Daido (annual cap. 96,000 t. together)

Oxygen-making equipment 160 m^3/hr.

(b) Rolling mills

Heating furnace (2-row charge, 3-zone type, 30 t./hr.); bar mill (20 – 30 t./hr 6 mm/–25 mm); annual target production: 70,000 t. of bars in the first stage, 90,000 t. in the second stage, 13,500 t. at full operation in 1970.

(c) Future plan

Additional installation of a 20-ton electric furnace (7,000 KVA) is under construction. To meet a variety of demands, the plan is being prepared to produce angle bars, deformed bars, wires (for nails), etc.

The mills personnel will number 400 in the first stage of the construction, 500 in the second stage and 600 in the third stage.

(2) Siam Iron & Steel Co., Ltd.

Located 120 km. north of Bangkok, this company formerly belonged to one of Thai representative enterprises, Siam Cement Co. as its iron & steel division; it gained its independent status in January 1966.

Siam Cement, having been affiliated with a Danish interest since its founding, has still received technical guidance from Danish engineers, with use of various Danish-made processing apparatus and instruments.

The mill comprises.

(a) Pig iron department

With three 20-t. charcoal blast furnaces, this department's pig iron production amounts to 2,000 t. a year. The iron ore in use here is obtained from its own mine 70 km. north, and the charcoal is supplied by its makers.

(b) Steel-making department

10-t. open heart	1 unit	Annual capacity. 2,000 t. together
High-frequency furnace	3 units	
Electric furnace (5-t.)	1 unit	
Oxygen equipment	2 units (70 m^3/hr , 200 m^3/hr.)	

(c) Casting department

Annual production: 4,500 t.

(d) Rolling department

Old-fashioned 3-stand high mill .... 1 unit, with 7,500 t. production/yr.

To cope with increasing demands, the mill is pushing on the rationalization of the iron & steel-making facilities. And further the mill is having an additional modernized rolling mill built

With the fulfilment of the above plans, these facilities are expected to possess the following capacities.

(a) Rationalization of existing mill

The rationalization of the rolling mill (going into resumption of operation in August, 1968) can elevate its production capacity. The casting facilities are to be expanded to an annual production capacity of 10,000 tons. Along the line of the plan, three units of 8 t.-high frequency furnace are to be set up

(b) New facilities

On the site adjacent to the existing mill, a rolling mill will be newly set up in

(b) New facilities

On the site adjacent to the existing mill, a rolling mill will be newly set up in two phases.

First-phase construction (1967 – 71):

Electric furnace (lectromelt daido) .... 2 units

(10,000 KVA each);

Continuous casting equipment .... 1 unit

3 - strand 80–125 mm φ S-type (concast type)

Rolling mill .... 2 units

Annual capacity: 150,000 t. (3 shifts), 5.5 mm – 9 mm bar in coil, 9 mm – 28 mm bar production; besides, 40 mm – 75 mm equal-angle steels, channel :up to 120 mm, beam: up to 100 mm, flat steels 20 mm – 75 mm.

Second-phase construction (1972 –)

Small type blast furnace or electric pig-iron making equipment

.... 2 units

LD converter

(3) Bangkok Steel Industry Co., Ltd.

This 1966-established reroller is now engaged in the production of bar from used rails and billets in 1,700 t. – 2,000 t. per month, with an actual capacity of 2,000 t. a month and in possession of three rolling mills.

Round bars with 8 mm – 12 mm sizes are manufactured as their main products. Now, the construction of two 10 t.-electric furnaces is under-planned, one to be completed in 1970 and the other by the end of 1972.

Rolling mill No.1 is for rolling billets, No.2 and No.3 for rolling such first-class scraps as used rails and ship scraps.

2.2.2 Steel pipe mills

(1) Thai Steel Pipe Industry Co., Ltd.

With the approval of the Thai Government Board of Investment under the Industrial Investment Promotion Act in December 1963, this company, a Japanese-Thai venture, began operation for steel pipe production on April 26, 1965.

The capital is 12,000,000 bahts. 73.4% of shares are held by the Japanese side and the balance, 22.6%, by the Thai side.

Doubling of the capital to 24,000,000 bahts is now being planned.

The mill is located at a place 15 km away from Bangkok, occupying a site area measuring 20,000 m^2 including a building area of 6,000 m^2.

The equipment comprises two systems, producing 1,500 t./month, 80% of which is in steel pipes and the balance 20% in black pipes.

Mill No.1 is composed of nine stands, with a welding speed of 35–45 m/min. producing 4 ɸ products and capable to make 1/2 ɸ sizes. The welder is of high frequency system.

Mill No.2 is composed of seven stands turning out 2 ɸ pipes, and capable of producing 1/2 – 2-1/2 pipes.

Both mills, provided with straighteners, produce good quality pipes.

The galvanizing equipment is put in operation six days a week on three shifts, with a production capacity of 3,000 t./mm

(2) Thai American Steel Co., Ltd.

This Thai-Hawaiian joint venture started operation in the end of 1964. With a capital comprising 49% Thai investment and 51% Hawaiian and is producing 1,500 t./ mon. of steel pipes of 4 ɸ and less.

(3) Sathask Driam (Thailand) Co., Ltd.

The initial operation of Sathask Driam was made in June 1968. The chief products are spiral steel pipes. The company's mill is located along the highway near Bangkok airport The site area measures 80 rais As of August 1968, the installation comprises steel pipe welder (1 unit) and steel pipe lining (concrete) and wrapping apparatus, both in actual operation.

One unit of steel pipe welder started its operation in October, 1968.

An outline of the installation is as follows:

(a) Mill No.1 for production of spiral welded steel pipes.

West-German Driam AC-made Model RE 1,200; Capable of making 16 to 60 ɸ products in 500 t./mon.; 300 Amp, 380 V, 50 cycles, 3 ph.

(b) Mill No.2 for production of spiral welded steel pipes:

West-German Driam C-made Model RS 900, capable of producing 5 to 28 ɸ steel pipes in 100 t./mon.; 100 Amp, 380 V, 3 ph. 50 cycles.

(c) Steel pipe-lining equipment:

Hongkong Tube & Metal Products Co. - made Model Spining type; capable of producing 8 – 60 pipes; 380 V, 3 ph. 50 cycles.

(d) Steel pipe-wrapping equipment:

Hongkon Tube & Metal Products Co. - made Model Semiautomatic; capacity; 5 – 6 ; 100 Amp, 380 V, 3 ph. 50 cycles.

(e) An outline of future equipment:

(i) *Steel pipe hydraulic testing equipment;*

West German Wilhelm Winter AC-made Model PA40; capacity; 5 – 60 ; maximum hydraulic pressure: 3,000 lbs/in^2; 60 Amp., 50 cycle 3 ph., 380 V.

(ii) *Electric welded steel pipe equipment*

Austrian Elin Union Co. - made Model PA40; *capacity;* 5 – 60 ; maximum hydraulic pressure: 3,000 lbs/in^2, 60 Amp., 50 cycles 3 ph., 380 V.

(iii) Steel pipe hydraulic testing equipment:

West Germany Wilhelm Winter AC-made Model HP4 x 14; capacity: 1/2 – 4 ; 35 Amp, 380 V, 3 ph., 50 cycles.

(iv) Steel plate hot dipped galvanized line (semiautomatic):

Austrian Puther AC-made; capacity: suitable for electric seam-welded steel pipes up to 4 ; 100 Amp, 50 cycle 380 V 3 ph.

(v) Steel plate finishing equipment:

Hongkong Tube & Metal Products Co. - made; capacity: 8 to 60 ; 10 Amp. 50 cycles 3 ph.

(vi) Steel pipe polishing equipment:

American Cement Co. - made; capacity: 6 to 60 , for polishing the surface of steel pipe by use of compressed air.

(vii) Others

Besides above, cranes (International Harvester-made) are installed now.

They are driven by 5-ton Diesel Engines, including a Mauser crane, indoor ceiling travel 10-ton crane, and the same type 5-ton crane, in addition to a Sweden Atlas Copco-made air compresser (100 lb/in^2), service repair shop, etc.

Furthermore, the Sathask Driam mill possesses concrete pipe-lining equipment, made by Hongkon Dran Bros. Co., usable for models of large and medium diameters, and also for 10–60 CMS - 70–170 CMS.

2.2.3 Galvanized sheet mill

(1) Sangkasi Thai Co., Ltd.

Established on April 28, 1960, this is a Thai-Japanese venture for the manufacture of GI sheet. The mill began its operation on January 1, 1961, and the company's sales business was inaugurated on January 1, 1961.

Of the capital of 7,500,000 bahts, 40% was invested by Japanese firms and 60% was local capital.

An enterprise designated by the Thai Government Board of Investment as under the Industrial Investment Promotion Act, this company has enjoyed favorable treatment as the customs duty on imported GI sheet was raised to 2,000 bahts in late 1961.

The mill launched its initial operation with three units of equipment, increased to five galvanizing lines, with one more line to be added by the end of 1968.

The five units –each of hot dipped system– are capable of producing 70,000 t./yr.

The business results of the company are very satisfactory under able management. It is expected to continue its growth.

As of 1968, the mill produced GI sheets at a rate of 50,000 – 60,000 t./yr. Outside of GI sheets the mill has been producing colored coating sheet since August 1964 though their production volume is limited, 90% of the GI sheet produced here are No.35 corrugated products.

The mill is located in the government-designated Factory Area of Samud Prakarn, 20 km. southeast of Bangkok.

Transition of Sales of GI Sheets

Year	Amount of Sales
	M.T.
1961	18,500
1962	32,400
1963	31,000
1964	41,000
1965	41,000
1966	39,100
1967	53,650

Source: SGT data

(2) Thailand Iron Works Co., Ltd.

The works, established on March 7, 1958, is a Thai-Japanese joint venture producing GI sheet.

Mill operation has been carried on since January 23, 1960.

The authorized capital is 20,000,000 bahts of which 15,000,000 bahts is paid up. The Japanese side is holding 40% of its total shares and the Thai side 60%.

The site are of the mill measures 7,040 m^2 containing 665 m^2 for the office building and 3,760 m^2 for the factory building.

The equipment comprises five units for GI sheet hot dipped, with annual capacity 60,000 t./yr. 1968's production amounted to 40,000 t.

Corrugated GI sheets account for 70% of the products of mill and the flat GI sheet for 30%. Of the corrugated GI sheet, No.35 is the main Product, and of the flat GI sheet, No. 14 to 19 and 20 to 35 are principal products. The mill is located at New Road, Bankoleam, Bangkok.

Sale Volume of GI Sheet

Year	Volume of sales	Year	Volume of sales
	M.T.		M.T.
1960	10,000	1965	33,000
1961	22,000	1966	31,000
1962	29,000	1967	38,000
1963	31,000	1968 (presumption)	40,000
1964	31,000		

Source: TIW data

(3) Far East Iron Works Co., Ltd.

Established in July 1962, this works was designated as an enterprise under the Industrial Investment Promotion Act on December 7, 1962. With a capital of 10,000,000 bahts, this Thai-Japanese joint venture is engaged in the production of GI sheet.

Japanese firms hold 30% of shares and the Thai side 70%.

The head office is located at No.781-783, Songward Road, Bangkok, and the mill at a place 170 km northeast of Bangkok.

The mill site has an area of 24,000 km^2, including 900 km^2 for office and residence housing, 2,731 m^2 for factory buildings, and 600 m^2 for other housing.

As equipment, the mill is provided with two units of hot dipped GI sheet lines for 12,000 t./yr.

The main product of the mill is No.35 product. Production of corrugated GI sheet has been suspended. The operation rate of the mill is 70% average.

The location of the mill is 170 km away from Bangkok, the center of the demands for GI sheets. The founding of the mill at such a distant place from the capital was in order to cooperate with the Thai Government's policy for the regional development of the country's northeastern region. The place where the mill stands is Nakorn-Rajsima, Pack Chong.

2.2.4 Tin plate mill

(1) Thai Tin Plate Co., Ltd.

Established in 1960, with a totally indigenous capital of 10,000,000 bahts (fully paid up), the company is engaged in tin plate production. Equipped with five units of hot dipped tin line, with an annual production capacity of 24,000 t. the mill is operating two of them now in adjustment to the present moderate demands, producing 700 - 800 t./mon. of tin plates. Besides, the company turns out 600 t./mon. of nails and nail wire.

2.2.5 Wire rods mill

(1) Sinthani Industry Co., Ltd.

This company is a Thai-Japanese joint venture, capitalized at 5,000,000 bahts, having begun production activity in April 1967, with the head office at No.21 Mucee 14, Samrongtai Prapradang, Samut, Prakarn.

The factory area has 9.78 rais, with buildings of 3.0 rais.

In the coverage of products are: iron wires, annealed iron wires, wires and barbed wires. The production of iron wires, is 1,000 t./mon.

Details of the equipment are:

Drawing machines	9 sets
Annealing furnaces	8 sets
Galvanizing equipment	2 sets
Barbed wire-making equipment	4 sets

The total capacity of the mill, in terms of iron wires, is 1,300 t./mon. This company, too, is a C-class-designated enterprise under the Industrial Investment Promotion Act.

L Kind of Products, and Se

Sinchani Industry Co.

Kind	Production per month	Beginning of production	Specification
Iron wire	150 M.T.	Apr. 1967	BWGS – BWG 22
Annealed wire	150 M.T.	May 1967	BWGS – BWG 18
Wire	600 M.T.	June 1967	BWGS – BWG 22
Barbed wire	100 M.T.	Aug. 1967	

This mill's production of barbed wire is chiefly in the products of BWG x BWG 13 x 10 kg (or 9 kg or 8 kg), BWG 14 x 10 kg (or 5 kg).

2.2.6 Plan for construction of cold rolled sheet mill

Established planning is now in progress to set up a cold-rolling mill to supply base plates to the three local galvanized sheet mills (Thai Iron Works, Far East Iron Works and Sangkasi Thai) and cold rolled sheet to other demands is planned.

For this purpose, two applications on the establishment of such a mill have already been made for government approval as of January 1969.

In this connection, the Board of Investment has expressed its intention to grant approval after a study of their plans in reference to ECAFE AIDC Second Steel Survey Mission Recommendations on Thai's cold-rolling mills Plan.

F.3 Concerning Construction of the Iron and Steel Integrated Plant

F.3.1 Possibility of construction

As mentioned above, the demands for cold-rolled sheets in Thailand are very encouraging, and they are expected to continue even hereafter at the more or less same rate. With the realization of a common market as a premise, further, the combined demands of the four countries– Malaysia, Singapore and Indonesia plus Thailand – will be shown in Table 25 which are equivalent to the capacity of one unit of the cold tandem mill in 1970 and for demand of Thailand alone in 1977 – 78.

In addition to such growing demands for cold rolled sheets, a considerable amount of demands for hot rolled sheets (inclusive of medium plates) can be expected. Now, the ratio of demands for hot rolled sheets to that for cold-rolled is 1 : 3 from the actual results in Thailand, the demands for hot coil needed as materials for those products come to about 650 thousand tons in that country alone in 1980, and the combined demands of the four countries to about 1,200,000 tons, this amount being equivalent to the four countries being considered as a premise, even if the hot strip mill is completed by 1977 – 78, it cannot be said too early. In view of the fact that Thailand's demand for rolled sheets account for over 50% of the combined demand, it is quite natural to make further study on the expansion scheme to an integrated steel mill in the country.

Table 25. Forecast of Demands for Cold Rolled Sheets in Four Countries

(Unit: 1,000 M/T)

	Thailand	Singapore	Malaysia	Indonesia	Total
1967	160	37	45	15	257
1970	201	45	60	32	338
1971	217	50	63	43	373
1972	232	56	72	54	414
1973	252	61	82	65	459
1974	273	66	93	76	508
1975	296	69	105	87	557
1976	316	73	110	99	598
1977	338	77	115	106	636
1978	361	82	120	111	674
1979	386	87	126	116	715
1980	413	92	132	121	758
1985	563	119	173	166	1,021

By the way, there is no equipment in Thailand for producing slab as the material for the hot strip mill, so that the country must look upon to imports for its entire use. This means that the greater becomes the amount of slab import, the greater trouble must be faced in securing this amount at advantageous price. Hence it is desirable to produce slab in its own country.

In order to produce slab economically in great amount to match the capacity of the hot strip mill, the construction of an iron and steel an integrated plant is reasonable.

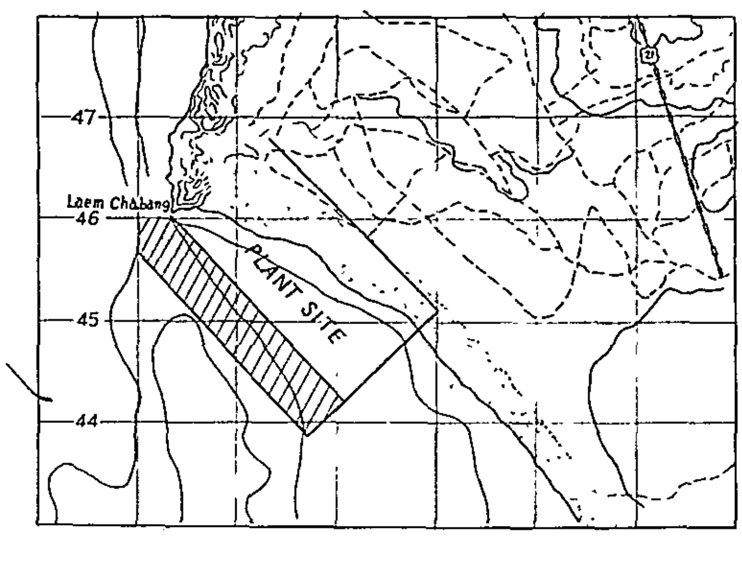
F.3.2 *Location Conditions for the Iron and Steel Integrated Plant*

As generally known, the integrated plant needs the use of large-size carriers in order to transport large amounts of ore, coal, products, etc. efficiently and economically, and it is desirable that the plant is situated near a deep-water harbor. Now the Thai Government, selecting Si-Racha area 130 km south of Bangkok as the most favorable site for a cold-rolling mill, has made a concept to set up an integrated plant there. But judging only from the maps presented to us and our inspection of the spot, we members of steel mission, cannot help pointing out that Si-Racha will not be suitable to the integrated plant site, because the sea along the coast from Si-Racha toward Bangkok is so shallow that spot of 10-meter depth can be reached as far as 3 – 5 km from seashore.

On the other hand, the coastal area southward from Laem Chabang about 15 km South of Si- Rache will be worthy of recommendation, judging from the map, and if close geometrical investigation should prove there to be suitable, this area could be selected as the plant site.

As apparent from the map shown below, the coast is situated relatively near deep sea of -10 m, with a low hill just behind. It will be possible to cut a sea route, shown by diagonal lines in the map, from deep sea and to prepare a plant site having a necessary area in front of seashore line with a great amount of soil obtained by dredging the sea and by cutting down the hill. It is noted, however, that the shape and area of the site will be determined by the scale of the plant and kinds of facilities to be established there.

For the construction of an iron & steel integrated plant, besides the engineering works as mentioned above, several additional facilities within plant site are necessary such as power station, industrial water systems, railway, road, etc. Since all these works can only be done at a great expense, it is desirable for the Government of Thailand itself to push forward the project positively.



Recently the mission received the information that the Thai Government has asked NEDECO, Netherlands, to make a survey for constructing a new international harbour in this area by 1975. And also they want to build a thermal power station there by the same time. These facts tell us how eagerly the Thai Government wishes to develop this area industrially. In view of the necessity to erect a modern integrated steel plant in Thailand, it is desirable to put these projects into practice as early as possible.

This iron and steel integrated plant, comprising iron-making and steel making facilities, a slabbing mill, a hot strip mill, a cold strip mill etc. specializing the production of steel sheet and coil, will start operation at the initial capacity of around 1,500,000 tons of crude steel annually, as one of the modern iron and steel works in the South-eastern countries.

F.4 Construction of Cold Rolling Mill

F.4.1 Technical recommendation on construction project

At first recognizing the steady growth of demand in the domestic market and, secondly presuming the realization of common market among Thailand, Malaysia, Singapore and Indonesia, there will be a good balance between demand and supply of cold rolled sheets when a cold tandem mill is to be brought in operation even at the earlier date.

However, a high degree of technique will be generally necessary for the production of cold rolled sheets, and it will take a long time before technicians in Thailand will gain sufficient experiences and skills to turn out such products as matching imported ones in quality and cost.

Supposing that a tandem mill of high productivity and construction expense will be set up early and that the production of quality sheets is only possible at the lower yield owing to immature skills and lack of experiences, there will be abnormally high production cost. This will not only make export of such products impossible, denying the premise of common market, but also will inflict damages to domestic consumers.

Table 26. Forecast of Demand for Cold Rolled Sheets in Thailand

(Unit: 1,000 M.T.)

Year	Combined demand (A)	G. I. Sheet		Full hard sheets (tons) (G = B x 0.9)	Annealed sheets	
		Tons (B)	Ratio (%) (B/A)		Tons (A – C)	Ratio (%) (A – C/A)
1967	160	103	64	93	67	42
1970	201	124	62	112	89	44
71	217	132	61	119	98	45
72	232	142	61	128	104	45
73	251	151	60	136	115	46
74	273	161	59	145	128	47
1975	296	173	58	156	140	47
76	316	180	57	162	154	49
77	338	189	56	170	168	50
78	361	199	55	179	182	50
79	386	208	54	187	199	52
1980	413	220	53	198	215	52
1985	563	273	48	246	317	56

By the way, Table 26 shows a forecast of demand for cold rolled sheets, a great part of which is occupied by GI sheets, and if the proportion of amount of full hard sheets (non heat-treated sheets) in total of GI sheets is kept at about 90%, based on their conventional tendency, more than 10,000 tons of full hard sheets per month will be necessary after 1972. These are very thin sheets, marked as No.35, and very difficult to produce in a tandem mill when the technical level is still immature.

From the reasons mentioned above, members of steel mission present following recommendations on the construction project of the cold rolling mill in Thailand.

(1) In order to minimize the loss of the enterprise due to immature skill and lack of experiences, at the first stage technicians & operators as many as possible must be sent to some steel making countries to gain skills and experiences in cold-rolling for a long time.

(2) In the initial stage of construction, a reversing mill of low productivity and construction expense should be erected, with which technicians and operators are to start production and also to practise the cold rolling method for some time. This mill is far easier to operate than the tandem mill. They will be able to shorten this practising period considerably by training abroad, and shortly also to elevate the operation rate of the mill.

(3) Since the production cost of the reversing mill can hardly be reduced because of high construction expenditure per ton of products due to its low productivity, it is necessary to erect the cold tandem mill as early as possible if granted from technical standpoint. When once both reversing and tandem mills reach to their full operations, they will be able not only to produce all sizes and kinds of cold rolled sheets for domestic demands in Thailand, but also to export surplus products to the other three countries within the common market. However, with all their productivities, the overall demands of the four countries and that of Thailand alone can not be met in 1972 – 73 and in 1980 or so, respectively, according to forcast of long-term demands in Table 25. Thus the necessity will arise to construct another cold rolling mill shop.

F.4.2 Outline of construction plan

4.2.1 Location of cold rolling mill

Assuring the common market among four countries as mentioned above, there exists necessity of constructing an iron & steel integrated plant. It is desirable to commence the measures for construction of such a plant as early as possible

Since cold rolling is the last step of processes in the integrated plant, there is no reason why the cold rolling mill should be located within the same site. Nevertheless, that is certainly advisable when considered the convenience in getting technical informations concerning exceeding processes, taking measures for operational troubles and transporting hot coils as the raw material of the cold rolling mill. From this reason it is desirable to establish the cold rolling mill shop, in the site of the integrated plant to be constructed near Si-Racha, as Thai Government's intention. Yet in view of the rapidly growing demand for cold rolled sheets in Thailand, a cold rolling mill operation as early as possible in the city of Bangkok maybe So we, members of steel mission, recommend the following two proposals regarding its operation: –

Proposal No.1 To set up the mill shop in the site of the integrated plant.

The location of the integrated plant is not yet decided and only expected to be near Si-Racha. It is desirable that intensive investigations will be carried out promptly to decide the location as early as possible and preliminary works the start of plant operation be proceeded with.

Proposal No.2 To set up the cold-rolling mill in Bangkok

In this case, at the full-operation stage of the mill shop more than 40,000 tons of hot coil will be used as raw material per month. So much amount of hot coils will not be carried in just in time by barge or by truck without high transportation cost In order to avoid these disadvantages, it is necessary to select the location of the mill at a suitable place along the Menam

River, provided with a wharf for hot coil carries.

Further, whether suitable water for rolling operation is available must be studied at first. Proposal 2 being only an alternative to proposal 1, it is desirable for Thai Government to endeavor to realize proposal 1 by all means.

4.2.2 Construction steps

Construction should be carried out in the following three stages, in each of which the capacity of each equipment will be controlled and increased progressively in order to match the anticipated production rate of the mill and eliminate waste investments. For instance, during the period in which only one reversing mill is in operation, the construction of the annealing equipment and the skin pass mill may be deferred by restricting its operation to the production of full hard sheets alone. The construction investment for these portions can be reduced for these portions can be reduced for the time being.

In the case of Proposal 1, if the decision on the site of the plant will be made within 2 – 3 years and construction start from October 1972, construction schedule will be as follows.

If these preliminary works should be completed earlier, construction schedule will be moved up.

It should be noted that the periods partially overlap for the convenience of construction work.

First period (1 year 7 months from October 1972 to April 1975):–

		capacity
Pickling line	1 unit	330,000 t/yr.
Reversing mill,	1 unit	78,000 t/yr.
Cleaning line,	1 unit	312,000 t/yr.
Shear & slitter line,	1 unit	66,000 t/yr.

Second period (2 year 3 months, from September 1974 to December 1976):–

Pickling line, expansion		510,000 t/yr.
Cold tandem mill,	1 unit	420,000 t/yr.
Skin pass mill,	1 unit	342,000 t/yr.
Annealing equipment	1 unit	101,000 t/yr.
Shear & slitter line,	2 units	294,000 t/yr.

Third period (1 year 5 months, from July 1976 to December 1977):–

Cleaning line, expansion		642,000 t/yr. (after expansion)
Annealing equipment, expansion		252,000 t/yr. (after expansion)
Shear & slitter line,	2 units	522,000 t/yr.

Time schedule of construction is shown in Table 27.

In the case of Proposal 2, construction schedule is ahead of Proposal 1 by three years, as follows.

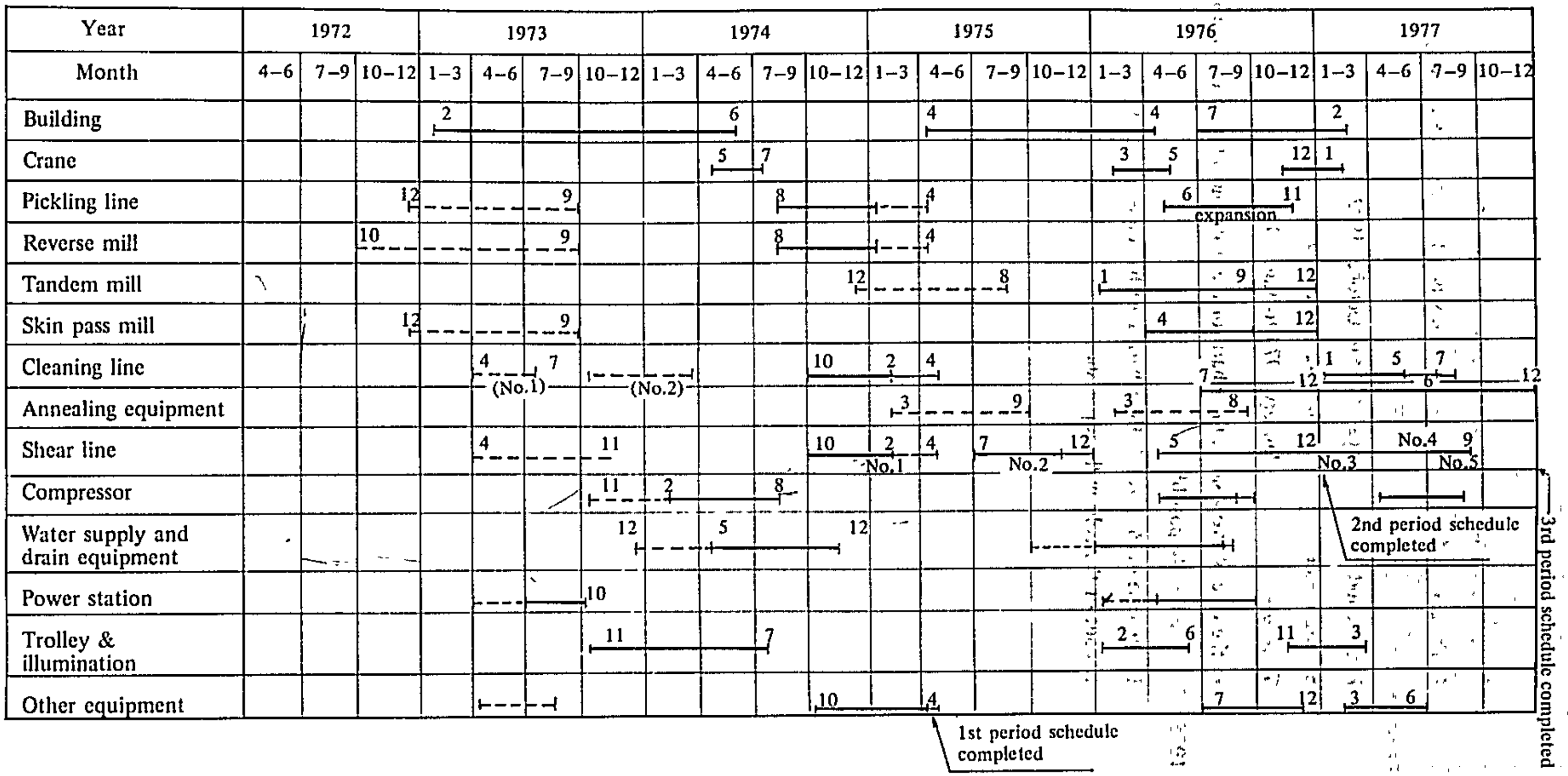
First period:	April 1970 to October 1972
Second period:	March 1972 to June 1974
Third period:	January 1974 to June 1975

In the case of Proposal 1, the wharf for the plant should be completed by March or so 1975. This is probably possible.

In the case of Proposal 2, the wharf must be completed during the first period.

Layout of the cold mill shop is shown below.

Table 27. Time Schedule of Construction

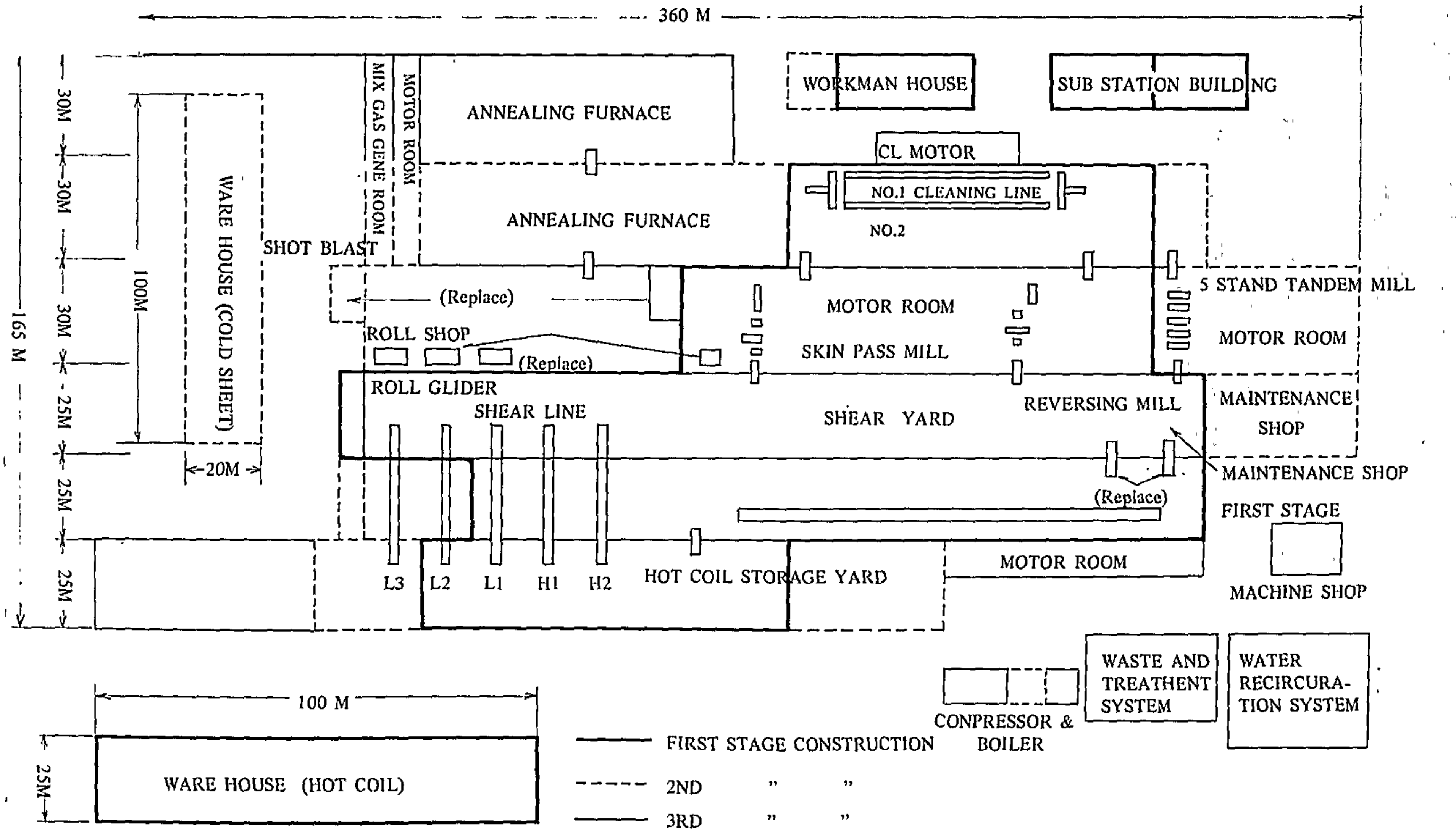


Remarks : ------ Foundation work

——— Equipment-installing work

——— Trial operation

LAYOUT OF COLD MILL PLANT



4.3.2 Main equipments

(1) Pickling line (to be installed in 1st period; expanded in 2nd period)

Type: Continuous H_2SO_4 pickling line

Hot coil: Thickness 1.6 mm – 4.5 mm

Width 510 mm – 1,270 mm

Weight max. 20 M.T.

Line speed:

	1st period	2nd period
Input	210 m/min.	420 m/min.
Pickling	90 m/min.	180 m/min.
Output	115 m/min.	230 m/min.

Pickling capacity:

330,000 t/yr. 510,000 t/yr.

(2) Reversing mill (installed in 1st period) (*refer to computation of capa·

Type: 1,420 mm 4 high type

Hot coil: thickness 1.6 – 4.5 mm

width 510 – 1,270 mm

Finishing coil: thickness 2.0 – 0.152 mm

width 510 – 1,270 mm

Roll elements. work roll 546 ϕ x 1,420 mm

back up roll 1,375 ϕ x 1,420 mm

Rolling speed· max. 762 m/min. (2,500 FPM)

Mill motor: 3,500 h.p. x 1 (2,600 kw)

Tension reel: 1,200 h.p. x 2

(3) Skin pass mill (to be installed in 2nd period)

Type:
Roll elements: } same as reversing mill's

Mill motor· 600 h.p.

Tension reel: 900 h.p.

(4) Tandem mill (to be installed in 2nd period) (*refer to calculation of capacity)

Type· 4-high 5-stand type

Coils in use: thickness 1.6 – 4.5 mm

width 510 – 1,270 mm

Finishing coils:	Thickness 2.0 – 0.152 mm	
	width 510 – 1,270 mm	
Roll elements:	workroll 546 ϕ x 1,420 mm	
	back-up roll 1,375 ϕ x 1,420 mm	
Rolling speed:	max. 1,370 m/min.	
Mill motors:	No.1 4,000 h.p.	22,000 h.p.
	No.2 4,000 h.p.	
	No.3 4,000 h.p.	
	No.4 4,000 h.p.	
	No.5 5,000 h.p.	
Tension reel:	1,000 h.p.	

(5) Cleaning line (one line to be installed in 1st period, and one more in 3rd period)

Thpe:	continuous alkali-cleaning line
Coils in use:	thickness 0.152 – 2.0 mm
	width 510 – 1,270 mm
Cleaning speed:	610 m/min.

(6) Annealing furnace (to be installed in 2nd and 3rd period successively)

Type:	circular bell type, direct-firing single pedestal system		
Fuel:	light oil		
Acid-preventive gas:	DX and HNX gas		
Coil stack height:	950 mm x 3		
Number of stack coil:	3		
Coil weight per bell:	20 t. x 3 max.		
Capacity:	700 t/mon./bell		
Composition:	2nd period	3rd period	Total
	33 bases	47 bases	80
	12 bells	18 bells	30

(7) Shear line

(a) Heavy shear line (1 unit to be installed in 1st period, totaling 2 units in 3rd period)

thickness of coil	0.15 – 2.0 (3.2) mm
width	510 – 1,270 mm
Shearing length	610 – 4,880 mm
Shearing width	500 – 12.50 mm
line speed	100 m/min.

thickness of coil	0.15 – 0.7 mm
width	510 – 1,270 mm
Shearing length	1,016 – 3,660 mm
Shearing width	500 – 1,050 mm
line speed	243 m/min.

(8) Wharf facilities

Wharf:	length	150 m	only in Proposal 2
	depth	7.5 m	
	crane	20 t LLC x 1	

Warehouses:	
Material store:	one building (25 m x 100 m) to be built in 1st period.
Crane 25 t:	one in 1st period and one more in 2nd period
Product store:	one building (20 m x 100 m) to be built in 2nd period.
Crane 20 t:	one in 2nd period and one more in 3rd period.

4.2.4 Construction budget estimate

Table 28. Construction budget estimates

(Unit: US$)

		1st period	2nd period	3rd period	Remarks
1	Land	780,555.6	–	–	112,500 m^2 (250 m x 450 m) US$6.94
2	Building	3,416,666.7	1,955,555.6	575,000.0	
3	Crane	*1,236,111.1	288,888.9	158,333.3	*including wharf crane
4	Pickling line	1,550,000.0	238,888.9 (expansion)	–	
5	Reversing mill	2,883,333.3	–	–	including spares
6	Tandem mill	–	*9,100,000.0	277,778.8 (spare parts)	*including spares
7	Skin pass mill	194,444.4 (base only)	*1,800,000.0	166,666.7 (spare parts)	*including spares
8	Cleaning line	984.722.2 (No.1)	–	777,777.8 (No.2)	
9	Annealing equipment	–	1,463,888.9	2,088,888.8	30 bells, 80 bases
10	Shear line	711,111.1	1,247,222.2	1,163,888.9	
11	Compressor boiler	108,333.3	58,333.3	22,222.2	
12	Water supply & drain system	230,555.6	144,444.4	5,555.6	including all pipes
13	Power-receiving station	647,222.2	338,888.9	50,000.0	
14	Other equipment	798,611.1	397,222.2	205,555.6	
15	Wharf facilities	(625,000.0)	–	–	including foundation for crane rail
	Total	13,541,666.6	17,016,666.7 30,558,333.3	5,547,222.2 36,050,000.0	Remarks in ( ) applies to Proposal 2 only
	Gross	(14,166,666.6)	(31,183,333.3)	(36,675,000.0)	

4.2.5 Production program

As shown in Table 29, the reversing mill will be operated on from one shift at first to gradually 2 and 3 shifts per day and will be brought to full operation in about one year. In about 18 months after commencement of the reversing mill, that is, from January 1974, the tandem mill will start, which will probably raise its operation rate to full in May 1975.

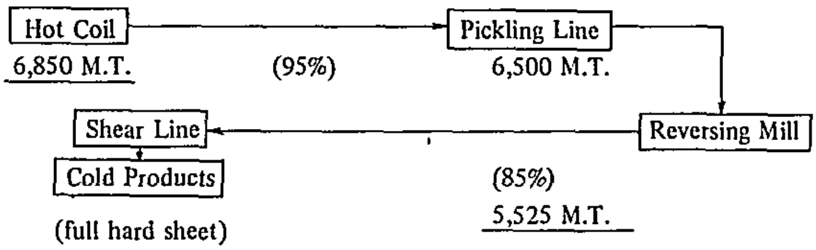
Table 29. Cold Mill Production Program

Year	Month	No.of shift	Reversing mill		Tandem mill		Total	
			Hot coil tons	Cold sheet tons	Hot coil tons	Cold sheet tons	Hot coil tons	Cold sheet tons
1975	1		electric adust-ment trial operation					
	2							
	3							
	4							
	5	1	1,000	600			1,000	600
	6	1	1,000	650			1,000	650
	7	1	1,500	1,020			1,500	1,020
	8	1	1,800	1,260			1,800	1,260
	9	2	2,300	1,660			2,300	1,660
	10	2	3,200	2,360			3,200	2,360
	11	2	3,600	2,740			3,600	2,740
	12	2	4,200	3,280			4,200	3,280
Total			(18,600)	(13,570)			(18,600)	(13,570)
1976	1	3	5,300	4,200			5,300	4,200
	2	3	5,800	4,600			5,800	4,600
	3	3	6,100	4,850			6,100	4,850
	4	3	6,300	5,020			6,300	5,020
	5	3	6,850	5,500			6,850	5,500
	6	3	6,850	5,500			6,850	5,500
	7	3	6,850	5,500			6,850	5,500
	8	3	6,850	5,525			6,850	5,525
	9	3	6,850	5,525			6,850	5,525
	10	3	6,850	5,525			6,850	5,525
	11	3	6,850	5,525			6,850	5,525
	12	3	6,850	5,525			6,850	5,525
Total			(78,300)	(62,795)			(78,300)	(62,795)

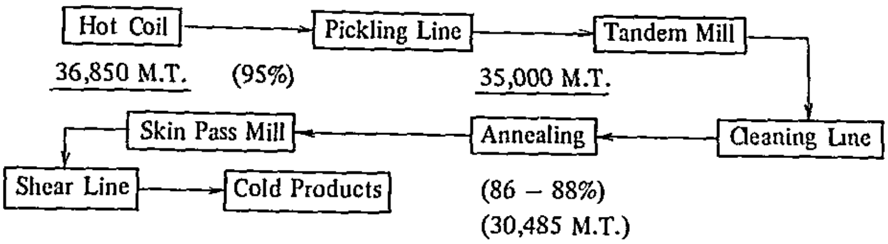
Year	Month	No.of shift	Reversing mill Hot coil tons	Reversing mill Cold sheet tons	Tandem mill Hot coil tons	Tandem mill Cold sheet tons	Total Hot coil tons	Total Cold sheet tons
1977	1	1	6,850	5,525	2,500	1,500	9,350	7,025
	2	1	6,850	5,525	3,500	2,280	10,350	7,805
	3	1	6,850	5,525	4,500	3,150	11,350	8,675
	4	1	6,850	5,525	5,500	3,930	12,350	9,455
	5	1	6,850	5,525	6,500	4,800	13,350	10,325
	6	2	6,850	5,525	10,000	7,680	16,850	13,205
	7	2	6,850	5,525	12,000	9,360	18,850	14,885
	8	2	6,850	5,525	14,000	11,100	20,850	16,625
	9	2	6,850	5,525	16,000	12,840	22,850	18,365
	10	2	6,850	5,525	18,000	14,620	24,850	20,145
	11	3	6,850	5,525	24,500	19,890	31,350	25,415
	12	3	6,850	5,525	27,300	22,310	34,150	27,855
Total			(82,200)	(66,300)	(144,300)	(113,460)	226.500	179,760
1978	1	3	6,850	5,525	29,500	24,230	36,350	29,755
	2	3	6,850	5,525	31,500	25,880	38,350	31,405
	3	3	6,850	5,525	33,100	27,180	39,950	32,705
	4	3	6,850	5,525	34,500	28,510	41,350	34,035
	5	3	6,850	5,525	35,700	29,490	42,550	35,015
	6	3	6,850	5,525	36,850	30,485	43,700	36,010
	7	3	6,850	5,525	36,850	30,485	43,700	36,010
	8	3	6,850	5,525	36,850	30,485	43,700	36,010
	9	3	6,850	5,525	36,850	30,485	43,700	36,010
	10	3	6,850	5,525	36,850	30,485	43,700	36,010
	11	3	6,850	5,525	36,850	30,485	43,700	36,010
	12	3	6,850	5,525	36,850	30,485	43,700	36,010
Total			(82,200)	(66,300)	(422,250)	(348,685)	504,450	414,985
1979	1	3	6,850	5,525	36,850	30,485	43,700	36,010
	2	3	6,850	5,525	36,850	30,485	43,700	36,010
	.							
	.							
	12		6,850	5,525	36,850	30,485	43,700	36,010
Total			(82,200)	(66,300)	(422,200)	(365,820)	524,400	432,120

Flow of material in each mill on the full operation basis is shown in the following:

(1) Reversing mill



(2) Tandem mill



4.2.6 Personnel assignment (excluding substitutes)

	Clarks	Technician	Workers		
			1st period	2nd period	3rd period
Pickling			11	31	31
Reversing mill			18	18	18
Tandem mill		4	–	21	21
Skin pass mill			–	15	15
Cleaning line			16	16	28
Annealing furnace		4	–	21	48
Shear			18	42	66
Crane			59	84	100
Roll shop			18	24	33
Power for oil water, system		5	21	24	24
Maintenance, repair			25	36	52
Electric measuring equipment		5	24	31	40
Work-programming		2	28	46	55
Checking			35	75	121
Administrating		5	9	9	12
Total	1st period:5 2nd, 3rd period: 10		272	493	664

4.2.7 Calculation of mill capacity

Calculating the capacity of the reversing mill and the tandem mill, the formula set down by the Japan Iron & Steel Institute in cooperation with specialists of Japan's principal iron & steel makers, is adopted.

(1) Reversing mill:

$P = T \times Pm$

Where P: annual capacity (T/Y)

T: annual rolling hours

Pm: rolling capacity (T/hr)

Then, as the rolling efficiency varies according to the size of products:

$Pm = 1/\Sigma\bar{\beta}/pth$

Where $\bar{\beta}$: composition ratio by size

Pth: production capacity by size (T/hr)

For various sizes the following formula is established:

$$Pth = C_1 \frac{60C_2W}{tP + tR}$$

C_1: Correction coefficient

W. Coil's unit weight (T)

C_2: Correction coefficient for coil's unit weight

tP: Preparatory time for rolling (min.)

tR: Rolling time (min.)

Then, when the product size of the reversing mill, its composition ratio ($\bar{ß}$) and each coil's unit weight ($1\bar{W}$) are assumed as follows.

Size	$\bar{ß}$	$\bar{W}$	C_1	C_2	tP	tR	Pth
0.17 x 780	0.80	14.7	0.5525	0.75	4.5	24.6	11.87
0.17 x 930	0.20	17.5	0.680	0.75	4.5	29.3	15.79

$$Pm = 1/\frac{0.87}{11.87} + \frac{0.2}{15.79} \doteq 12.5 \text{ T/hr}$$

T = 6,600 hr (stop on holidays, round-the-clock operation)
P = 12.5 x 6,600 = 82,500 T/Y
When operation rate is fixed at 95% of that in Japan.
P = 82,500 x 0.95 ≐ 78,400 T/Y
≑ 6,500 T/M

Note: The number of tons is in terms of pickled tons.

(2) Tandem mill

$P = T \times Pm$

$Pm = C_1 \times 1/\Sigma\bar{\beta}/th$

$$Pth = 60\ C_2W/tP + tR + ta$$

$$tR = 10^6C_2W/7.85C_2Va.b$$

C_1 : Correction coefficient by mill

ta · Acceleration-deceleration time (min.)

C_3. Correction coefficient for theoretical rolling speed

V : Theoretical rolling speed (m/min.)

a.b Thickness x width (mm^2)

The composition ratio for size of products (   ) is assumed by referring to the past actual results; $\bar{W}$ is an assumption of the coil's unit weight to the various dimensions; and the other specific values are decided according to the performance of the mill.

Size	a x b	C_3	$\bar{V}$	$\bar{\bar{W}}$	tR	tP	Pth	$\bar{\beta}$	$\bar{\beta}$/Pth
0.17 x 780	132.6	0.90	1,370	14.7	8.57	1.70	62.7	0.35	5.582
0.17 x 930	158.1	0.90	1,370	17.5	8.56	1.70	74.7	0.10	1.339
0.23 x 780	179.4	0.95	1,370	14.7	6.02	1.70	82.8	0.02	0.242
0.23 x 930	213.9	0.95	1,370	17.5	6.00	1.70	98.9	0.04	0.404
0.27 x 780	210.6	0.95	1,370	14.7	5.12	1.70	93.4	0.01	0.107
0.27 x 930	251.1	0.95	1,370	17.5	5.11	1.70	111.3	0.04	0.359
0.4 x 780	312	0.95	1,300	14 7	3.45	1.40	129.4	0.02	0.155
0.4 x 930	372	0.95	1,120	17.5	4.21	1.40	134.1	0.07	0.522
0.6 x 780	468	0.90	990	14 7	33.6	1.40	131.7	0.03	0.228
0.6 x 930	558	0.90	820	17 5	4.05	1.40	137.9	0.09	0.653
0.6 x 1,270	762	0.90	620	20 0	4.49	1.40	146.6	0.06	0.409
1.0 x 780	780	1.00	910	14.7	1.97	1.40	182.3	0.01	0.055
1.0 x 930	930	1.00	760	17.5	2.36	1.40	196.0	0.04	0.204
1.0 x 1,270	1,270	1.00	570	20 0	2.64	1.40	209.8	0.04	0.191
1.6 x 780	1,248	1 00	800	14.7	1.40	1.60	203.1	0.01	0.049
1.6 x 930	1,488	1.00	670	17.5	1.67	1.60	223.3	0.02	0.090
1.6 x 1,270	2,032	1.00	500	20.0	1.88	1.60	241.3	0.02	0.083
2.0 x 780	1,560	1.00	720	14.7	1.25	1.60	212.9	0.01	0.047
2.0 x 930	1,860	1.00	600	17.5	1.50	1.60	234.6	0.01	0.042
2.0 x 1,270	2,540	1.00	450	20.0	1.67	1.60	255.7	0.01	0.039

C_1 = 1.0, C_2 = 0.75, ta = 0.25

Pm = 1/ /th – 92.6 t/hr

P = 92.6 x 5,070 ≑ 469,500 T/Y

/th – 10,800

T = 5,070 hr

When operation rate is fixed as 90% of that in Japan.

$$P - 469{,}500 \times 0.9 \approx 422{,}600 \text{ T/Y}$$
$$\fallingdotseq 35{,}000 \text{ T/M}$$

F.5 Estimates of Production Cost for Planned Cold Rolling Mill

F.5.1 Basis for calculation

Calculations of the production cost, operating profits and losses, and financial program were made on the basis of the following plans and the aforementioned equipment and production project.

Plan No.1 : Envisages, assumping the cold mill site in Si-Racha, the start of operation of the reversing mill in May 1975 and that of the tandem mill in January 1977. The full operations to be carried in June 1978 in keeping with the progress of the regional industrial development program.

Plan No.2 : Envisages, assumping the site in the suburbs of Bangkok and its operation starting as early as possible to satisfy the demand for the products, the start of operation of reversing mill in November 1972 and that of the tandem mill in July 1974 and the full operations in December 1975.

Calculating the production cost given below no distinction is made between Plan No.1 and No2. Logically, there should be the difference of cost between the two plans since they envisage different dates and locations for plant construction. This was deliberletely overlooked however, since no problem of any serious magnitude is foreseen even if same figures were to be adopted for the two different plans. The years indicated are calendar years running from January to December, and the unit of weight adopted is metric ton.

F.5.2 Production cost

5.2.1 Calculation of production cost (for 1979 with Plan No.1, and for 1976 with Plan No.2)

Item \ Kind of products		Reversing mill (as rolled)		Tandem mill (as rolled)		Tandem mill (as annealed)		Tandem mill		Total	
Amount of production		66,300 t		162,000 t		203,820 t		365,820 t		432,120 t	
Material for hot coils		82,200 t		198,360 t		243,840 t		422,200 t		524,400 t	
Yields		80.7%		81.7%		83.6%		82.7%		82.4%	
		US$ per ton	amount US$ 1,000	US$ per ton	amount US$ 1,000	US$ per ton	amount US$ 1,000	US$ per ton	amount US$ 1,000	US$ per ton	amount US$ 1,000
Materials cost (hot coils)		117.80	7,810	116.37	18,853	113.52	23,139	114.79	41,991	115.25	49,801
Variable Cost	Roll cost	5.64	373	3.76	610	1.29	263	2.39	873	2.88	1,246
	Supplies cost	5.09	338	4.57	741	2.31	470	3.31	1,211	3.58	1,549
	Power cost	7.97	528	6.93	1,124	4.05	825	5.33	1,949	5.73	2,477
	Full cost					1.22	250	0.68	250	0.58	250
	Repair cost	3.89	259	3.47	561	2.36	482	28.5	1,043	3.02	1,302
	Other variables	5.56	369	5.56	899	5.56	1,133	55.6	2,032	5.56	2,401
Sub-Total (A)		28.15	1,867	24.29	3,995	16.79	3,423	20.12	7,358	21.35	9,225
Invariable Cost	Labor cost	2.23	147	1.86	306	1.84	372	1.88	678	1.91	825
	Depreciation	7.00	464	3.81	617	51.6	1,052	4.56	1,669	4.94	2,133
	Other invariables	1.96	130	1.96	313	1.97	404	1.93	717	1.96	847
Sub-Total (B)		11.19	741	7.63	1,236	8.97	1,828	8.37	3,064	8.81	3,805
Operating cost total (A) + (B)		39.34	2,608	31,92	5,171	25.76	5,251	28.49	10,422	30.16	13, 030
By-products (−)		-8.62	-572	-8.03	-1,302	-6.98	-1,424	-7.46	-2,726	-7.54	-3,298
Production cost		148.52	9,846	140.26	22,722	132.30	26,965	135.82	49,687	137.77	59,533

5.2.2 Remarks for calculation

(1) The "yield" here means the over-all hot coil yield that incorporates yields at various processes at full capacity operation with fair operating skill.

(2) The purchase prices of material for hot coils are inclusive of freight, interest, heavy charges and miscellanious charges on the basis of US$80 FOB and calculated assumping exemption of all import duties.

(3) Details of variable costs (unit consumption and prices)

	Reversing mill (as rolled)			Tandem mill (as rolled)		Tandem mill (as annealed)	
	Unit consumption	@	US$ per ton	Unit consumption	US$ per ton	Unit consumption	US$ per ton
Roll cost	4.8 kg	1.17 $	5.64 $	3.2 kg	3.76 $	1.1 kg	1.29 $
Supplies cost					4.57		2.31
Sulfuric acid	2.6 kg	0.08	2.02	2.7 kg	2.10	1.8 kg	1.40
Degreasing	6.2 kg	0.07	0.43	6.2 kg	0.43	2.1 kg	0.15
Steel grit		0.30				0.2 kg	0.06
Palm oil	4.7 l	0.40	1.88	3.2 l	1.28	0.6 l	0.24
Lubricant	1.9 l	0.40	0.76	1.9 l	0.76	1.1 l	0.44
Anticorrosive oil		0.04				0.6 l	0.02
Power & Utilities cost			7.97		6.93		4.05
Steam	475 kg	0.005	2.64	480 kg	2.67	210 kg	1.17
Power	300 KWH	0.017	5.00	230 KWH	3.83	160 KWH	2.66
Water supply	20 m^3	0.017	0.33	26 m^3	0.43	13 m^3	0.22
Fuel cost							
Light oil		0.036				31.1	1.11
LPG (butane)		0.017				6.3 m^3	0.11
Repair cost			3.89		3.47		
Other variables			5.56		5.56		5.56
Total variable cost			28.15		24.29		16.79

Note: Repair cost was calculated separately from, but in due proportion to, equipment cost. The "other variables" includes crating cost, inspection cost, roll maintenance cost and cost of transportation within the plant premises.

(4) The "labor cost" includes wages and fringe benefits. The object of this cost is the full size of the personnel force afore-indicated in the Personnel Program for the full operation of the plant-including 10 clerks, 25 engineers, 664 workers, plus executives, physicians and auxiliary personnel (15% of regular workers) in a total of 91, aggregating 790. In it is also incorporated an annual 5% wage raise.

(5) The "depreciation cost" is calculated in accordance with the "straight line" method on the basis of the annual depreciation, 5% of the assessed value of the residual property and of the service life of 16 years.

The construction cost is made for the plant in Bangkok as envisaged in Plan No.2, but this can apply to Plan No.1 as it is. The construction cost of the wharf and the foundation may be somewhat understimated, but it will be feasible to consider any further outlay in some other category.

(6) The "other variables" refer to Local Development Taxes, plant administration expenses, etc.

(7) The "by-product" is calculated on the assumption that rejects are to be disposed of at the local scrap price (750 bahts per ton).

(8) In cost calculations those costs common to the reversing and the tandem mills are apportioned according to production.

F.5.3 An outline of production costs

5.3.1 Cost (over-all) per ton

The production cost per ton of product is predicted to become considerably high even at full operation. The material cost appears to be high yet it should be considered as the minimum imaginable, since the estimate is made on the basis of $80 FOB as hot coil purchase cost, which is the most favorable price available at the present circumstances, and of total execution of import duties.

The yield calculated on the basis of No.35 sheet as the principal product, is not expected to rise any higher even at full operation.

On the contrary, since considerably high technical skill is assumed here, failure to reach that level of skill will result in the drop of yield from the presently estimated level, and a rise of production cost. Particularly, as the production of No.35 sheet by the tandem mill, is rare even in Japan, yield will remain at a considerably low level. As a whole, the operating costs are considered appropriate.

The rejects will have to be disposed of at the local prevailing scrap price.

5.3.2 Cost comparison between the reversing and tandem mills

Comparing the reversing and tandem mills in terms of production cost, the former exceeds the latter by $8.26 per ton of production as rolled. This is because production is more expensive in the tandem mill than in the reversing mill, paticularly from the viewpoint of yield, labor cost and equipment depreciation. Reasons for starting with a reversing mill instead of a tandem mill despite the above factors are firstly the consideration of technological level immediately obtainable and secondly the necessity of avoiding high-cost operations should the demand for the product fail to inspire full operation of the mill. If these points could be overlooked, it would be more advantageous from the standpoint of profitability a have a tandem mill from the beginning.

Further, even among the products of a tandem mill, the production cost of the sheets as rolled is $7.94 higher than the sheets. This is as-counted for the facts that the whole of the sheet as rolled are of No.35 while the annealed sheets are the products thicker than No.35 sheets, and that the production cost of the former, though the process is simpler, is higher because of the high unit consumptions.

5.3.3 Comparison of costs of Plans 1 and 2.

Though calculations of the individual costs of Plan 1 and Plan 2 were not carried out, it is assumed that the former's cost, at the head of depreciation expenses, becomes extremely high. In the case of erecting the plant, construction of a harbor, the leveling of ground, and the completion of infrastructure, if carried out on a full scale, will involve and enormous amount of money in comparison with the case of erecting it in Bangkok. Consequently its depreciation expenses will be high. To burden all of this on the enterprise base is utterly impossible, as described later, from a point of view of a economic feasibility.

Unless backed up by some governmental aid or operated as a governmental project the plan would hardly be realized. Considering the above the mission has made Plan 2 on the basis of the Thai Government's development program.

F.6 Study of Economic Feasibility for Planned Cold Rolling Mill, and Recommendations

F.6.1 Capital program (Plan No. 1 only)

Requirements		Supplies	($1,000)
Construction funds	36,100	Capital paid in	10,000
(land)	780	Long-term loans payable	11,000
(equipment)	24,250	Short-term loans payable	8,400
(work)	11,070	Deferred payments for equipment	16,000
Engineering Fee	1,000		
Operators training expenses	250		
Operation preparation expenses	100		
Organization expenses	60		
Construction interests	50		
Working funds	8,740		
Total	46,300		46,300

Remarks:

(1) Engineering Fee: for guidance from preliminary investigation of work up to starting of operation.

(2) Training expenses: necessary for trainees to learn skill abroad including pays for six months.

(3) Operation preperation expenses: for sample materials, supplies for trial operation, rolls and fixed property taxes (from purchase of land up to starting of operation).

(4) Organization expenses: for establishment of corporation and office.

(5) Construction interests: for deferred payments from completion of installation of equipment up to starting of operation.

(6) Working funds: estimated amount of sales for two months.

(7) Long-term loans payable: loans from ADB, etc., on assumed rate of 5.7/8%; conditions: two-year deferment, repayment in 15 years with annual equipment.

(8) Short-term loans payable; borrowing on the spot on rate of 10%.

(9) Deferred payments for equipment. As for machines, they are imported ones, to be paid in 30% at delivery, the rest, 70%, on long-term deferred payment.

Supplemental remark:

For the required capital, the raise of $10,000,000 seems rather small, but with the subtraction of the deferred payment portion for equipment, about 30%, it is considered an appropriate sum in view of the actual payment power. As for the long-term loans, it is desirable to make positive utilization of the capital of Asian Development Bank etc.

In principle machines will have to be all imported. As for payments, for them the condition of deferred payments is absolutely necessary.

F.6.2 Prediction of profits

	Plan No.1 1979: full operation		Plan No.2 1976: full operation	
	Unit US$/t	Amount (US$1,000)	Unit US$/t	Amount (US$1,000)
(1) Sales	147.98	63,944	143,44	61,986
(2) Cost of goods sold	(–)137.77	(–)59,533	(–)137.77	(–)59,533
(3) Profit on sales	10.21	4,411 (6.9%)	5.67	2,453 (4.0%)
(4) Selling, general and administrative expenses	(–) 3.39	(–)1,464	(–)3.14	(–)1,358
(5) Operating profit	6.82	2,947 (4.6%)	2.53	1,095 (1.8%)
(6) Non-operating loss	(–)5,83	(–)2,518	(–)6.72	(–)2,902
(Interest paid)	(–)5.15	(–)2,225	(–)6.04	(–)2,609
(Miscellaneous loss)	(–)0.68	(–)293	(–)0.68	(–)293
(7) Net profit	0.99	429	(–)4.19	(–)1,807
	Cumulative loss: about US$5,900 millions		Cumulative loss: about US$4,900 millions	

Remarks:

(1) Production of sales was made on the basis of following considerations that: Products will be sold immediately; exportation will be made only after satisfying domestic demands; price is estimated on the basis of FOB $110/t plus cost of product grade and extra cost for annealing; domestic sale price will be constituted of the above price plus freight, usance interest import procedure expenses, import duty of 100 bahts/t for No.35 and other expenses of 220 bahts, but with deduction of 3% commission.

(2) General management and sale expenses are estimated at US$1.1/t, plus business tax corresponding to 1.5% of sale and local tax corresponding to 1.0% thereof, totaling 1.65%.

(3) Interest payment was calculated from the separate repayment program for loans:

long-term loans payable:	rate,	6. 7/8%
short-term loans payable:		10%
Deferred payments for equipment:		7%

(4) Miscellaneous loss, viz. the repayment of deferred expenses, is made repayable in five years in an equal amount. The deferred expenses comprise engineering fee, training expenses, operation preparation expenses, organization expenses and construction interests, estimated at $14.6 million in all.

Supplementary remarks:

The results of calculation of profits and losses in Plan No.1 and Plan No.2 present extremely severe values, this is because production cost and interest are after all greater than the sale prices.

The difference in calculation of Plan No.1 and Plan No.2 results chiefly from that in the sale prices; in the case of the sale, the including a domestic and an export sale prices the domestic one is easily estimated because of its protection by tariffs, etc., but the export one must be estimated in the light of international prices, so that the greater weight of exports in the sales the greater the relative loss (see the below-given remark). Accordingly, in view of the growth of domestic demands in the case when the full scale operation is started in 1979 and 1975, the former case is much profitable.

Considering from the payability of the enterprise, Plan No.2 is unadvisable unless some special measure will be taken. As for Plan No.1, it provides some advantages over Plan No.2. It is considered possible to mount it on a payable base if supported by Thai Government. Nevertheless, a number of problems will rise to fulfil the plan requiring the attention of those concerned.

Incidentally, despite the fact that Plan No.1 and Plan No.2 are different in location, their equipment costs are regarded identical. It should be noted that the difference of timing will virtually appear. Adoption of Plan No.1 will not present reasons to negate the Bangkok location in terms of profit and loss. In the case of selecting Si-Racha it is feasible only after overcoming various conditions

Note: (Unit: US$1,000)

	Unannealed plate				Annealed plate	
	Reversing mill		Tandem mill		Tandem mill	
	Export	Domestic	Export	Domestic	Export	Domestic
Sale price	130.95	155.20	130.95	155.20	115.43	145.52
Variable cost	140.72	140.72	136.02	136.02	126.72	126.72
Marginal profit	-9.77	14.48	-5.07	19.18	-11.29	18.80

F.6.3 Recommendations

(1) The Thailand's rolling plant project will be economically feasible provided it will be sufficiently considered and appropriate measures will be taken by the government. The completion of the plan will increase the domestic demand as well as demands in the neighbouring countries.

The establishment of a tandem mill prior to a reversing mill seems to be more advantageous in terms of cost than the reverse. But the reverse order of establishment seems to be an appropriate measure, if emphasis is placed on the technical phase in starting the cold rolling skill from nil.

A construction plan with 1979 as the target year for starting the full scale operation of the two mills is recommended considering profits and losses. Of course, there is no objection to expedite such timing, but it requires some risks to export a large portion of the products caused by the short domestic demands.

As for a decision on the location of the plant, we refrain from making any conclusions on it at this time. Nevertheless, in view of the future potential of the mill, the location of related industries, and the timing of its construction, the selection of the plant location in the Si-Racha area would be economically desirable. And this is the key problem of the Thai Government's development program of heavy industries.

(2) If the location will be decided on Si-Racha, the outlays for construction, land levelling and preparations for other secondary works, etc. should be borns by the Government.

Assuming the above, the construction cost for fundamental works in Plan No.1 was estimated small. It is desirable that the Government will make positive endeavors on the Si-Racha Industrial Area Development Program requiring an enormous amount of money a and allow the plant-enterprise to utilize it; otherwise, the enterprise will hardly find itself payable.

(3) When these measures will be taken by the Government, the establishment of an integrated steel mill for flat products in Thailand, in due course would be feasible.

The construction of the mill is recommended in a step by step basis as follows.

(i) first stage – the installation of one cold reversing mill with a capacity of about 78,000 tons in 1975 or earlier.
(ii) second stage – the installation of a cold tandem mill in 1976 or immediately thereafter with a capacity of about 420,000 tons annually. This recommendation is premised in the installation of port facilities, power supply and other infrastructures of the plant before 1975. The proposed site of the plant should also be investigated

The immediate training of personnel before the construction of the plant is also suggested at an early stage.

(iii) third stage – the installation of a hot strip moll enlarged with a blast furnace – LD facilities is also suggested at some later date after a careful study of the project.

The existing domestic and potential market in the country justifies this installation.

(4) In the case of raising capital through investment and long term loan payable, the Government must help the enterprise. The investors will not be able to take a dividend for more than ten years. As for raising long-term loans payable, it will the difficult to obtain stable and generous capital. In any way the Government's support is indispensable.

A large part of the items above are measures requiring Governmental actions. Needless to say, it is enterprise's obligation to appropriately repay its debts to the Government, when it is able to yield sufficient profit.

ANNEX

1. COMMENTARY ON THE ELECTRIC IRON MAKING PROCESS

2. COMMENTARY ON THE CONTINUOUS CASTING PROCESS

3. COMMENTARY ON COLD ROLLING FACILITIES

4. PROPOSED ESTABLISHMENT OF A SOUTH-EAST ASIAN STEEL INSTITUTE

5. MARKET SURVEY ON CAMBODIA

Annex 1. Commentary on the Electric Iron Making Process

a. Present situation of Electric Iron Production method and Problems to be settled.

(1) General situation

Electric power has been utilized for a long time to reduce the iron ore, but no satisfactory result has been obtained. Recently, with the adoption of the improved furnace structure namely the sub-merged arc furnace which makes the reductive action in the furnace more efficient, possibility of reducing power consumption by means of prereduction of iron ore and also expectation of low cost electric power to be made available by the development of the atomic power generation system, the electric iron-making method has again been spotlighted.

The major electric pig iron making plants at present in operation in various countries are shown in the Table 1.

Table 1. Major Electric Pig Iron Plant

Location (country)	Remarks	Capacity (T/Y)
Chimbote (Peru)	13,200KVAx2 (T.H)	65,000
Lulea (Sweden)	12,000KVAx3 (T H)	80,000
Belo Horizonte (Brazil)	17,000KVAx2 (S D)	--
Bremanger (Norway)	33,000KVAx1 (T H)	80,000
Mo-i-Rana (Norway)	33,000KVAx4 (T.H)	360,000
	60,000KVAx2 (T.H)	360,000
Matanzas (Venezuela)	33,000KVAx9 (T.H)	700,000
	(One was converted to Strategic Udy)	
Skipje (Yugoslavia)	34,500KVAx3 (T.H)	360,000
	34,500KVAx4 (T.H)	500,000

T.H = Tysland – Hole type S.D = Siemens – Demag type

(2) Submerged arc furnace

Almost all the electric furnaces at present in operation are submerged arc type ones. Figure 1 shows the cross section of a typical submerged arc furnace.

Of a 33,000 KVA furnace, the shell diameter even reaches to 15m The hearth of the furnace is made in such a way that inside of the vessel is lined with fire bricks on which carbon stamp is laid, or carbon blocks or magnesite bricks are laid and carbon stamped.

On the lower part of the furnace wall, lining is made on the fire brick with carbon blocks or stamp or magnesite bricks. The roof is made generally with silica-almina bricks or magnesite bricks.
Generally, Soederberg electrode is used.

A long cylinder is shaped by several iron plates welded, and inside of the cylinder ribs are added for promoting electric current introduction into the electrode. Into this cylinder, semi-plastic paste is deposited. The paste is made of ash-free anthracite, coke breeze and tar-pitch, and, being sintered by the heat of electric furnace and electric current, the paste is made itself a continued electrode.

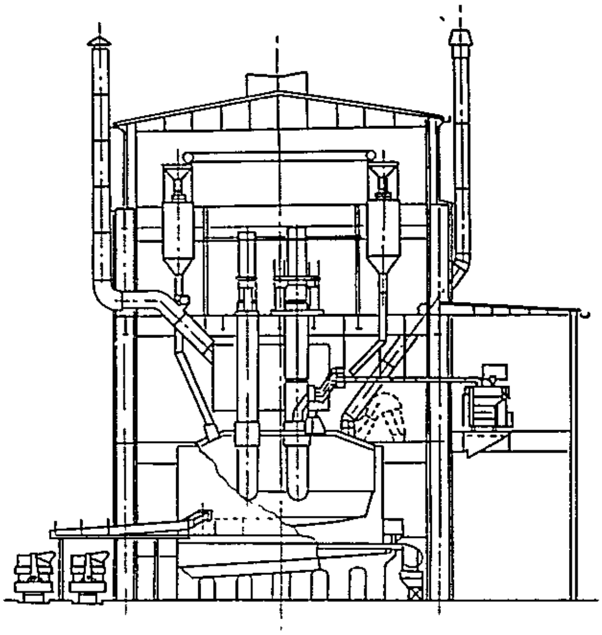


Fig. 1 Cross section of a typical modern Tysland-Hole submerged-arc furnace plant

(3) Raw Materials

Hematite, magnetite, limonite, titanium iron ore, iron sand, pyrite cinder, scale, scrap, etc. are used as iron charges. The size of ore is mainly 20–40mm for a large furnace. Those which are too fine or too big lump should not be used.

The fine ore is better to be used in the form of sintered ore or pellet for the purpose of stabilizing furnace condition and helping gas ventilation in the furnace which accelerates indirect reduction and consequently saves electric power consumption.

As the reducing agent, coke and coke breeze are most widely used. Charcoal, fine anthracite, brown and even peat were also used. The reducing agent is not only useful for its primary function of ore reduction and carbonization but also plays an important roll as the conductor of electric current. It is generally said that, as the reducing agent, mixture of breeze and lump are better. The mixture which has been used in the Tysland-Hole furnace with good result is shown below.

Coke	20 – 60 m/m	30%
Coke breeze	5 – 10 m/m	35%
"	5 mm under	35%

As the solvent, lime stone is used, and slag basicity is within the range of 0.9 – 1.4. When using high grade ores slag volume is less than 300 kg per ton of iron, in rare case, silica or river sand is used in order to increase slag volume.

The selection of charging materials is the most important matter in improving the operation result of the electric furnace, and at present lump ore and coke are selected most generally.

Under these conditions, furnace operation is influenced greatly by the kind of ore to be used. As an example, comparative result on three kinds of ores is shown in Table 2.

Table 2. Comparison of Three Submerged-Arc-Furnace Ironmaking Operations Using Crude Ore

		Charging Magnetite of Low Reducibility	Charging Mematite of Moderate Reducibility	Charging Hematite and Limonite of High Reducibility
Charge per metric		1900kg magnetite	1465kg hematite	1867kg self-fluxing ore
		40 kg Mn ore	30kg Mn ore	
		280kg limestone	231kg limestone	
			74kg quartzite	
		2200kg Total	1800kg Total	1867kg Total
		510kg anthracite	420 anthracite	429kg coke
		and coke	15kg electrode carbon	10kg electrode carbon
Slag Production per metric THM Furnace Gas Characteristics		750kg	313kg	258kg
Temp	°C	300	700	450
CO,	%	76	71	72
H_2,	%	8	8	8
CH_4,	%	–	2	–
CO_2,	%	16	19	20
Electrical requirements, kw/hr/metric THM		2800	2520	2360

Test performed by Elektrokemisk and supervised by IRSID for a French firm, using Ouenza ore from Algeria.

It show clearly that the degree of reduction has played an important role. This fact is also proved by the heat balance shown in Table 3.

Table 3. Thermal Balances for Submerged-Arc-Furnace Iron-making Charging Crude Ore (in kcal per metric ton of hot metal)

	Magnetite	Hematite	Hematite & Limonite
Heat Requirements			
Decomposition of carbonate & gydrates	119,000	91,500	147,000
Vaporization of water & decomposition	79,500	130,000	118,000
Reduction of oxides	1,042,500	835,000	830,000
Sensible heats of Iron	307,500	302,500	302,500
of slag	330,000	144,000	112,000
of gas	59,500	182,500	131,000
of charge	–	3,000	–
Diverse losses	537,500	502,500	397,500
Total needs	2,475,500	2,191,000	2,038,000
Heat of slag formation	-93,500	-39,000	-32,000
Heat furnished by electrical energy	2,382,000	2,052,000	2,006,000

Comparing with the above result obtained from using the crude ore, if the self-fluxing sinter is used, operation result will be improved to some degree. That is to say, heat requirements for degydration and removal of carbonate be lessened to approximately 200,000–250,000 Kcal which correspondes to 230–300 KWH. Further, dust is lessened, ventilation of burden improved and reducibility increased. Table 4 shows an example of an operation in which self-fluxing-sinter is used.

Table 4. Data from Submerged-Arc-Furnace Iron-making Operations Based on Self-Fluxing Sinter (all figures per metric T H M)

	Hofors, SKF, Sweden One 12,000-kva furnace	Domnarvet, Stora Kopparberg, Sweden Two 7500-kva furnaces	Mo-i-Rana, Norsk Jornverk, Norway Test on One 33,000-kva furnace
Charge	1700kg sinter 400kg coke	1580kg sinter 385kg coke	1600kg sinter 330kg coke
Electrical requirement	2300kw-hr	2050kw-hr	2000kw-hr
Electrode carbon consumption	16kg	15kg	10kg
Slag volume	480kg	–	350kg
Furnace gas	650cu meters	450cu meters	550cu meters

By these operation examples, various unit consumptions are as follows.

When 65% Fe crude ore is used. When sinter obtained from 65% Fe ore is used.

Coke	400 – 450 kg/T	350 kg/T
Electricpower	2,300 – 2,600 KWH/T	2,000 KWH/T
Electrode	15kg/T	10 kg/T

(4) Preheating and prereducing

As the above examples show, preheated or prereduced ore reduces coke and power consumption better than crude ore directly charged into the furnace.

Such a pre-operation is carried out either within the furnace itself so as to utilize the gas generating from the furnace hearth, or in an auxiliary furnace using cheaper fuels than electric power or coke.

The explanation is made on the preoperations which have been brought to industrial scale as follows:

(a) Strategic – Udy process

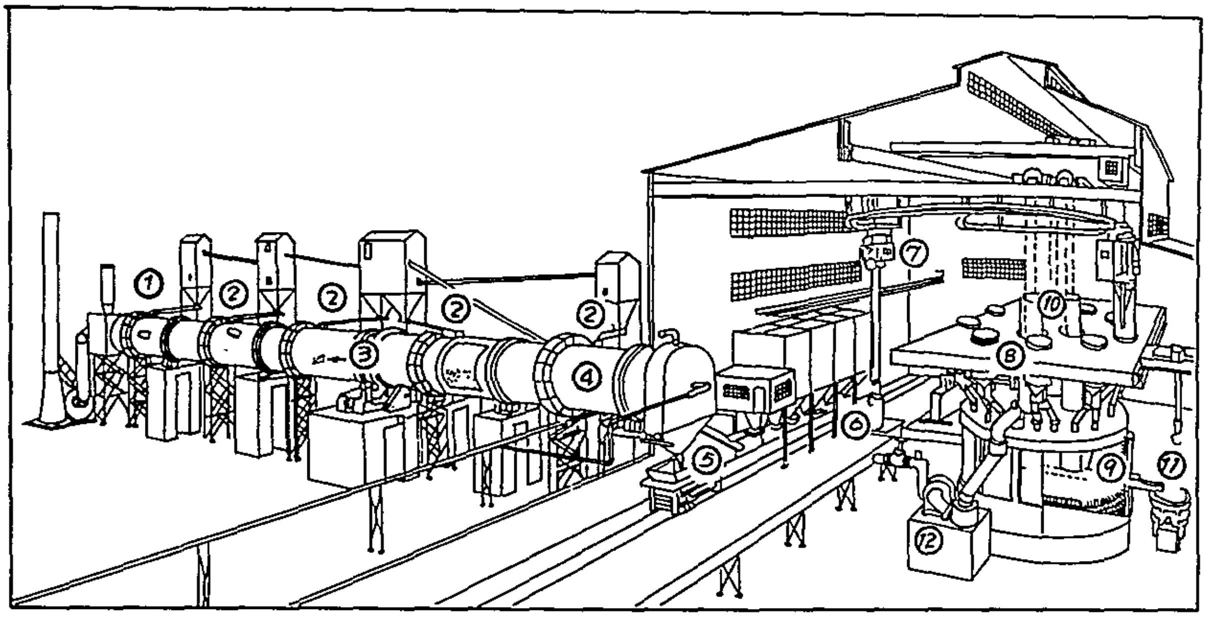


Fig. 2 Strategic-Udy installation at Matanzas, Venezuela: (1) ore and flux charged into end of kiln, (2) coal introduced at four points along kiln, (3) side air fans for combustion control, (4) firing end of kiln, (5) scale car for kiln discharge, (6) insulated transport bucket (7) furnace charging crane, (8) nine charging hoppers, (9) Strategic-Udy open-bath smelting furnace, (10) self-baking carbon electrodes, (11) tapping ladle, and (12) off-gas system.

Figure 2 shows main facilities in the strategic-Udy process which are composed of the open-bath type electric furnace and the separate rotary kiln.

The kiln functions to pre-heat the charge, pre-reduce the ore and eliminate the volatile matter of the coal. The pretreated charges are put into the furnace through the transport bucket when needed.

By this means, it is said that, when based on a 65% Fe ore, consumption of materials amounts to 0.5 ton of coal with 74% fixed carbon, 1,200–1,300 KwH, and 7–8 Kg of electrode per metric ton of pig iron. However, in this case, the cost for pre-treatment of charges must be taken into account.

(b) Elektrokemisk process with rotary kiln

In this system, submerged arc furnace is connected directly with the rotary kiln. Figure 4 shows the pilot palnt of this system at the Elektrokemisk Research Station in Norway.

As the volume and quality of gas emerging from the electric furnace is not enough to pre-treat the charges, supplemental fuel is used in the kiln. By this means, it attains the result similar to that of the Strategic-Udy process. This process is industrialized at the Nouma Plant of Le Nickel in New Caledonia and at Skopje in Yugoslavia.

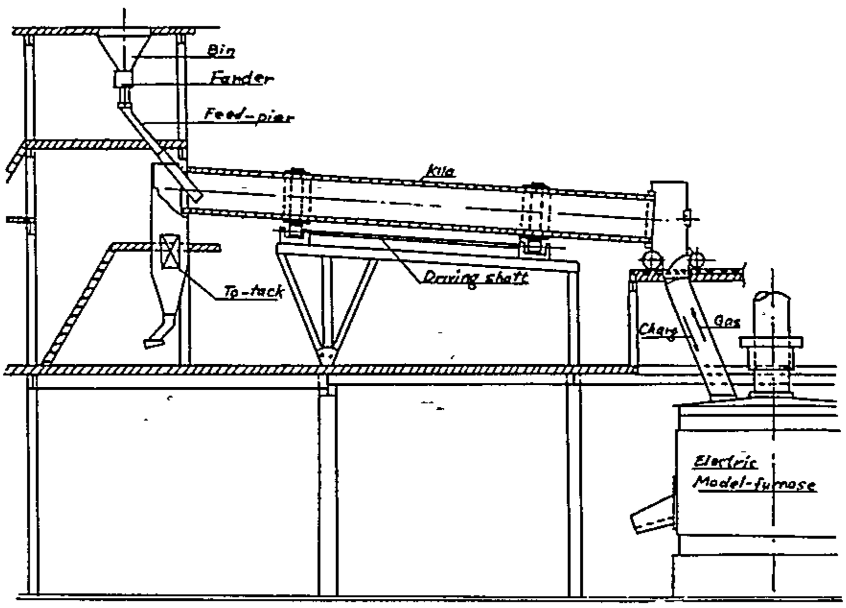


Fig. 3

(c) Elektrokemisk process with shaft furnace

In this process, the submerged arc furnace is connected directly with the shaft furnace. In this case, supplemental fuel is also used in addition to the gas produced in the furnace. Fig. 5 shows a model of this system.

By this process, basing on 65% Fe, ore consumption of materials are said to be 365 kg of coal having 74% fixed carbon or 320 kg of coke having 85% fixed carbon, 1,200 – 1,300 KWH of electric power and 7 – 8 kg of electrode per ton of pig Iron.

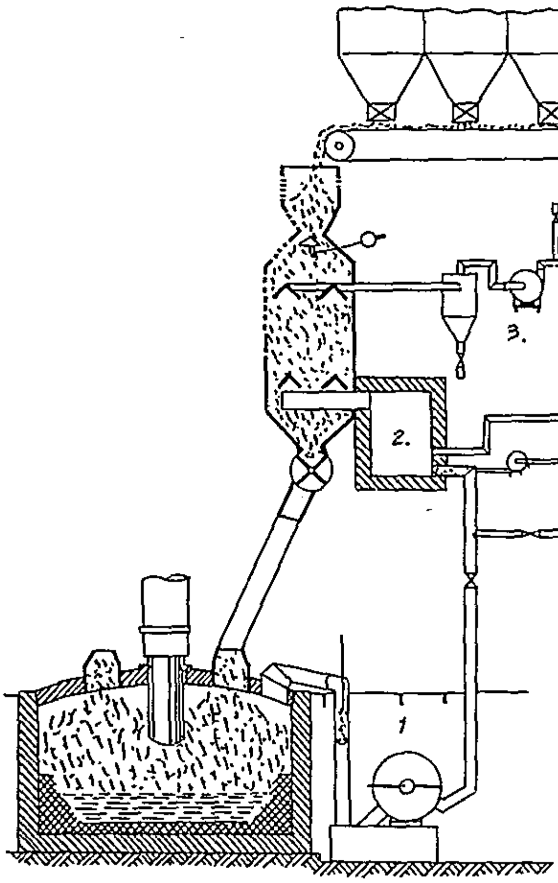


Fig. 4

(5) Operation of electric iron making furnace

The electric iron making furnace can be operated, due to its adaptability to various operational conditions, with extremely large flexibility. Especially, with regard to the fluctuation of electric load, when power supply has changed seasonally, daily or hourly, or load is lowered to 50% or less, no operational hindrance is caused. In other hand, even of the maximum load is slightly exceeded, still it can operate at the best condition.

(a) Operation

Charges composed of iron ore, carbon-bearing material for reduction and solvent mixed uniformly, is put into the tank above the furnace and charged into the furnace evenly through the several charging chutes. The regular electric current, the voltage of which being within the range of 80 – 150V, is charged automatically or by hand. Discharge of pig iron is made 4–8 times a day, namely in every 3–6 hours. Immediately before it, slag is discharged. The quantity of slag per one ton of pig iron is usually 300–500 kg, the basicity of which being 0.9–1.4.

(b) Conditions in furnace

Electric current flows into the charges through carbon-bearing material making numerous small sparks. The horizontal section of the melting sphere of a furnace with 3 electrodes arranged in triangle forms a clover leaf.

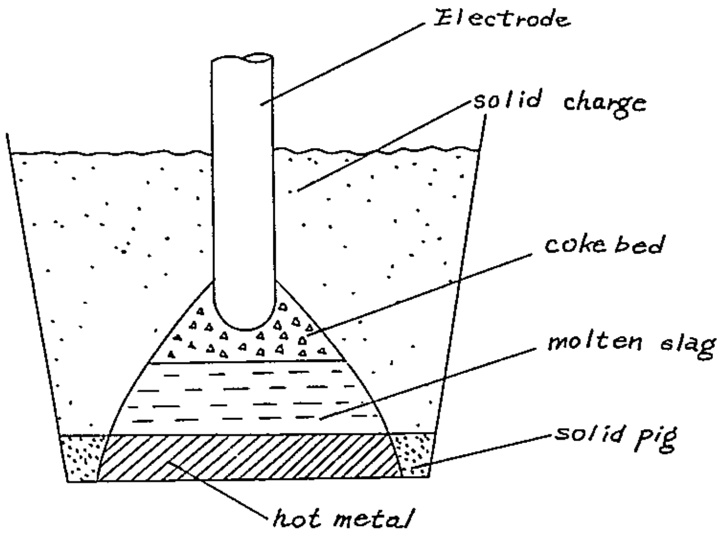


Fig. 5

Mr. F.C. Collin in France supposed that, under the electrode, coke is piled forming a bed, as shown in Fig. 5.

In the electric iron making furnace, iron ore is mainly direct-reduced by solid carbon, differing from the conventional blast furnace, the formula of which being as follows:

$Fe_2O_3 + 3C = 2Fe + 3CO$

$Fe_3O_4 + 4C = 3Fe + 4CO$

$FeO + C = Fe + CO$

Co gas generated here has little chance to reduce the ore as it comes in contact with the ore for brief time. As a devise to utilize this gas of high CO content, it is burned within the furnace to CO_2, and the heat generated at the time can be used to pre-heat the charging material. Adopting this idea, the Mizushima Ferro-Alloy KK of Japan is manufacturing Fe-Mn.

Figure 6 is the rough sketch of the apparatus which shows the devise in which the reductive gas is burned and introduced to the shaft furnace to pre-heat the charging materials come down from above. The material ore is pre-heated by this means to 200–300°C and, further in the furnace, exposed to the radiant heat emitted from this combustion zone. It is considered that, from its very nature, this principle can be applied to pig iron making.

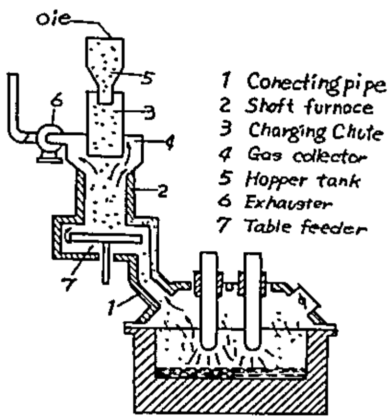


Fig. 6 Reheating apparatus of raw materials for ferromanganese by Nasu – process

Annex 2. Commentary on the Continuous Casting Process

The idea of continuously casting steel in an endless strand is a century old, and some 40 years ago, aluminium and other non-ferrous alloys were cast in this way. During the past 25 years or so, tremendous advances have been made in the continuous casting of steel, and the process can now be regarded as being commercially workable.

Modern continuous casting machines can produce billets ranging from 70 x 70 to 300 x 300 mm, and slabs up to 140 x 1,200 mm, and even now some facilities can produce slabs measuring up to 220 x 2,000 mm, and there is every sign that bigger slab cross-sections will be possible in the future.

Some very promising investigations have been carried out into the continuous casting of hollow bodies for tube manufacture.

Originally, continuous casting machines were of the vertical type and measured up to 30 m in the height, these machines were installed in pits up to 17 m deep to reduce the height of the tower above the shop floor. The latest development is aimed at reducing the overall height as such, and in Western Europe various solutions have been arrived at. One alternative is the vertical plant with a bending device to take the solidified strand from the vertical to the horizontal plane; other alternatives are the bow-type or oval casting machines. The vertical plant with strand bending facility reduced the overall height of the tower by about 1/3, i.e. by some 10 m, and bow-type and oval casting machines by 2/3 and more, i.e. the overall height of the latter machines lies between about 6 – 10 m. Bending of the strand must be effected when the strand is still so hot that the surface has solidified but the core is still pasty, if not in some measure liquid. Experience gathered to date indicates that these machines are perfect for smaller cross-sections. However, machines for bigger cross-sections, and particularly big slabs, are still in the pilot stage. In contrast to Western Europe, the USA and the USSR still use vertical machines for big cross-sections and slabs.

Rimming steel still poses some problems in the continuous casting field, and various posibilities of overcoming the difficulties are being investigated, e.g. by using degassing equipment ahead of the continuous casing plant. This steel is still in demand for certain applications, e.g. various types of plate and wire; some 25% of all rolled products are made from rimming steel. This demand can not yet be catered for by continuous casting machines. Efforts are also being made to establish whether and to what extent rimming steel low in silicon can be replaced by steels killed with sluminium.

In order to guarantee continuous operation, continuous casting machines must have a minimum of two strands one of which is made ready for the next cast while the first is in operation. This takes about 20 – 30 minutes.

Continuous casting operations are also influenced by the supply of liquid steel. The casting time is limited to a maximum of about 60 minutes; beyond this point the steel would begin to freeze in the ladle. Full utilization of a continuous casting plant is relatively easy when using hearth furnaces, e.g. open hearth or electric arc furnace, provided the operations are well coordinated; the situation is much more difficult when the steel is supplied from an oxygen steelworks, the tap to tap times of the convertors beeing 40 to 60 minutes. In these cases, two continuous casting machines must be used per converter to ensure smooth operations. The number of strands per machine is also governed by the relationship between the strands dimensions and casting rates and the ladle capacity and casting time. As the steel temperature is set within very narrow limits, basic Bessember steel can not yet be continuously cast, having very high temperature fluctuations.

The refractory linings of the casting ladles and tundishes must be given special attention, as the wear rates are particularly high here.

Nowadays, stopper ladles are normally used for continuous casting operations, the heat losses being lower than those of tilting ladles.

The continuous casting machine yield is about 5 to 10% higher when compared with a product of the same size rolled down from an ingot in a blooming or slabbing mill.

Whereas ingots often have to be rolled out to 10 – 15 times their initial length-for rails, a 20-fold elongation is specified - experience indicates that continuously-cast material need not be rolled out to this degree in many cases.

Continuous casting plants can be of combined design, i.e. for both squire sections and slabs.

The power requirement of continuous casting plants varies between 5 and 20 KWH/T, depending on the design; cooling water consumption equals about 3 m^3/t and approximately 3 Nm^3 of oxygen are needed per ton of steel for the cutting torches.

Casting rate are difficult to specify, as they are in great measure dependent on the size of the cross-section being cast; for example, a strand measuring 300 x 300 mm is cast at the rate of 4 m/min, or 18t/h.

The investment costs also vary with the plant capacity, strand dimensions, and plant design, i.e. whether vertical or how-type. In general, larger plants can be estimated as costing approximately 15 to 20 $ per ton capacity. A comparison of prices shows that those of a continuous casting plant and a slabbing mill are even at a capacity of about 1.5 million tons. In other words, the rolling mill becomes much less expensive as capacity increases, whereas the continuous casting plant investment cost remain practically the same as further strands are added on the unit construction principle.

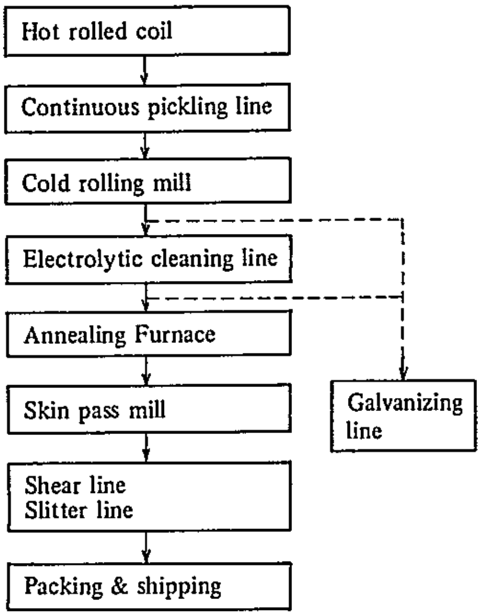
Annex. 3 Commentary on Cold Rolling Facilities

Cold-rolled steel sheets and coils are made from hot-rolled coils through the steps of cold-rolling, annealing and skin-pass. Cold rolled products are far thinner and of more excellent quality than hot rolled ones. That is to say, cold rolling provides thin sheets of uniform thickness, fine appearance and of no surface defects such as scale, and they have mechanical properties suitable for deep drawing as their structure becomes very fine through appropriate heat treatment.

Also through skin pass it is possible to prepare their surface conditions according to various uses, and produce sheets of excellent properties such as proper stiffness and flatness, which are suitable for a wide range of use.

The general flow diagram for the production of cold-rolled steel products is shown in Fig. 1.

Fig. 1 Flow diagram of cold rolling mill shop

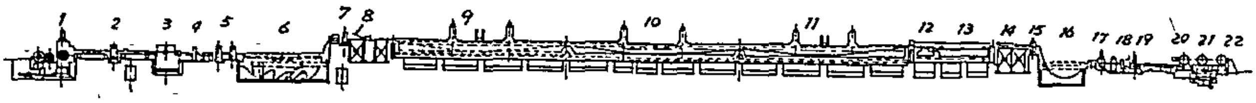


3.1 Pickling line

(1) Outline: The hot coil, the material for cold-rolled strip has a considerable amount of mill scale on its surface, resulting from continuous hot rolling and down-coiling in coil form at an elevated temperature. If such a coil is fed into cold rolling mill, a strip with a beautiful surface can't only be produced owing to scales bited in, but also serious obstacles will be caused in the subsequent processes. From the reason it is necessary to remove mill scales from hot coil through pickling ahead of cold rolling. Pickling is carried out by immersing the strip into the pickling solution when it passes through pickling tanks in the line, whereby the surface scale dissolves and drops off.
Solution of sulfuric acid or hydrochloric acid is used as pickling agent.

(2) Equipment and operation:

Fig. 2 Continuous Pickling Line



1. Uncoiler	2. Shear	3. Welder
4. Flash trimmer	5. No. 1 pinch roll sticher	6. Looping pit
7. No.2 pinch roll	8. Dancer roll	9. Pickling tank No. 1
10. Pickling tank No. 2	11. Pickling tank No. 3	12. Cold water spray tank
13. Hot water rinse tank	14. Dryer	15. No. 3 pinch roll
16. Looping pit	17. No. 4 pinch roll	18. Shear
19. Side trimmer	20. Recoiler	21. Scale
22. Conveyer		

The hot-rolled coil fed into the uncoiler, after uncoiled here, is delivered into the line, at first being levelled in the pinch roll leveller, then being cut by the shear. Then, the end of the preceding coil and that of the following coil are joined electrically by the welder, whereby the strip can be supplied continuously into the pickling tank. The flash or excess metal resulting from the upsetting action of the welder is trimmed off by the flash trimmer to make it suitable for cold rolling. The coil joined by welding, is stored in the looping pit. This is for the purpose of carrying out pickling at a constant speed without interrupt even when welding, and this is effective in preventing over or under pickling and in reducing down-time. If there is another looping pit before the welder the down-time for uncoiling on the entry side can be reduced, so that the pickling operation can show its full efficiency. The recent tendency is, in order to prevent injuries on the surface of strips caused by friction between them in the looping pit, to adopt the means in which the loop car, supporting the strip to travel horizontally, stores the strip loop. Prior to entering the pickling tank, if the scale layer on the surface is broken by bending the strip by a scale breaker, the pickling effect is greater and the pickling speed becomes faster.

Pickling tanks in an high-speed line is as long as over 75m, and composed of three or four tanks of steel plate, the inside of which is rubber-lined and laid with acidproof bricks. The pickling speed in some of the latest ones, is over 200 m/min. A raw acid is supplied from No. 3 tank, which overflows into No. 2 and No. 1 tanks. The concentration of the sulfuric acid is maintained at about 10% in No. 1 tank, about 15% in No. 2 tank, and about 25% in No. 3 tank, and the temperature at 90 – 95^{o}C by steam-heating.

The pickled strip is washed in a cold water spray tank and then in a hot-water-rinse tank. The strip then is sheared at the coil end, trimmed off its both edges which have bad effects on cold rolling, oiled on its surface, and then coiled to send cold rolling mill. Recently it is the general tendency to use a tension reel in order to avoid injuring of the strip in recoiling operation.

(3) Pickling solution:

Sulfuric acid solution has hitherto been used as pickling agent. This was because hydrochrolic acid, a substitute for sulfuric acid, is expensive despite various advantages, and also because there arises problems about acid-proof materials, intensively corrosive hydrochrolic fume etc.
However, such problems and other technical ones have been solved with the latest development of hydrochrolic acid-recovering equipment, leading to the use of hydrochrolic acid in the pickling line in many cases.

The advantageous features of the use of hydrochrolic acid pickling over sulfuric acid are:

1. The use of Hcl reduces pickling time, which permits a faster pickling speed resulting in an improvement of productivity.

2. Hcl provides a better surface appearance of the pickled strip; the surface of the product is more whitish and prettier.

3. In the Hcl line, the scale breaker becomes unnecessary. In the case of H_2SO_4 pickling, though the solution itself lacks in the ability to dissolve the scale, the acid penetrating through the cracks produced in the scale layer discolves the scale near and on the surface of the base iron or the base iron itself, generating simultaneously H_2 gas which drops off the scale. So it is effective to create cracks mechanically by providing a scale breaker for bending the strip or by a skin pass mill for applying a few per cent reduction, concurrently for correcting the flatness of the strip.

3.2 Cold Rolling Mill

(1) Outline:

The procedure of rolling pickled coils at normal temperature is called cold rolling. Actually, however, the surface temperature of the material under rolling becomes near 200°C.

The aims of cold rolling are:

(a) To produce thin strip economically.

(b) To provide desired mechanical properties suitable for from "full hard" to deep drawing sheets with or without subsequent processes such as heat-treatment, skin pass etc.
The total reduction in the cold rolling is 50 – 70% for sheet gages and amounts 90% for tin plates. The reduction in this case refers to the percentage of the reduced amount of thickness of a strip to its original thickness, and represented by:

$$\frac{\text{Original thickness} - \text{rolled thickness}}{\text{Original thickness}} \times 100\%$$

The workability of cold strip is directly determined by its chemical composition, finishing temperature of hot rolling, coiling temperature, cold rolling reduction and annealing temperature; so these conditions must be properly considered for the production of quality products.

(c) To provide a smooth, pretty surface.

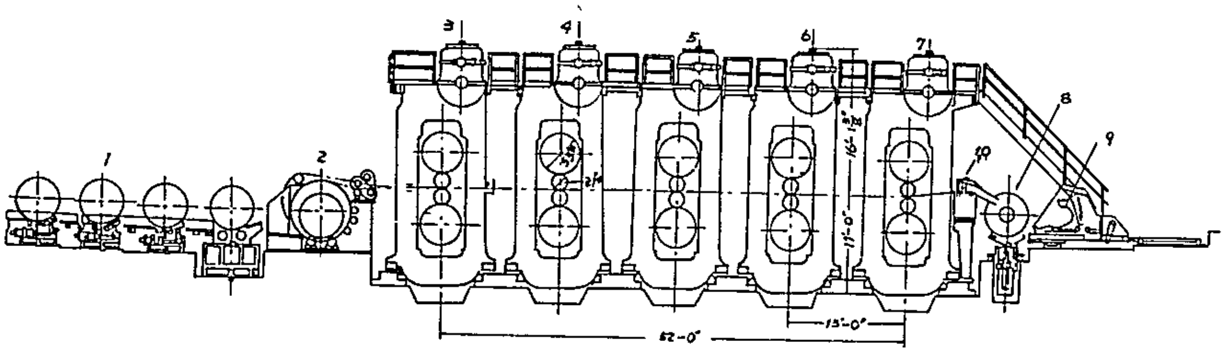
(d) To provide strips with more uniform thickness than by hot rolling.

The strip mill which brough an epoch making progress in the rolling of steel plate, has made a rapid advance with the growth of demands for thin steel strip and technical developments, and its rolling speed has become faster and faster along with an increase in the weight per coil; nowadays some cold strip mills are being operated at the delivery speed as high as over 2,000 m/min.

(2) Type of the rolling mill:

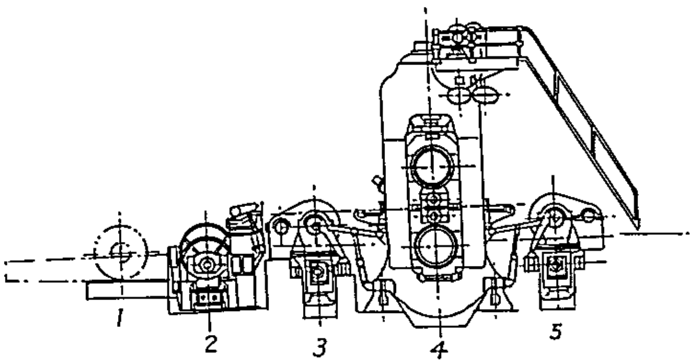
There are two types of cold strip mill; the tandem mill and the single reversing mill. The reduction of cold strip ranges from 40 to 90%, and it is difficult to obtain such a high reduction at one pass of rolling. In the tandem mill four to six stands of the same type are arranged tandem, through which the strip passes continuously, on the other hand, in the reversing mill the strip repeats passing through single stand several times. Fig. 3 shows the arrangement of a cold tandem mill and Fig. 4 the arrangement of a cold reversing mill.

Fig. 3 Arrangement of a Five-Stand Cold Strip Mill



1. Coil ramp	2. Coil box	3. No. 1 stand
4. No. 2 stand	5. No. 3 stand	6. No. 4 stand
7. No. 5 stand	8. Tension reel	9. Belt wrapper
10. Thickness gage		

Fig. 4 Arrangement of a Reversing Four High Cold Strip Mill



1. Coil ramp   2. Coil box   3. Tension reel
4. Rolling mill   5. Tension reel

In the tandem mill, since total reduction is shared to each stand, it is possible to roll a coil with one pass, which permits high-speed rolling; in many modern mills the maximum rolling speed being more than 1500 m/min. On the other hand in the reversing mill rolling direction must be changed for every pass and in one pass its speed is not constant; low at start, maximum in the middle and also low at the end of rolling, commonly the maximum rolling speed being 600 – 800 m/min. The tandem mill, being of a continuous type, is advantageous for mass production of products of a single kind, but lacks in operational flexibility, so that it is difficult to cope with changes of the size of the products. In this respect, because of its adjustability the reversing mill is convenient to roll various kinds of products.

In comparison of the tandem mill and the reversing mill, it can be said that the tandem mill, though higher in construction expense (about four times that of the reversing mill) and lower in adaptability to varied kinds of products, is cheaper in operation cost and far higher in productivity (five to six times that of the reversing mills), which is suitable for mass production.

(3) Equipment and operation:

In reference to Fig. 3 of a tandem mill, a coil is fed into the coil box, where its end is uncoiled and threaded into the mill train, in which guide plate supports it on each side and sends it out. The coil next to be rolled ready in the coil ramp. The mill housing, containing rolls, roll chocks, screw down mechanism etc. is constructed so robustly that it can stand big rolling pressure with few deformation and permits rolling of high accuracy.

The 4-high mill, which can perform a strong reduction even in the course of rolling with a large screw-down mechanism and its drive installed on the top of the housing has two work rolls supported by two back-up rolls in the housing window. The back-up roll, the diameter of which is about 2.5 times that of the work roll, can support the deflexion of the work roll caused by big rolling pressure, and maintain its shape uniformly, whereby can keep accuracy of thickness in the width direction of the strip. Ordinarily, work rolls are driven and back-up rolls are rotated by friction force between the two kinds of rolls. The work roll is made from forged steel with the hardness of H_S90 or more, which is least susceptible to wear and finished by polishing. On the entry side of the housing is provided the mill guide to clamp the strip through wooden pieces and at the same time refrain the tracking of strip by virtue of side guides. In front of and behind the work roll are installed many spray nozzles which cool the heat produced by rolling and at the same time spray the rolling oil and roll coolant acting as lubricant in rolling. The selection of their quality and quantity, and their spraying method are the important technical requirements. On the delivery side of the final stand is provided a tension reel for recoiling the strip in the coil form. This reel being of overhang mandrel type, the coil is taken out by collapsing the drum with the hydraulic mechanism. The belt wrapper serves to guide the top end of the strip around the reel mandrel. The rolled coil is delivered to the coil ramp on the delivery side by coil car.

At No.1 stand and the delivery side of No.5 stand are set X-ray thickness gages. The former gage gives reference for controlling the thickness of the material at constant value and the latter indicates the finishing thickness accurately.

In the inside of the housing is a lead cell to measure the rolling pressure, and between two stands a tensiometer for measuring tension there. By combining the signals of these instruments, the A.G.C. (automatic gage control) operates to automatically adjust the rolling pressure and the tension in order to control the variation of the strip thickness to a minimum.

The rolling speed refers to the speed at which the strip comes out of the final stand, and actually it is indicated by the circumferential speed of the roll. When this speed is determined, those of former stands are to be settled by the reduction percentage. The rolling tension is provided with between each two stands, and between the stand and the tension reel. This tension is not only helpful to rolling but important to prevent climping. But if the tension is too strong there is the danger of breaking the strip, and so it must be adjusted properly. And yet since the tension must be maintained constant even when changing the rolling speed, there is provided a device to take its balance by electrically compensating the mechanical inertia. Besides, in order to make a flat strip, selection of a roll curve and adjustment of the quantity of the coolant during rolling become necessary so as to maintain the roll curve.

3.3 Cleaning Line

(1) Outline:

In cold rolling, vegetable and mineral oil are used as rolling oil, which tends to attach to the surface of the rolled strip together with stains. If the strip is annealed in such a state, carbon caused by incomplete combustion of oils remains on the surface of strip, which injures the surface beauty of the strip, and particularly affects badly the continuity of plating effect. For this reason the cold reduced strip is generally subjected to cleaning after rolling.

(2) Method of cleaning:

Among various methods of cleaning, the principal ones are

(a) the immersion method, (b) electrolytic method and (c) solution-spraying method. Here explanations will be given about (a) and (b) as the most common methods.

(a) Immersion method:

This is a way of cleaning by immersing the strip in an alkaline solution. In this case, as the temperature of the solution has great effect on the eleaning result, this operation is generally carried out at a temperature near the boiling point of the solution. In most cases this method is practiced in combination with some mechanical cleaning such as brushes or hot water spray.

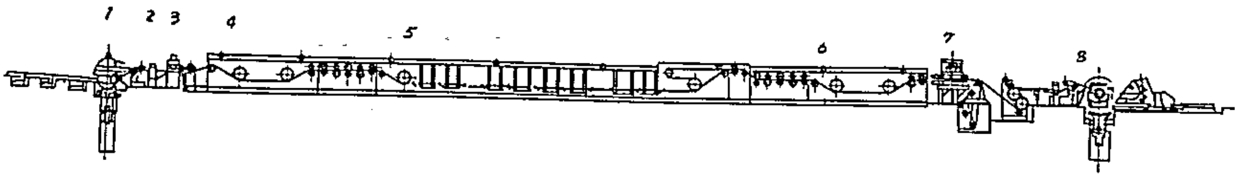
(b) Electrolytic method:

This method aims at the promotion of cleaning through the mechanical action of hydrogen and oxygen gases which are produced on the surface of the strip due to the electrolytic action of a low voltage current in the alkaline solution. The method is widely used in which the strip passes between several pairs of positive and negative electrolytic grids, making itself the neutral pole.

(c) Equipment and operation:

A cold reduced coil is fed into an uncoiler. The end of a preceding coil and that of the following coil, after cut square to the line, are weld-joined by a seam welder or a spot welder, and fed to a cleaning tank continuously. At first, the strip enters into an alkali cleaning tank containing an alkaline solution of the temperature of about 100°C, then into an electrolytic cleaning tank, where a DC current of 10 – 15V, 100 – 3000A. is supplied. In front of and behind this tank are installed several sets of brush rolls rotating in opposition to the moving direction of the strip and a section for mechanically cleaning the strip by spraying a hot water of about 70°C. After that the strip enters into a hot rinse tank where it is completely removed of residual alkaline and stains in a hot water of 90 – 100°C, then after draining with a wringer roll, it is dried with hot air through a drier. Thus cleaned strip, after given an appropriate tension, is recoiled in a reel, in which E.P.C. (edge position control) apparatus is provided for the purpose of arranging in order the edge of the strip for convenience in the following annealing process.

Fig. 5 Arrangement of Continuous Electrolytic Cleaning Equipment



1. Uncoiler
2. Shear
3. Welder
4. Alkali cleaning tank
5. Electrolytic cleaning tank
6. Hot rinse tank
7. Drier
8. Tension reel

3.4 Annealing Furnace

(1) Outline:

As a cold rolled strip retains a residual stress in it caused by great reduction while rolling, and its structure elongates in the folling directions, its hardness is so extremely high that it is not suitable for practical uses other than special purposes. So, a method is applied to recrystallize its structure to normal by heating at some temperature between A_1 transformation point and recrystallization temperature so as to improve its mechanical properties. This is so called annealing process.

(2) Annealing method:

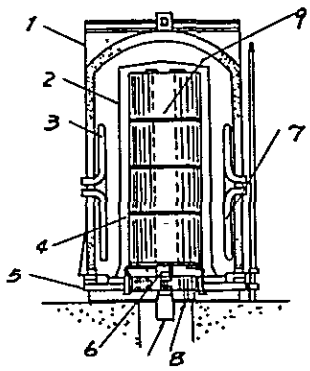
Annealing can be carried out in two ways; sheet and coil annealing. And coil annealing can be classified into box annealing of single or multi-stack, and continuous annealing. Sheet annealing is today limited to only special case and continuous annealing is adopted primarily for annealing tin plates. Generally either the single stack or the multi-stack annealing method is adopted. In comparison with the multiple annealing method, the single annealing can heat the coil uniformly, but as its treating capacity is limited, it is adopted for annealing products of various kinds under different conditions. The multiple annealing method, on the other hand, has several times as large a treating capacity as the single annealing method, so that its operating cost is low and is suitable for mass production.

(3) Equipment and operation:

Fig. 6 shows an example of a single stack furnace. At first coils are stacked on base. Between coils are placed connector plates in order to improve heat conductance by introducing gas.
Then, after an inner cover is placed over the coils to shut off outside air, an atmosphere gas is charged into the inside to substitute the air. The bottom part of the inner cover is sealed with sand or the like and inside gas pressure is maintained positive for protecting.

When the inside air has been completely replaced by the atmosphere gas the casing is put over the inner cover, which is heated by burning the fuel in the radiant tube or directly. In the inside of the inner cover, the atmosphere gas is at first heated, which then heat the coils by circulating from outside to the inside of the coils by virtue of the base fan.

Fig. 6 Construction of Single Stack Annealing Furnace



1. Casing	2. Inner cover
3. Radiant tube	4. Connector plate
5. Base	6. Base fan
7. Position of thermo-couple No.1	8. Pipe for thermo-couple No.3
9. Coil	

After the coils are heated for a specific time at the specific temperature, the casing is taken over and coils in the inner cover are cooled naturally or compulsively to the specific temperature, then the inner cover is removed and coils are unloaded from the base and cooled again to handling temperature.

The furnace efficiency depends upon heat conductivity and cooling speed. So it is necessary to consider the efficiency of the base fan at high temperature, the shape of the convector plate, and the forced cooling. By inserting the thermo-couple right under the coil on the base plate, temperature control is to be conducted. Fuel must be burnt at constant rate until the couple shows the set temperature, and after having reached this temperature, the amounts of the fuel and the air are automatically controlled so as to hold the coils at a specific temperature for a specific time until heating is completed.

The most widely used atmosphere gases are listed in the table below. As all of the gases are reducible, so that the oxidation of the coils can be completely prevented. In this case the decomposition reaction occurs;

$$2CO \quad C + CO_2$$

as a result, carbon is deposited on the surface of the coils, which tends to stain it. So the value of CO/CO_2 needs strict control. In this respect, as HNX gas contains few CO and CO_2, tending least to stain the coil surface, so it is used in the annealing of the tin plate.

Table 1.

Kind	Gas composition (volume %)						Use for: (carbon steel)
	CO_2	CO	H_2	CH_4	H2O (dew point)	N2	
DX	5–6	9–10	10–12	0.5–1.0	+5°C	balance	bright annealing
NX	0.1	0–4	1.1–4.5	–	-40°C	balance	"
HNX	0.05	0.05	3–10	–	-40°C	balance	super-bright annealing
AX	–	–	75	–	–	25	bright annealing
RX	1	17–19	34–40	–	–	balance	"

3.5 Skin Pass Mill

The annealed strip is so soft and weak that it is not suitable for ordinary working. It is subjected to a slight reduction of 1.0–2.0% through skin pass mill, thereby to improve workability and flatness, to prevent formation of stretcher strain caused by decrease in yield elongation and also to receive surface conditioning

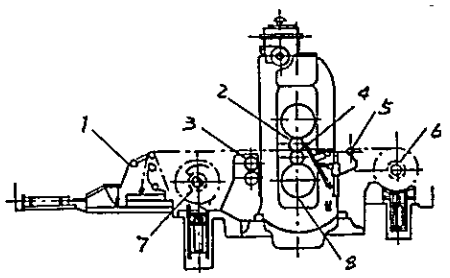
A application of excessive reduction deteriorate its workability for drawing. In the case of providing stiffness to the product, a reduction of about 2% can be applied.

The skin pass mill has such varieties as single stand 2-high mill, single stand 4-high mill, 2-stand 4-high mill, etc. and usually a non-reversing single stand mill is used. But as it becomes difficult to afford the desired stiffness and flatness to the strip with only single stand mill when its thickness becomes thinner like that for tin plate, the 2-stand mill is to be used for skin pass of thin strip exclusively.

In order to roll thin strip efficiently, such a high rolling speed as 1800 m/min. has been adopted. The structure of the skin pass mill is virtually identical with the cold rolling mill.

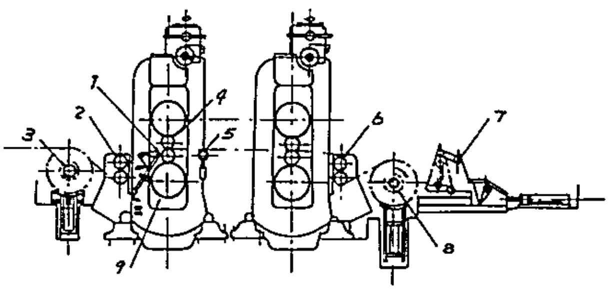
Fig. 7 shows a single stand 4-high skin pass mill and Fig. 8 a 2-stand 4-high skin pass mill.

Fig. 7 Single Stand Skin Pass Mill



1. Belt wrapper
2. Work roll
3. Tension roll
4. Climp roll
5. Deflector roll
6. Pay-off reel
7. Tension reel
8. Back-up roll

Fig. 8 2-Stand Sking Pass Mill



1. Climp roll
2. Tension roll on entry side
3. Pay-off reel
4. Work roll
5. Tensiometer roll
6. Tension roll on delivery side
7. Belt wrapper
8. Tension reel
9. Back-up roll

The skin pass mill rolls a strip at room temperature by applying tension. But it differs from the cold mill for reducing the thickness of the strip in that the former does not use the rolling oil.

In the skin pass mill, tension is applied on the strip through friction between the tension roll and the strip, from the fact that when excessive tension is applied on the strip between the pay-off reel and tension reel there arises injuries in the surface of the strip caused by mutual friction between strips.

The roll surface is ground or polished, or for dull-finish short-blasted, in accordance with the requirements for the cold strip such as its workability and coatability, adhesivity of zinc plating, and shape and surface conditions for the tin plating.

Beside the above mentioned, there is an single stand 4-high mill which perform the functions of both the reversing mill and the skin pass mill, which is called the combination mill. As this mill can be constructed at a low expense, and is usable for rolling and skin passing it suits small-scale production, and in the case of the existence of a separate tandem mill and a separate skin pass mill, it can be used as their buffer.

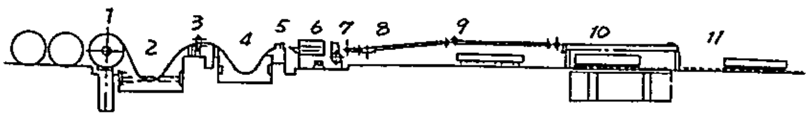
3.6 Shearing Equipment

The coil which was previously subjected to annealing and skin pass is delivered to shearing line or the slitting line. In the shear line the strip is trimmed of its edges to a specified width, cut to desired length, inspected of its surface, oil-coated and piled.

Also in the slitting line, coils are trimmed of their edges to a specified width, after which they are recoiled by a tension reel, packed and shipped.

It is also possible to recoil a coil in several coils by split-cutting in the width direction simultaneously with side trimming.

Fig. 9 Sheet Shear Line



1. Uncoiler
2. No.1 looping pit
3. Side trimmer
4. No.2 looping pit
5. Flying micro
6. Roller leveller
7. Flying shear
8. Inspection conveyer
9. Reject piler
10. Prime piler
11. Runout conveyer

The coil is uncoiled by an uncoiler, its edges are trimmed by the side trimmer to a specific width, then passes through a roller leveller to be corrected of its shape and is cut continually by a flying shear to a specific length. Sheared sheets receive a surface inspection on the inspection conveyer, through which prime sheets are piled in the prime piler, and rejected sheets in the reject piler. The thickness of the strip is continuously measured by the flying micro placed before the leveller. In the light gage shear line there is a pinhole detector to check holes on the sheets; if a pinhole on a sheet is discovered, a signal issues and the sheet is dropped in the reject piler. If necessary, specifications and other markings as well as oil-coating can be applied on the sheets in the line. When the prime sheets have been piled to a specific height, the prime piler is lowered and the sheets are transferred on to the conveyor, on which or at another suitable place they are packed and then shipped.

Annex 4. Proposed Establishment of a South-east Asian Steel Institute

(1) Objectives

Having inspected South-east Asia recently, we felt the need and desire to develop iron and steel industry in the area. We are aware that the development of this industry in the area concerned has many obstacles, lack of capital, weakness of domestic market, lack and disutilisation of trained personnel, lack of certain resources, and the lack of technological knowledge.

The last aspect could best be eliminated by the establishment of some institution with functions of collecting, disseminating and maintaining statistical data, exchange of informations and experiences within Asia and with other organizations and nations, and making joint researches. We think that it is the appropriate time to start some actions in regard to the establishment of this type of institution, which for convenience we call the South-east Asian Steel Institute.

The proposed institution is to concentrate its activities in scientific and technological aspects. Other efforts in eliminating disadvantageous factors in the growth of iron and steel industry in the concerned area should be accompanied with those of this Institute. Various supports from nations, organizations and individuals with different experiences, knowledge and sources are necessary.

We hope that the establishment of South-east Asian Steel Institute would initiate and encourage the determined and cooperative attitude of the area for development of the iron and steel industry and general development.

(2) Activities

The task of South-east Asian Steel Institute is to develop technology and technical know-how through cooperation of nations with limited resources and experiences in the field and with support of nations with already developed industry. The Institute should undertake the following activities to start with.

1) Joint research of iron and steel production techniques among Asian nations. . . . . . this would be useful to the development of the industry in the area which shares certain peculiarities together and which as well has a variety of conditions.

2) Exchange of various experiences on plant establishment and construction ..... In order to accelerate South-east Asia's efforts, experiences within the area and outside should be best utilized.

3) Collection, dissemination and maintenance of statistical data ..... Informations are foundation of rational planning and management, in any field.

4) Exchange of technical, scientific and other relating informations with similar organizations in the world, The Iron and Steel Institute of Japan, American Iron and Steel Institute, Institute Latino-americana del Fierro y Acero, Verein Deutscher Eisenhuettenleute, Iron and Steel Institute (British), for example.

5) Publication of a quarterly periodical concerned with various aspects pertaining to iron and steel industry of the area concerned.

6) Others.

a. On standardization and improvement of quality of steel and iron products.

b. On training personnel and selecting of advisors. For instance, the Iron and Steel Technical College with dormitory and other facilities is located in Osaka. It is possible to establish a training program there in cooperation with the college.

c. Planning of development program in regard to technical aspects and information.

d. As a councelling and advisory body.

(3) Organization

President	Board of Directors (one from each member nation and advisors from supporting nations)
Secretariat	
Executive Director	One
Staff	Three (initially)

(4) Location

Head Office can be either in Bangkok or Singapore considering various factors: communications, location of facilities related to activities of the proposed institution, location of offices of regional, inter-regional and international organizations, presence of business and commercial offices, for example.

(5) Members

There will be Sustaining Members, consisting of companies engaged in iron and steel production, research institutes, other organizations concerned with the steel industry and government concerned. There will be Individual Members.

Further it is desirable for the Institute to have some leading steel making countries which have fairly developed industry with a variety of technological, scientific, economic experiences which would be useful to the developing industry of other nations as Supporting Members.

(6) Finance

1) Expenditure

Table 1 below shows expected expenditures of the Institute considering its proposed activities and objectives. However, they are would-be expenditures when the Institute becomes fully in operation. We think that it would require $80,000.00 yearly.

Table 1.

Publications			$20,000.00
Meetings			3,000.00
Salary	(Executive Director	$12,000.00)	40,000.00
	(3 Clerks	18,000.00)	
	(Others	10,000.00)	
Rent of Head Office			6,000.00
Communications			3,000.00
Travel			5,000.00
Others			3,000.00
Total			$80,000.00

2) Income

Sources of income are firstly dues on Sustaining Members, secondly Individual Members who subscribe the Institute's publication, and thirdly financial support from leading steel making countries. More detailed explanations on this are given below.

A. Dues on Sustaining Members

Members' dues are often collected according to the amount of production in the institutes similar to the proposed one, ISIJ (The Iron and Steel Institute of Japan), VDEH (Verein Deutscher Eisenhuettenleute), and IISI (International Iron and Steel Institute), for example.

We think it is appropriate to have the same system in Southeast Asia Steel Institute.

0.5 cent per ton of the final finished product per member is the average amount of dues of other institutes. However, considering various factors of companies and governments of South-east Asia, we think 0.3 cent per ton is more realistic.

B. Individual Members

Considering the Institute's activities, we expect long-term subscribers to the periodicals published by the Institute. Rate of periodicals of other institutes are $10.50 per year for Journal of Metals (AIME) and $20.00 for Stahl und Eisen (VDEH). We think that the charge of $10.00 per year would be appropriate.

The expected income from this source and the first one would be as follows, although at present the number of Individual Members could hardly be estimated.

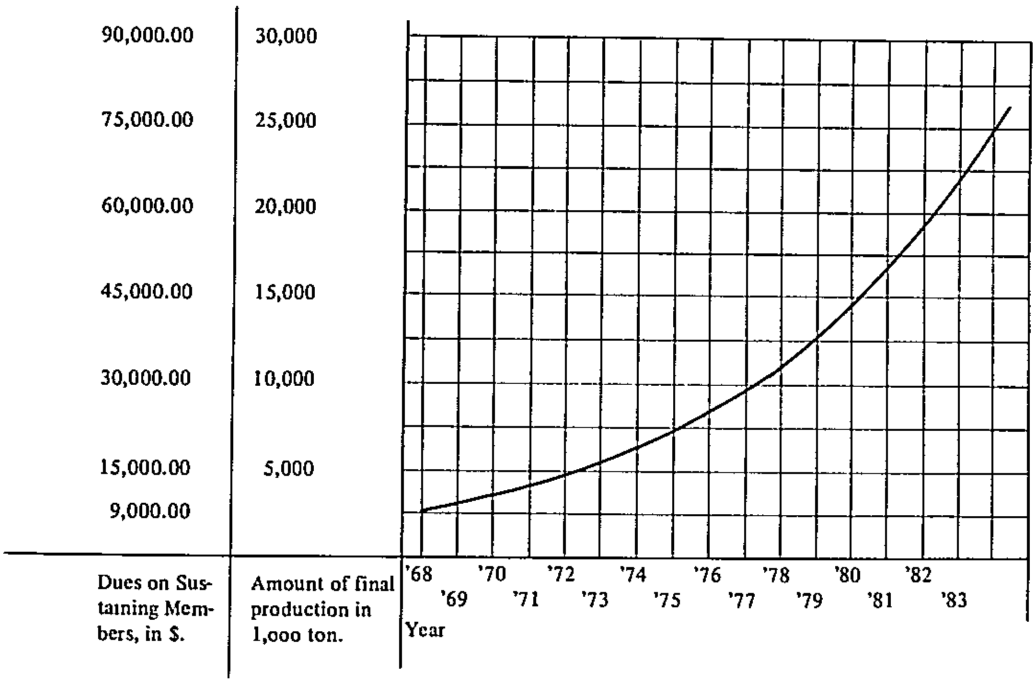
Sustaining Members	$9,000.00
The expected amount of final finished product is 3 million ton for 1968.	
Individual Members	3,000.00
If the number of subscribers were 300.	

3) Financial Contribution

As described above, the major income of the Institute would be from Sustaining Members. Considering future incomes of the Institute from the most optimistically estimated amount of production in 1968 and 1969; 2,863,000 ton and 3,321,000 ton respectively; the yearly growth rate is 15%. Even if this rate could be continuously maintained (the growth of production is shown in Diagram 1 below), it requires some 15 years before the income and expenditure may balance out.

However, 12 to 13% yearly growth may be the most we can expect. What is explained above suggests that for a long time to come the Institute would have to depend on external financial assistance.

Diagram 1 Growth in Amount of Final Production.



Since this blue-print is hardly expected to work out in the initial period of the Institute, activities would necessarily be limited in scale and scope. Activities below shows the plan for the Institute in its starting years.

Expenditure

Publications	$10,000.00
Meetings	2,000.00
Salary	10,000.00
Communication	2,000.00
Rent of Head Office	3,000.00
Travel	3,000.00
Others	2,000.00
Total	$32,000.00

Income

From Sustaining Members and very little from individual members.	$9,000.00

This indicates the shortage of $23,000.00 for which we should look for some other sources.

Role of other steel making nations is greatly appreciated in this aspect. Not merely technical assistance but also friendly financial assistance is indispensable for the Institute.

We hope that some nations with already developed iron and steel industry would contribute financially in the initial period of the Institute, or till the Institute's operations become self manageable by Southeast Asia.

Annex 5. Market Survey on Cambodia

General Economic Back Ground and Present Situation of Demand and Supply of Steel Products in Cambodia

Cambodia's GNP (Gross National Products) has for the past ten years continued at an annual growth rate of 6.6%. Of its industrial components, agriculture, wholesale and retail services, public administration and defence-related services constitute an overwhelmingly large portion, while the percentage of the manufacturing and construction industries related directly with demands for Steel Products is markedly small. Nevertheless the fact that the production growth in such industries is recently, though gradually, on an increasing tendency, is a hopeful sign to expect an increase in the future demands for iron and steel.

GNP & Population

Year (C.Y)	G N P (Billion riel)	Population (1000 person)
1953	13.5	...
1954	15.0	...
1955	14.7	...
1956	16.7	...
1957	17.8	...
1958	18.7	...
1959	20.6	...
1960	21.9	...
1961	22.0	5600
1962	23.1	5770
1963	25.5	5892
63/53 Annual Growth Rate	6.6	

Sources: UN ECAFE

INDUSTRIAL ORIGIN OF NET DOMESTIC PRODUCT

(billion riels)

Country, currency, and year CAMBODIA (a) (billion riels)	Total	Agriculture forestry fishing	Mining	Manufacturing	Construction	Transportation, communication, utilities	Wholesale and retail-trade	Ownership of dwellings (b)	Public administration and defence	Other services (b)
1959	21.0	9.0	0.1	1.8	1.0	1.0	4.5	...	2.5	1.1
1960	22.3	10.1	-	1.9	0.9	1.1	4.3	...	2.8	1.2
1961	22.5	10.0	0.1	1.9	0.9	1.0	4.5	...	2.9	1.2
1962	23.7	9.8	-	2.0	1.4	1.1	5.1	...	3.1	1.2
1963	25.5	10.5	0.1	2.2	1.5	1.2	5.4	...	3.3	1.3

Note: (a) Gross Domestic product at 1962 Market prices for data of 1959 – 1962 : and Current prices for 1963 estimates

(b) Ownership of Dwellings Included under "Other services"

INDUSTRIAL ORIGIN OF NET DOMESTIC PRODUCT (%)

Country, currency, and year	Total	Agriculture forestry fishing	Mining	Manufacturing	Construction	Transportation, communication, utilities	Wholesale and retail-trade	Ownership of dwellings (b)	Public administration and defence	Other services (b)
1959	100	42.9	0.005	0.09	0.05	0.05	21.4	...	11.9	0.05
1960	100	45.3	...	0.09	0.04	0.05	19.3	...	12.6	0.05
1961	100	44.4	0.004	0.08	0.04	0.04	20.0	...	12.9	0.05
1962	100	41.4	...	0.08	0.06	0.05	21.5	...	13.1	0.05
1963	100	41.2	0.004	0.09	0.06	0.05	21.2	...	12.9	0.05

Sources: UN ECAFE

Cambodia's imports of iron and steel from nine principal iron-steel-manufacturing countries amounted to 94,000 M.T in 1967, plus imports from Singapore, India and others, presumably gross-totaling 30,000 to 35,000 M.T. Of the import of iron and steel, the principal products were round bars and galvanized sheets totaling less than 10,000 ton per year, respectively.

It is surmised that Cambodia has not yet produced iron and steel, though unknown about their actuality. If such a state is taken into consideration, in Cambodia, even if the increase of demands for iron and steel grows to reach someday the extent to neet her own iron and steel plant, she will still have to depend on imports until its materialization.

Nowadays, however, the scale of any such plant has become so large that its production is too great for Cambodia to meet her own demands alone. When to have a plant to neet her own need, therefore, Cambodia should previously make agreements with neighboring nations about the disposition of the surplus products of the plant. If such a measure is possible, that country has good environmental conditions to construct a plant at an early date. In any way, as to the prospect for a steel industry in Cambodia, further investigations are necessary before finding a way to develop it in that country.

The import quantities of iron and steel in Cambodia

(1,000 M/T)

Year	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967
Pig Iron	0.1							–		
Ferro-Alloy		0.1	–		–	–	–	0.1	–	
Steel ingot & semi-finished product		–								
Wire rods	1.4	2.0	2.0	1.6	4.7	4.8	0.5	1.0	8.3	4.4

Year	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967
Steel bars	5.3	2.7	4.4	2.9	6.7	4.4	1.2	1.5	2.0	1.6
Bright steel bars	–	–	0.2	0.1	6.1	0.2	0.1	0.4	0.4	0.6
Steel shapes	0.7	0.4	0.4	0.5	0.2	0.6	0.4	0.3	1.1	0.5
Sheet piling								0.1		
Steel plates	1.0	0.2	0.3	0.5	0.3	0.1	0.1	0.6	0.3	1.3
Steel sheets	0.3	0.3	0.1	0.1	0.1	0.1	0.3	0.4	–	–
Electric steel sheet									–	–
Cold rolled steel sheet & plate	–	0.1	0.1	0.2	0.1	0.3	2.6	2.6	0.9	1.7
Tin plate	–	0.5	1.1	0.4	0.7	1.5	1.0	1.5	2.5	1.6
Galvanized steel sheet	1.8	3.5	4.0	4.3	7.2	8.0	3.2	5.2	2.3	6.8
Other coated steel plate & sheets	–	–	0.1				–			–
Hot rolled hoop & strip	–	–	–	–					–	–
Cold rolled hoop & strip	–	–	–	–	–	–	0.1	0.1	0.2	0.1
Other coated steel hoop & strip	–	–	0.3	–	–	–				
Rails and accessories		0.1	0.3	0.2	0.2	–	–	–	0.6	–
Wheel, axles, types		–								
Cast iron pipe & accessories	3.4	3.0	4.5	3.7	1.7	0.6	0.7	–	0.3	0.2
Steel pipe & accessories	1.1	0.7	1.1	1.4	2.1	1.0	0.2	2.5	1.5	1.7
Steel casting						–				
Steel forgings										
Iron & steel wire	0.3	0.2	0.7	2.1	4.4	2.8	1.6	2.7	3.8	1.9
Galvanized steel wire	0.2	0.5	0.3	1.1	4.8	0.4	0.7	1.9	1.0	1.0
Other iron & steel		0.1		–		–	–	–	0.2	–
Barbed wire	0.1	0.2	–	0.2	–					–
Steel wire rope & stand wire	–	–	–	–	–	–	–	0.2	–	–
Steel wire nails	1.0	0.6	0.6	0.4	0.1	–	–	–	0.1	0.2
Other nails	–	0.1	0.2	–	–	–	–	–		
Wire netting	0.1	0.1	–	0.1	–	–	–	–	–	–
Metal lath	–	–	–			–		–		
Heated screw	0.6	0.2	0.3	0.1	0.7	0.4	–	0.1	0.7	0.2
High-carbon steel and alloy steel coil for re-rolling				0.1	–	0.1	–	0.1		
Total	17.4	15.6	21.0	20.0	30.1	25.3	12.7	21.3	26.2	23.8

Note: Gross of imports from the EEC, U.S., U.K. and Japan. In addition, plug imports of round bars from Singapore and other countries; Gross total is presumed to have been in the order of 30,000 – 35,000 tons in 1967.

Source: Data from JISF (Japan Iron & Steel Federation).