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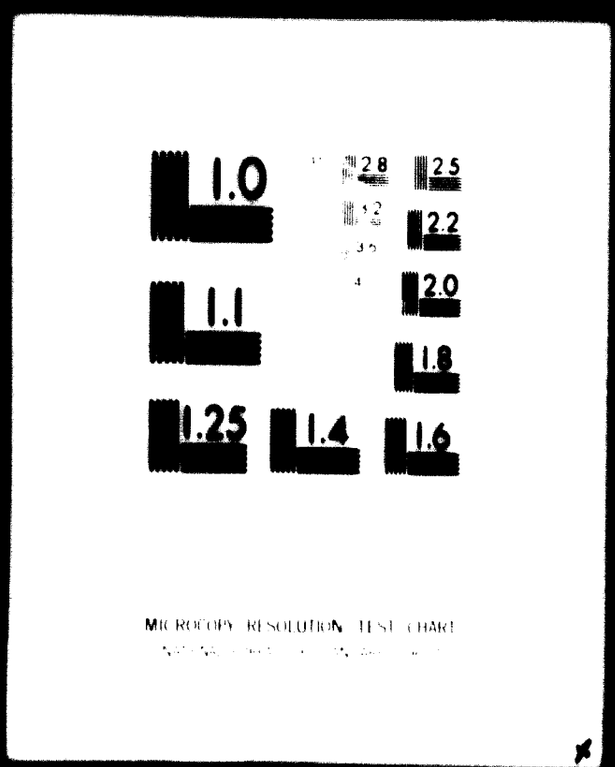

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THE IRON AND STEEL INDUSTRY OF DEVELOPING COUNTRIES OF LATIN AMERICA, AFRICA, THE MIDDLE EAST, AND ASIA

prepared by

The Central Research Institute of Information and Technical and Economic Investigations of the Iron and Steel Industry

under

the Ministry of the Iron and Steel Industry
of the Union of Soviet Socialist Republics

(M. Kuleshov, Director of the Institute)

Moscow, 1969

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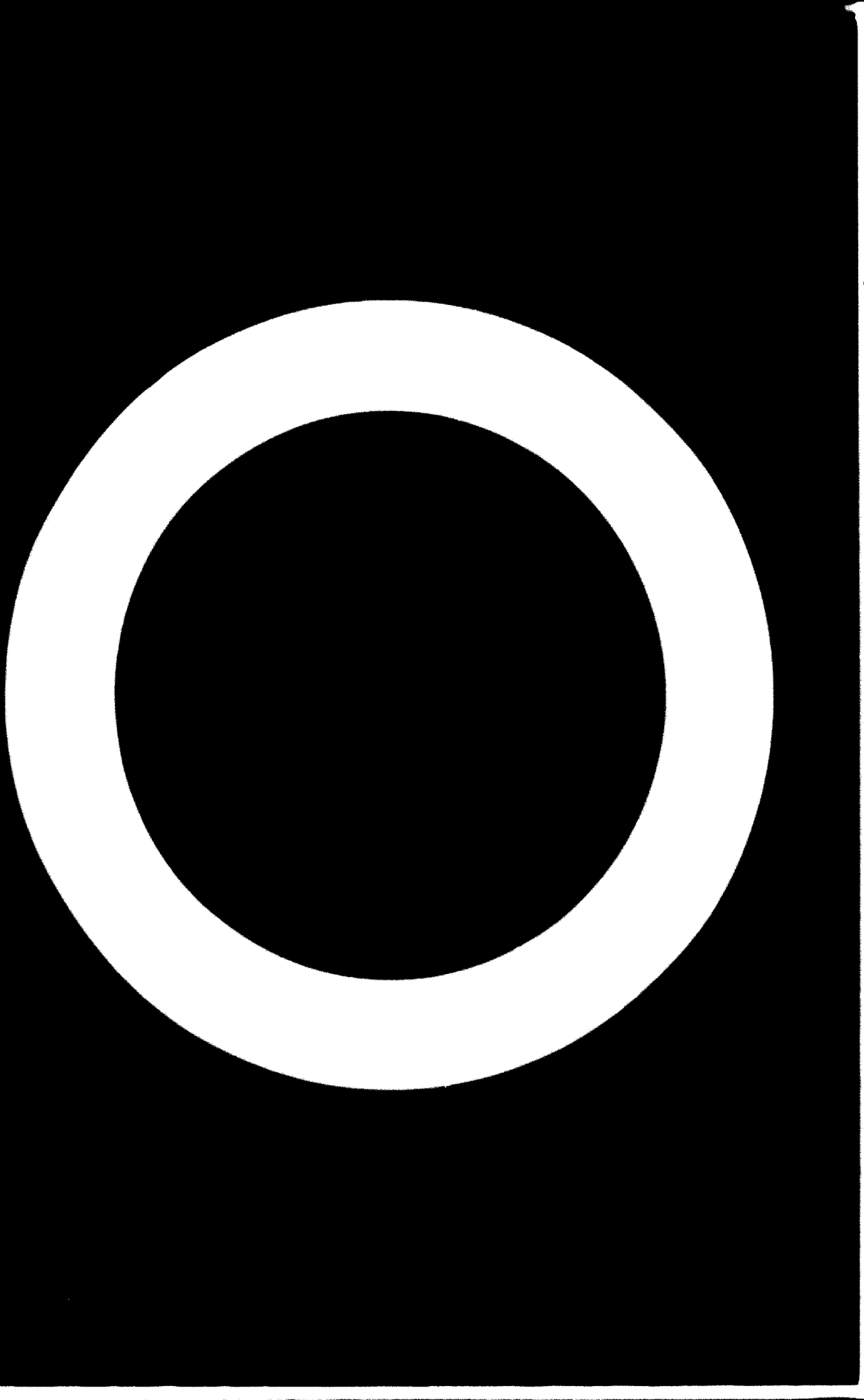

F O R E W O R

The survey "Iron and Steel Industry of the Developing Countries of Latin America, Africa, the Middle East and Asia" has been prepared by the Central Research Institute of Information and Technical and Economic Investigations of the Iron and Steel Industry under the Ministry of the Iron and Steel Industry of the Union of Soviet Socialist Republics as per a contract concluded with the United Nations Industrial Development Organization (UNIDO).

The survey discusses the development of the iron and steel industry in Latin America, the Middle East, Africa and Asia for the period from 1955 to 1967, and contains forecasts for the near future. Published information available in the Soviet Union, materials of the United Nations, shorthand records of reports made at the Second Symposium held in Moscow (September-October 1968), as well as other documents furnished by the UNIDO to the Institute were used in preparing the survey.

The survey is composed of the following parts:

1. General characteristics of the iron and steel industry of developing countries (Chapter 1);
2. Technical progress in the iron and steel industry (Chapter 2);
3. The iron and steel industry of separate countries according to continents and regions (Chapters 3-4).

4. Foreign trade and consumption of ferrous metals in the developing countries of Latin America, Africa, the Middle East and Asia (Chapter 7); and

5. Conclusions.

The more detailed discussion on the iron and steel industry of the separate countries in Chapters 3 through 6 is arranged generally in the following sequence: raw materials, production of ferrous metals, iron and steel works, consumption of ferrous metals, and imports-exports of ferrous metals.

Inadequacies of information on a number of questions along with inconsistencies in some of the available data created difficulties in making the survey. Such paucity of information is particularly true of the tabular data presented, resulting in some cases in incomplete columns in some of the tables.

Finally, the sketchy amount of information made for an inadequate description of the present development of ferrous metallurgy in many of the countries, and in some instances, for description of the industry not necessarily commensurate with the importance of the respective country.

CHAPTER 1

GENERAL CHARACTERISTIC OF IRON AND STEEL INDUSTRY OF DEVELOPING COUNTRIES

Many developing countries of Africa, Asia and Latin America started their industrialization programmes after 1955.

From 1958 to 1965 industrial production of developing countries increased by 75 per cent, while the output of their process industries increased by 67 per cent. New branches of industry have been started in a number of countries beginning to develop domestic production of capital goods. Output of ferrous metals has substantially increased. Large fully integrated iron and steel plants have been constructed in India (four plants), in the United Arab Republic (a plant in Helwan), in Tunisia (a plant in Menzel-Bourguiba), in Brazil (two plants), in Venezuela (a plant in Metansas), in Argentina (a plant in San Nicolas) and in Malaysia (a plant in Prai). Many small non-integrated steel plants have also been constructed. Production of quality steels has been started. In Iran the construction of an initial works for the production of large diameter steel pipes has been completed. In the decade (1957-1967) the output of steel in developing countries has increased from 5.1 million tons to 18.7 million tons (1), while their

share in the world production (excluding the United Soviet Republic and other centrally planned economies) increased from 2.0 to 5.3 per cent.

Many countries have expressed great interest in the development of a domestic iron and steel industry, considering this as the basis for many-sided development of the national economy as a whole.

A considerable portion of the capital spent on the construction of iron and steel plants has been obtained through foreign loans and credits to the developing countries. These funds were used for costs of preliminary operations and for services of foreign experts, for buying machines and equipment, and for covering expenses in training local technical personnel and skilled labour.

In many developing countries, it is the State that plays the principal role in creating the iron and steel industry. The state budget carries the main burden of expenses required for constructing plants, buying machines and equipment, while the firms participating in the construction operations are given various financial, tax, and transport exemptions and privileges. The iron and steel plants of a number of the developing countries are therefore completely or partially state-owned, also because private companies prefer to invest their capital in less expensive enterprises and in those branches of industry which are likely to ensure a profit in a shorter time.

In spite of relatively high rates of industrial growth in developing countries, the significant difference in production levels per capita between developing and developed countries has not been substantially reduced during the last decade. Total industrial production per capita in some developing countries is as little as 5 per cent of that of developed countries, and in the process industries, this percentage is even lower (2). For example, the apparent consumption of ferrous metals per capita in the developing countries is only 4 to 5 per cent that of the advanced countries (3), and the consumption of high-alloy metals is even lower relatively.

The 112 countries classed by the United Nations as "developing" differ markedly as to population, area and economic development. There are 65 countries with populations under 5 million, and an additional 26 with populations under 15 million. By contrast, the population of India is 523 million (the world's largest after the 732 million of mainland China) and that of Brazil is 88 million.

Brazil has a territory of 8.5 million sq. km; India, 3.3 million sq. km; Argentina, 2.8 million sq. km; whereas Rwanda has a territory of only 26,300 sq. km; Lebanon, 10,400 sq. km. Western Samoa has a territory of 2,800 sq. km, and the Maldive Islands only 300 sq. km.

Only a small number of developing countries have major iron and steel industry plants. These are: Algeria, Argen-

tina, Chile, Columbia, India, Mexico, the United Arab Republic and Venezuela. Most of these countries have ample natural resources and in most cases an advanced mining industry.

In the decade 1958-1967 Argentina increased its output of steel from 200,000 to 1,300,000 tons; Brazil, from 1,300,000 to 3,700,000 tons; Mexico, from 700,000 to 3,000,000 tons; Venezuela, from 20,000 to 700,000 tons; India, from 1,700,000 to 6,600,000 tons. These five countries increased their total output of steel by 11 million tons accounting for over 80 per cent of the total increase of 13.6 million tons for all developing countries in the decade.

In addition to this small group of countries with substantial iron and steel operations, there are about 30 countries possessing small semi-integrated and non-integrated steel plants. These include Burma, Ethiopia, Ghana, Guatemala, Morocco, Pakistan, Philippines, Thailand, Uruguay and some 30 others.

Three types of plants exist in these countries:

Non-integrated plants with rolling mills processing imported semi-finished products;

semi-integrated plants using scrap in electric steelmaking shops and having finished mills; and

steel-processing plants for manufacturing galvanised sheet or pipe of imported flat-rolled steel.

The plants processing imported blooms and billets and the

plants based on electric steelmaking are usually engaged in manufacturing reinforcing bars and wire rod although some also manufacture pipes.

Some of the difficulties in industrialisation of developing countries are: limited capital (especially of the foreign currency required for buying equipment, patents, and the services of expert personnel); limited opportunties for balanced development of all phases of the national economy; low rate of metal usage resulting in incomplete utilisation of the productive capacities of a fledgling industry; and shortage of trained domestic personnel in both management and labour.

For most developing countries, national income is not sufficient to support the growth of small manufacturing enterprises needed for balanced industrial development. Annual gross national product in nearly half of the developing countries is less than $1 billion each. This is clearly insufficient to raise the capital of $300 to $600 million required for the construction of an integrated iron and steel plant of just 1 to 2 million tons annual capacity (3). To further illustrate the capital problem, in 1965 United Nations estimates of average annual per capita income in developing countries was $142 as compared with $1,700 in nations with developed economies (1965,2).

Even in the more industrialised developing countries limited internal markets and lack of competitiveness of

domestic products in these internal markets as compared to imported products from advanced countries result in a further decrease in the efficiency of large-size enterprises with their high-volume production capabilities. In India, for example, according to data of the Central Statistical Bureau of that country, industrial capacity is only 75 per cent utilized; in some branches of industry not more than 35 per cent is utilized. In countries with less advanced iron and steel industry it has been stated that most metallurgical plants are being utilised at only 40 to 50 per cent of their capacity (7).

Economic co-operation between developing countries is one of the preconditions ensuring efficient industrialisation. Because they are short of finances, technical experience and high-skilled personnel, many developing countries face difficulties in enlarging their national economy independent of each other, particularly since they are also competing with the large industrialized states. Hence the tendency to industrial integration is of vital interest for many developing countires. Inter-nation industrial cooperation based on specialization and division of labour would allow higher production levels in high capacity facilities. This concept offers considerable scope for creating industries, which would otherwise prove to be economically inefficient in the limits of a single national market. Enlarging the scale of industrial production, due to such an expansion of the market, in turn, contributes to a decrease in costs and an increase in profitability.

There are a number of trade-and-economic groupings of developing countries, which have already been engaged in creating joint "integrated" industrial enterprises. The necessary market for the products of such enterprises is hoped to be created through long-term trade agreements or through creating "common markets" for their output. "Integrated" organizations of this kind are being established in the scope of common markets of countries of Central America, Latin-American Association of free trade East African common market, Organization for Regional Cooperation of Turkey, Pakistar and Iran, and other similar groupings.

In the post World War II years many industrially developed countries aided developing countries in constructing iron and steel plants. The Soviet Union, since 1955, has been giving technical assistance in designing and constructing plants and units of the iron and steel industry, and at present has agreements with eight developing countries, namely: Algeria, Afghanistan, India, Iran, Iraq, the United Arab Republic, Turkey and Ceylon. To date, 15 such projects of total annual capacity (in thousand tons) have been undertaken in these countries: ore mining - 13,400; production of sinter - 11,900; production of coke - 7,200; iron making - 9,100; steel making - 9,500; and rolled products - 8,300. As of 1/1/68, somewhat more than 25 per cent of these tonnages had been commissioned (4). Credits granted by the Soviet Union have been at an interest rate of 2.5 per cent, with repayment over a 12-15 year period (4).

In India, the Soviet Union has rendered assistance in constructing Hindustan Steel Ltd!s Bhilai Works with a present capacity of 2.5 million tons of steel. In the United Arab Republic, the Helwan Iron and Steel Works is being enlarged with assistance of the Soviet Union and other socialist countries. The first stage of the works was commissioned in 1958 as a joint United Arab Republic-Demag (Federal Republic of Germany) venture. The Helwan complex comprises a number of enterprises including an iron and steel works, coke oven and by-product plant, a sintering plant, a forge works, and a plant for manufacturing electrically welded chains. Increasing the annual capacity of the Helwan works to 1,500,000 tons of steel by the mid 70s will create a strong iron and steel industry base for the United Arab Republic (5).

In 1965, at Agra (India, Uttar Pradesh state) there was commissioned a wire-rod mill, constructed with the assistance of Poland under contract with Prakesh Engineering Company and Rolling Mills (6). Poland also concluded in 1966 a contract for building a semi-integrated works with steelmaking shops in Kham (Syria), the annual capacity of which amounts to 75,000 tons of reinforcing bars and castings (7).

In 1966, Czechoslovakia and Iran entered into an agreement for engineering and constructing a metallurgical and machine-building combine in Tebriz. Czechoslovakia will furnish the complete plants and equipment for this combine

on the basis of an agreement concluded with Iran earlier (8). Measures are planned for further expansion in cooperation between Yugoslavia and Iran in prospecting and exploiting oil fields, as well as in developing a mining industry (9).

The United States, the Federal Republic of Germany, Great Britain, France, and Japan also invest considerable capital in the national economy of developing countries. The United States has greatly assisted in the development of the iron and steel industry in Latin American countries. Brazil's largest iron and steel works, the Cia Siderurgica Nacional at Volta Redonda was constructed with the financial and technical assistance of the United States. Almost all the large iron and steel works in Latin American countries were granted credits for construction. Recently, the Export-Import Bank of the United States approved a loan to the Argentina Company of SOMISA ($33,700,000) for enlarging the iron and steel works in San Nicolas; a loan to the Brasilian company of Vale do Rio Doce ($17,700,000) for expanding iron ore mining capacities; a loan of $36,000,000 for enlarging the iron and steel works at Volta Redonda; a loan of $50,000,000 for increasing the ore mining capacity of the Orinoco Mining Company in Venezuela, etc. Altogether, the Export-Import Bank to date has assisted in financing iron and steel works in excess of $3 billion dollars with direct capital loans, export credits, and financial guarantees.

Recently, Japan has also started to invest its capital in the development of the iron and steel industry of Latin American countries. Japanese companies have participated in the construction of an iron and steel works of the Brazilian company USIMINAS in Ipatinga, with 40 per cent of the stock being owned by Japan. The Japanese company Nippon Kokan has granted to USIMINAS a credit of $24,000,000 for the purpose of expanding the annual capacity of this works from 600,000 to 1,400,000 tons of steel, which should be reached in 1972. Moreover, Japanese companies participate in the development of the iron and steel industry of Chile and Colombia and have installed rolling facilities in some countries of Central America.

Companies of the Federal Republic of Germany also invest capital in the iron and steel industry of the developing countries, some becoming co-owners of the constructed works. In Colombia an iron and steel works will soon be commissioned, which is being built with the financial and technical assistance of the Federal Republic of Germany. By 1970 Demag will furnish to Mexican company Altos Hornos equipment for constructing a blast furnace operating with high top pressure, and the equipment for constructing the first oxygen converter shop in Mexico with annual capacity of 500,000 tons of steel. All the equipment will be installed at the works in Monclova. Two banks of the Federal Republic of Germany finance the supply of the equipment.

The French Societe Anonyme Fives-Lille-Cail will furnish the equipment for constructing an oxygen converter shop for the Cia. Acero del Pacifico (Chile), which will be financed by the Banque de Paris et Pays-Bas.

Extensive assistance to the developing countries of Africa and Asia in constructing iron and steel works has been given by Western countries and Japan, in addition to that previously mentioned from the Soviet Union.

The growth of domestic steel production in some developing countries because of assistance given them by industrially developed countries, will be greater than the growth of their metal demand. As a result, in the near future demand for ferrous metals in some developing countries will be substantially met by their domestic production. This is true, for example, of Brazil, Chile and Mexico in Latin America, the United Arab Republic in Africa and India in Asia.

REFERENCES

1. Stahl and Eisen, 1969, No. 9, S. 504.

2. World Economy and International Relations", Moscow, 1967, No. 4, p. 110, 118, 119.

3. Annales des mines, 1969, No. 6, p. 24, 33.

4. "Technical Assistance of the Soviet Union in Establishment and Progress of Ferrous Metallurgy in Developing Countries; its Main Principles and Arrangement, Long-Term Credits and their Payment. The Second United Nations Inter-Regional Symposium on the Iron and Steel Industry", Reported by M.I. Syrjakov, Moscow, 1968, October.

5. BIKI, 1968, No. 82.

6. "Zycie Warshawy", 1965, April 9.

7. Mining Journal, 1966, vol. 267, No. 6850, p. 423.

8. "Privda", 1966, March 24.

9. BIKI, 1968, No. 74.

CHAPTER 2

TECHNICAL PROGRESS IN THE IRON AND STEEL INDUSTRY

Major progress in technology and equipment of the mining and metallurgical industries occurs mainly at enterprises of high capacity usually located in developed countries. Small iron and steel works of the type found in developing countries as a rule are non-integrated. They are also operated in all developed countries and some worthwhile types of technical progress also occur in these works.

The following description of technical developments in both large and small enterprises of different countries may be useful for iron and steel industry personnel of developing countries in Asia, Africa, and Latin America both for those already having an iron and steel industry and for those planning one.

A. FERROUS METAL ORE MINING

The wide introduction of open pit mining of ore deposits wherever geological conditions permit is a principal trend in the mining industry in the last two decades. This practice compared to underground mining results in lower material and labour costs, better labour conditions and more rapid increase of mining production. World-wide open pit mining

results in labour productivity two to three times higher and cost of mining per ton of useful minerals one-third to one-half that of underground mines. Open pit mining of iron ore has become the major method during the last 15-20 years in all countries of the world and continues to rise. Underground mining of ferrous ores is used mainly to work deep-lying natural ores.

The trend to using powerful and high productive equipment has existed in open pit mining for a long time. In the open pit mining of ferrous ores without blasting, diesel tractors of 200 to 400 HP, equipped with several rippers as well as self-propelled scrapers, power shovels with three to six cu. m. buckets and 35 to 60 ton dump trucks are widely used. Diesel equipment is used in open pit mining especially during development and the initial years when the extent and grades of haulage roads are still inadequate. Walking draglines with a range of bucket capacity up to 25 cu. m. having booms up to 100 m. long are used in stripping when the overburden is of considerable thickness and soft or unconsolidated. Continuous stripping complexes (a bucket-wheel excavator, a conveyor system of a considerable length and a self-propelled stacker) are used to mine friable burden. Their output ranges from 1,000 to 11,000 tons per hour. When open pit equipment is electrified the working of rocky ores and wastes is carried out employing cyclical or continuous-cyclical methods of drilling and blasting. Percussion drills with compressed air supplied by the port-

able diesel rotary vane compressors are widely used in small open pit mines. Self-propelled rotary rigs are employed to drill blastholes with a diameter up to 320 mm and up to 40 m. deep in rocky ores and burden. Self-propelled jet piercing drills are used in drilling ores and burden with high SiO_2-content. These drills permit widening the holes up to 600 mm in diameter in any part of the blastholes. Self-propelled loading trucks are used to charge blastholes with mixture of granular ammonium nitrate-fuel oil or with water-bearing explosives.

A progressive technique of iron ore breaking used in the Soviet Union is: A delay-action blasting of a great number of charges carried out simultaneously on two or three benches in "squeesed space" (where the fragmented rock broken by the previous blast has not been yet hauled). Up to two million cu. m. of well fragmented rock may be broken by one blast. In the cyclical method of rocky ore and waste mining a number of shovels with a range of 6 to 12 cu. m. bucket capacity are used as well as different haulage equipment, viz. electric (DC or AC) or diesel-electric locomotives up to 150 ton weight and dump cars having capacities up to 100 ton. In the Soviet Union dump cars with a capacity of up to 180 ton have been developed. In the United States haulage trucks of 200 ton capacity are used.

Combined transport systems is a characteristic feature of the continuous-cyclical method of surface mining. The

most widely used kind of transport in developing countries is a combined truck-and-belt conveyor system. The continuous-cyclical technology is effectively used in iron ore open pit mines of India, Liberia, and Peru. The transport schedule of these mines includes: blasted ore loading by shovels into haulage trucks, ore hauling by trucks to a fixed screen installed at the charging end of belt conveyor system, ore hoisting from the open pit and hauling by belt conveyors to a concentrating plant or to a storage (hopper) in a harbour or at a rail terminal.

The Barsua Mine (India) at an annual output of 3 million tons employs ore loading by three cu.m. shovels in 34-ton diesel trucks then hauling to the charging hopper of a belt conveyor system more than two km. long. The daily output of this system hauling ore to the rail terminal is 6,500 to 7,000 tons. The conveyor system slopes in the direction of the railhead and operates with electric power recuperation, feeding into the power network up to 600kWh per day (1). The Nimba Mine (Liberia) with an annual production of 7 million tons employs three to five cu. m. shovels and 30-ton dump trucks. Ore hauling to the crusher plant is by truck and from it to the rail terminal by a conveyor system more than 3 km. long. The average angle of belt incline is 18°, and the conveyor system recuperates up to 200 kWh per day (2).

Some of the most powerful and high productive mining handling equipment is used in the Marcona Mine (Peru).

Annual output of this mine is upwards of ten million tons per year. The continuous-cyclical method of mining is also used in this mine. Broken ore is loaded at the face by 7.6 cu. m. shovels into 100 ton trucks. The conveyor system is of great length (about 14 km.) and has a capacity of 12 million tons per year. A considerable part of this system is inclined and it also recuperates energy when hauling ore (3-4).

In recent years a variation of the continuous-cyclical method with traveling screen and crusher (in a number of cases crushers are self-propelled) has been employed in open pit mines. This practice practially eliminates the need for trucks resulting in considerable cost savings.

When designing open pit mines special consideration has to be given to the layout of ore storage. Separate stock-piling for different grades or ore is necessary so that shipping merchantable ore with controlled analyses is possible and at high production rates. Ore storage is of: 1) open type ground storage with the ore stockpiled by reversible belt stackers and ore reclaiming by bucket-wheel excavators and 2) bin storage with the ore loaded into bins by reversible belt stackers and with ore reclaiming by belt conveyors running under the bins.

B. IRON ORE BENEFICATION

The tremendous world-wide growth of iron and steel in-

dustry in recent decades has resulted in steady growth of iron ore beneficiation. Comparatively little iron ore is used in the natural state, since high production blast furnaces now demand extremely uniform ore feed, both as to sizing and chemical analysis. Also, during the coming decade, the use of highly metallized ores as direct feed to electric arc furnaces will become more and more widely practiced. Finally, from the standpoint of the many developing countries which are suppliers of iron ore, the more work that can be done on the ores in their countries, the greater the industrialization advantage for the country.

A major advantage of such beneficiation is to extend the raw material resources of the iron and steel industry. Beneficiation processes have been developed or improved for producing high-grade concentrates containing over 65 per cent Fe, even from low grade ores. Rich ore fines are a good resource for pellets. Pelletizing plants using high-grade concentrates from lwo-grade ores are also in operation in several countries including Brazil and Liberia. It should be noted, however, that high-grade ores such as magnetite, martite, and hematite ores (those containing 50-55 per cent iron) as well as siderite and limonite ores with up to 50 per cent Fe are still being used in blast-furnace burden without treating.

In the production of high-grade concentrates from low-grade ores, various high-efficient processes have been developed and are in operation. Ores mostly used for this

purpose are magnetite quartzites, beneficated through magnetic flowsheets which provide for 64-66 per cent Fe concentrates. Magnetic separators (types IIbM-4 and C3-209) have been designed in the Soviet Union with efficiencies of recovery of 97-98 per cent magnetic mineral from ores. Some multistage and combined benefication flowsheets involving ore and ore pebble grinding make it possible to produce 66-71 per cent Fe concentrates from magnetite quartzites. With flotation it is possible to increase Fe contents in the concentrates by 5-6 per cent. At the large Erie Mining complex in the United States 0.1 mm vibrating slit screens are utilized for gravity concentration, resulting in a silica content decrease of more than 2 per cent absolute (5).

To beneficate oxidized ferrous quartzites reduction-roasting process followed by magnetic separation can be successfully used. At the Krivoi Rog Central Mining and Ore Concentration Complex, oxidized ferrous quartzites containing 32 to 34 per cent iron are treated in kilns. Concentrates containing 62 per cent Fe are produced by the process which includes three stages of roasted ore grinding and four stages of magnetic separation. Coarse disseminated hematite-quartzites are beneficated in spiral separators (Canada, the United States). Combined gravity-flotation and magnetic-gravity-flotation methods of benefication of oxidized ferriferrous quartzites have been developed in recent years in the Soviet Union. The first method is

carried out on spiral separators, the second one on polygradient separators with high-intense magnetic field. Both methods yield 63 per cent Fe concentrates with iron recoveries over 83 per cent. Mixed hematite-magnetite quartsites are successfully beneficated at Liberia's Bong-Range mining complex. The flowsheet includes autogenous ore grinding, spiral screen separation and spiral screen tails benefication in permanent magnet separators. The process results in concentrate containing 65.5 per cent Fe and 6 to 7 per cent SiO_2 from ores of 38 per cent Fe and 40 per cent SiO_2 (6). Low grade magnetite iron ores combined in basic rock are treated according to simple magnetic flowsheets at sizing of 90 per cent passing 0.074 mm screen. For either valuable or detrimental impurities in these ores optimal benefication should provide for recovery or removal as desired, at the same time securing a natural basicity of the beneficated ores.

In the Soviet Union hematite-martite ores containing 45 to 57 per cent Fe are beneficiated by polygradient separators with high-intensity magnetic field. Variations of this separator design are used in the United States and in Australia. High grade hematite ores are processed according to gravity flowsheets, including gravity suspension, spiral screen and jig separating. At the Marcona Mining benefication plant in Peru in processing both high-grade and impoverished hematite and pyritiferrous ores, a more complex flowsheet is utilized with magnetic separators,

spiral screens, jigging machines and gravity suspension separation. The Marcona flowsheet permits benefication of ore of all grades into concentrates with 60 to 67 per cent Fe. Most grades of iron ore found in developing countries can be treated in accordance with one or more of these successful flowsheets.

C. COKE PRODUCTION

Recent developments in coke and by-product production have been in the construction of coke ovens of a high capacity with volumes of 30 cu.m. and more Underjet-fired, side-fired and combine-fired (both rich and poor gas) coke ovens of high capacity are in operation in all developed countries.

Soviet coke-oven batteries have a high level of mechanization and automation of operation (charging, handling of doors, as well as of vertical channels and gas collectors, discharging and quenching coke and so on). They also are installed with systems for smokeless charging of coal and for hydraulic operation giving increased oven life. The output of one such large-oven battery amounts to 830,000 ton per year (8). Two batteries with the world's largest ovens (volume per oven 39.6 cu. m.) have been constructed recently at the Mizushima Works of Kawasaki Steel Corporation, Japan, according to the designs of the Carl Still Co., (Federal Republic of Germany) (9).

When developing countries have sufficient reserves of coking coals and, for regional cooperative enterprises, even on the basis of imported coals, it seems expedient to construct such coke oven batteries of high productivity with ovens of high capacity. Coke ovens of medium capacity and with chemical by-product plants can also be installed. Such coke and by-product plants have been built with the technical assistance of the Soviet Union in India (works in Bhilai and in Bokaro), in Iran (works in Isfahan) and in other countries. Similarly, coke and by-product plants have been installed in Mexico, India, Brazil and other countries with the technical assistance of Federal Republic of Germany (C. Otto Co.), the United States (Koppers Co.) and others. The coke by-product plants make it possible for developing countries to produce fertilizers (ammonium sulfate, diammonium phosphate, ammoniac water), raw materials for the development of a domestic chemical industry (bensol, naphtalene, phenol and others) and gas for industry and utilities.

Methods of coal benefication in heavy media and selective grinding, drying and preheating of coals have been developed for the better utilisation of coking coal reserves. This allows local poor-coking and non-coking coals to be introduced in the coking charge and thus import of coking coals to be decreased. The method of selective grinding of coals depending on their petrographic analysis is used successfully both in developed and in developing countries too

(India, Algeria) (10, 11). Drying and preheating of coals are used on industrial scale at some plants (12-14). Such methods of coal preparation for coking permit coke oven productivity to be increased and sometimes coke quality to be improved as well.

The process of the continuous production of coke from poor-coking coals by means of formed or briquetted coke has been developed in some countries. The choice of the production method depends on the quality of the available coals and on the requirements of coke users. Two methods for the production of blast furnace coke are available: the Soviet method of producing formed coke, consisting in rapid heating of coal to the plastic temperature, forming, and then coking the formed coal; and the American method of preheating the coal, semicoking it in a fluidized bed, briquetting of the semicoke with a binder and coking of the semicoke-briquette.

Experimental smelting of iron in the blast furnace has been done with coke produced for smelting of ferroalloys, phosphor, and carbides (usually petroleum coke). Production of formed coke from brown coal for mixing with normal coke in low shaft blast furnaces has been done in the German Democratic Republic. Output of the plant calculated on the coal charge, is 2.3 million tons per year. The process consists of briquetting the brown coal and drying and coking the briquettes in retort-ovens. A process for production of formed coke from high Btu coals is for foundry use is

widely used in Poland. Formed coke (not for the blast furnace operation) is produced from anthracite with the addition of 10 per cent of coking coal in Canada, the Federal Republic of Germany, Morocco, Peru, and Venezuela. In summary, developed technology of coal preparation and coking makes it possible to use nearly any type of coal in the iron and steel industry at greater or lesser cost depending on local conditions.

D. IRONMAKING

Blast Furnace Ironmaking

Throughout the world the blast furnace process has been characterised by continuous increase of the blast furnace volume both in new and rebuilt furnaces, by the improvement of ore preparation for blast furnace feed, the introduction of various other measures directed to the increase of the blast furnace output and reduction of coke consumption and mechanisation and automatic control of the operation.

In recent years large blast furnaces have been built in developing countries as well as in the developed ones. Furnaces with hearth diameter of between eight and nine meters were built in some Latin American countries, Turkey and India. Furnaces with useful volume of 1719 cu.m. have been constructed in India (15). Blast furnace burdens now include high-strength fluxed sinter, pellets and crushed and screened lump ore. For homogeneous chemical analysis

of the burden ore components are subjected to careful blending. Blending stockyards equipped with high-efficiency stackers and reclaimers have been built at both iron and steel works and at mining enterprises.

High capacity sintering machines with the sintering area up to 312 sq. m. are operated in developed countries, the Soviet Union, and Japan. In the developing countries such large sintering machines are not in widespread use. Sintering machines with effective area more than 100 sq. m. operate as part of integrated steel works in India and Mexico.

Iron ore pelletizing plants with a total combined capacity of nearly 90 million tons are in operation throughout the world, with more than half in the United States. Conveyor type roasting machines are widely used for pellet hardening, and such machines with useful area up to 350-400 sq. m. are in operation at enterprises in Liberia, the Netherlands and Australia (16, 17). Pelletizing plants with annual capacity of 2 million tons made from naturally rich ore operated in Liberia and Brazil. Conveyor type machines with a floor area of 354 and 278 sq. m. respectively are used for pellet firing. In Liberia rich slurries from the washing plant come direct to the pelletizing plant, with slurries from lean ores being first concentrated by flotation (18). Other types of pelletizing machines, e.g., combination of grate and kiln and circular machines are in

use as well. Methods of pellet hardening without firing are under development and construction. In Sweden a plant with annual capacity of 1.6 million tons of pellets hardened without firing is being erected. A fine grinding cement clinker will be used as the hardening additive. A pelletising method using a carbonate binder at low setting temperature is under development in the United States. Known as the Block Iron process, it is being promoted world-wide by the Koppers Company (United States).

Developments in decreasing blast furnace coke rates are under way in all countries. The most important is through use of additional fuel (particularly natural gas and oil) injected into the furnace tuyere zone. Injected materials also include coal dust, coal-fuel oil suspension or coke gas. Where injected fuel is used, most operators enrich the blast with oxygen. Fuel injection with oxygen-enriched blast is used for most blast furnace production in Japan, the Soviet Union and the United States.

Low-shaft blast furnaces have been investigated in several countries of the world. Their main advantage is the capability of using nearly any carbonaceous material, including low-strength coke, lignite, and other types of fuel. Low-shaft furnaces have been used for the production of ferroalloys (ferromanganese, ferrochrome and ferrosilicochrome) as well as of pig iron. Oxygen has been experimentally used in these furnaces.

Iron smelting in electric furnaces is done in a number of countries where electric power is readily available and of low cost (21). Furnaces up to 60,000 kva are producing iron with a higher or lower content of silicon, manganese and phosphorous as well as the more normal hot metal for steelmaking and cast iron. Most often used are low-shaft furnaces of Tysland-Hole design since these can use low quality reducing agents including coke, coke breeze, gas coke, anthracite, brown coal and lignite. Consumption of reductant depends on the type of iron produced and the quality of the ore being used and ranges from 300 to 800 kg per ton of iron. Power consumption fluctuates from 2,500 to 3,000 kWh per ton of iron (20).

Direct Reduction of Iron Ores

Considerable activity exists throughout the world in commercial development of producing highly metallized iron direct from ores. Plants with a total of approximately five million tons of annual capacity are currently operating or going on-stream. Direct reduction of iron ores promises to be the most important process in the iron and steel industry now under development.

At Hojalata y Lamina's works in Mexico sponge iron is produced from rich iron ore, with natural gas as the reducing agent. The sponge iron is charged into arc furnaces using 57 per cent sponge iron and 43 per cent scrap (23).

Metallized materials can be used both for electric iron smelting and in open hearth and arc furnaces for steelmaking. Prereduced materials in electric smelting furnaces and arc furnaces can double output with power consumption reduced from 3,000 to under 1,800 kWh per ton, along with a decrease in electric consumption. Such prereduced charge is used in electric furnaces for smelting iron in Portugal and in Venezuela. In Venezuela one of nine furnaces was using the Strategic-Udy process, but this practice has been abandoned.

Commercial installations using highly metallized pellets for electric furnace steelmaking exist in Oregon Steel Company (United States) using Surface Combustion produced pellets. A similar plant will come on-stream in the early 70s at Georgetown Steel (United States). Similar plants are being put into production in the Federal Republic of Germany, at Skopje (Yugoslavia) and at Iuchon, South Korea using Demag plants.

A method for production of hot metal has been developed in the United States known as D-LM process. The process uses ore sized to less than 0.83 mm, limestone and coal blended in a disk pelletizer with further hardening and partial reduction in conveyor type machine. Resultant pellets have a basicity up to 1.2, an iron content from 13 to 26 per cent, sulphur content up to 0.3 per cent and non-volatile carbon up to 11 per cent. Hot pellets are charged into arc furnaces for further processing. In 1968

McWane Cast Iron and Pipe Company (United States) started iron production using the D-LM process (24).

The SL-RN process is presently being applied in several countries, under the general engineering direction of the Lurgi Company (Federal Republic of Germany). The Steel Co. of Canada has operated an SL-RN pellet plant for plant scale studies in both blast furnace and steelmaking furnaces. Blast furnace test showed output increases up to 22 per cent, with coke rates (without fuel injection) decreased by 20.8 per cent. Burden included 30 per cent pellets at 90 per cent metallization. Metallized pellets were used in the charge of a 45 ton electric arc furnace as well as a 95 ton oxygen converter and 360 ton open hearth furnaces at the works of this company all with consistent success. Similar test heats with metallized pellets have also been made in other countries (23).

In summary, decisions as to ironmaking process are influenced by the type of metallurgical raw materials, fuel and electric power which are available in any country. Construction of blast furnaces has been customary when iron ores and good coking coal are available, and for large steelworks it is expedient even when coking coal is imported. When iron ores are available but when available coal is unsuited for coking electric pig iron smelting may be developed. Of greatest promise are direct reduction processes which are rapidly becoming practicable for use in developing countries.

E. STEELMAKING

The primary steelmaking process used throughout the world will clearly be oxygen-converters--the BOF. World wide capacity in oxygen-converter plants is 270 million tons of steel per year (1970) and will exceed half of all steelmaking in the early 70s (25). The oxygen converter process is used both in developed and in developing countries. Oxygen-converters have capacities from 10 to 300 tons so that appropriate units for any required output can be selected. Oxygen-converters of 12 to 100 ton capacity are operating in India, with 14 ton sizes in Malaysia, 27 ton in Peru and from 22 to 100 ton in Spain, and so on. Since capital investment for constructing oxygen-converter shops is up to 40 per cent less than for open-hearth shops, it is likely that no new open hearth shops will be built. In addition, operating costs for oxygen-converter steel is usually lower than that of open-hearth steel owing to significantly reduced labour requirements (26). Steels of nearly any analysis including low-carbon (rimmed, semi-killed, killed), medium and high-carbon, low-alloy high alloy steels including ball-bearing, electrical, stainless and other steels are now made in oxygen-converters.

The oxygen-converter process makes it possible to produce quality steel using all types of hot-metal, including low-phosphorus, high-phosphorus, low-manganese and naturally-alloyed irons. In the majority of converter shops iron with low (up to 0.3 per cent) phosphorus content is blown, with

scrap up to 30 per cent of the total metallic charge. Oxygen of 99.5 per cent purity is blown through multi-jet lances. Deoxidation is generally carried out in the teeming ladles. In Western European countries high-phosphorus pig iron is blown using powdered lime carried in the oxygen stream (the LD-AC and OLP processes). The injected lime promotes early formation of slag and quick transfer of phosphorus into the slag, as a result, high-quality low-phosphorus steel is produced. The high phosphate slag is a valuable agricultural fertilizer (27). Of particular interest for the developing countries is the possibility of using oxygen-converters at works having no blast furnaces. One method is by using hot-blast cupolas making molten iron from scrap and coke. Cupola output can reach 50 tons per hours, sufficient to supply up to 70 ton oxygen converters (28). All cold-scrap charged oxygen converters are also under development, using high intensity fuel-gas oxygen preheat burners.

Under development for several years are systems for automatic control of converter process. A static system of converter heat control has been developed and is in use in a number of countries. The more difficult dynamic systems for control using data of current conditions of a heat are still under development.

The oxygen-converter process is a natural to be used with continuous casting of steel. In the Soviet Union a converter shop of high-output in which all molten steel is cast in continuous casting machines is operating at Novo-

developed and are in operation. Ores mostly used for this

lipetsk Iron and Steel Works (11). In the United States nearly ten million tons per year is being cast in eight converter- continuous casting installations. Two small double-strand continuous casting plants are in operation at the works in Manzel-Bourgiba (Tunisia). Steel for those plants is produced in twelve-ton oxygen converters with annual capacity of 77,000 tons per year.

Electric furnace steelmaking has the advantage of low capital investment and the capability of making high quality steel. For electric arc steelmaking, both electric power and scrap are required, although highly metallized pellet production will reduce the need for scrap in many countries. Electric arc furnace installations, with furnace capacities up to 30 tons, or more, are the most common steelmaking units throughout the world, both in developed and developing countries. Several thousand such furnaces exist, with typical installations described in references (33),(34)and (35).

In a number of developing countries the open-hearth steelmaking process is still used. Small furnaces up to 30 ton charge are usual, but larger furnaces exist. Five 250 ton and five 500 ton open-hearth furnaces of total annual capacity of 2.5 million tons of steel are in operation at the Hindustan Steel works in Bhilai. Large open hearths are also used at Hindustan Steel's Durgapur works and Tata Iron and Steel in India, as well as at SOMISA in

recent years in the Soviet Union. The first method is

Venezuela, CAP in Chile, SOMISA in Argentina and Volta Redondo in Brazil.

Efficiency of open-hearths can be increased by the use of basic refractory materials for roofs and regenerative checkerworks, by converting the furnaces to firing with high calorific value fuel (natural gas, fuel oil) and by the use of oxygen for combustion and for deoxidation.

F. CONTINUOUS CASTING OF RAW STEEL

Continuous casting of raw steel produced is rapidly becoming standard practice especially in newly-built iron and steel works. Nearly all blooms and billets in new plants are now continuous cast and it can be expected that by the mid 70s much of the slabs for rolling flat steel products will also be made by continuous casting. By 1973 more than 84 million tons of continuous casting capacity will exist, representing nearly 14 per cent of the world's steel capacity (37).

Three types of casting machines are in use, viz. vertical, vertical with bending the casting into horizontal position and curved mold. Continuous casting plants exist in which several million tons of steel per year are cast, while there are also continuous casting plants of only 20,000 tons annual output.

Vertical continuous casting machines were developed

earliest, with the Soviet Union having emphasized this design. Successful technology for casting steels varying from low-carbon rimmed to high-alloy steels exists. Any cross-section from less than 50 to more than 2100 mm nominal dimensions are now produced throughout the world in machines of all three types.

Continuous casting machines in which the casting is bent below the withdrawal rolls are generally used for producing billets of smaller cross-sections. Total height of the machines is up to six m. less than some of the earlier design vertical ones. Such continuous casting plants are in operation in Peru (four-strand plants for producing blooms of 80-150 mm sq. from a ladle of 25-28 ton capacity), in India (one-strand plant for blooms of 90 mm sq. from 7 ton ladle), in Mexico and in many other countries.

In recent years, curved mold continuous casting machines have become widely used. Machines of this type are characterised by low height. Such continuous casting machines have been installed in India, Tunisia, Argentina, Australia, Brazil, Turkey, and other countries. Continuous casting of steel increases yield up to ten per cent as compared to ingot practice and makes it possible to build iron and steel plants without primary breakdown mills. Continuous casting of steel combined with direct rolling could reduce capital investment in steel plants for developing countries (38).

G. ROLLING

In recent years progress in rolling includes continuous operation and high speed of metal working, mechanization and automation of operations, widening the range of rolled products and improving their quality. The proportion of flat-rolled (sheets and plates) in the total output of rolled products has continued to increase in developed countries.

Continuous wide hot strip mills characterised by speed of rolling up to 25 m. per second and coil weights up to 40,000 kg have been installed in a number of countries. In new rolling mills the systems of automatic control of the rolling process (from slab charging into the furnace to coil removal) are universally used, with temperature, rolling sequence and gage all computer controlled. Data recording of operational conditions of the mill is carried out. Coils of up to 40 tons can be produced in new continuous cold-rolling mills and the rolling speed reaches 30 m. per second. Most mills are equipped with automatic gaging for the control of strip thickness. A 1420 continuous five-stand cold-rolling mill is in operation at the works of Hindustan Iron and Steel Company in Rourkela (India). The dimeter of work rolls is 585 mm, the diameter of back rolls is 1420 mm. The maximum speed of rolling is 30.5 m. per second. The mill is equipped with automatic gauge of strip thickness. The power of the main electric motors amounts to about 21,000 kW (39).

The British company Davy-United Engineering has manufactured a 2220 mm five-stand four-high cold-strip mill and a 2220 mm single-stand four-high temper mill for the Netherlands. It is designed to roll hot-band to finished minimum of 0.01 mm thickness up to 1050 mm wide sheet in coils weighing up to 45 ton. The five-stand mill speed can exceed 25 m. per second. Entry bridles providing for minimum idle times in feeding the coils will be used in the mill. The temper mill is designed for rolling coils of the same weight with speeds over 28 m. per second.

An 1170 mm combination blooming-slabbing two-high mill, a plate four-high mill, a 1670 mm Steckle reversing hot-strip mill, a 1670 mm continuous four-stand cold-strip mill, and a 1760 mm temper mill were installed by Koppers Co. (United States) in the works of Eregli Demir (Turkey). Annual output of this plant is currently 110,000 tons of blooms and slabs, 55,000 tons of plates, 50,000 tons of strips, 46,000 tons of hot rolled flats and 77,000 tons of cold rolled sheets, 50,000 tons of tin plate (40). Multi-roll mills (Sendzimir type) are used for cold rolling of stainless and electrical steels.

Section and wire rolling mills, some of small output suitable for developing countries, are available. A light-section mill designed for annual production of 65,000 tons of angles, strips and other light shapes from billets up to 80 mm cross-section was recently put into operation at the

works of the Iranian Rolling Mills in Ahvas (Iran). This first Iranian rolling mill consists of two three-high roughing stands and six finishing stands. It is planned to bring the annual output of the mill up to 150,000 tons after commissioning its second stage (41). An 800 millimeter reversing primary two-high mill for rolling billets from 1.8 ton ingots, a 450 millimeter Belgian-type medium-section mill with a removable vertical-roll stand for rolling wide flange beams, and a wire-rod mill have been installed at the iron and steel works in Seixal (Portugal) (42).

A universal combination mill of 180,000 tons capacity can roll both structurals and sheet product, and is in operation at the works of Norrbottens Jarnverk in Lulea (Sweden). Product includes sheet from 150 to 1,000 millimeterswide, at 7 to 60 millimeters thick and structurals including H-beams up to 400 millimeters in section. The mill design makes it possible for quick change from one product to the other. Such a combination mill requires only about half the capital investment of two single specialised mills and is therefore practicable for small capacity works. Surface finish and tolerance of the rolled products made in this mill are equal to those of products rolled in special mills. Equipment for welding H-beams up to 1,000 millimeters section can be added to the mill (43).

Rolling equipment of the new iron and steel works of

Acos Anhanguera S.A. in Mogi das Cruzes (Brazil) comprises an 865 millimeter blooming mill, a four-strand medium section mill and heat-treating and finishing lines. Carbon and alloy constructional and ball-bearing steels are produced at the works (44). An 1150 millimeter blooming mill, a continuous billet mill, a rail and structural mill, a 350 millimeter medium section mill and a 250 millimeter wire mill are installed at Hindustan Steel's Bhilai works (India).

H. PIPE AND TUBE PRODUCTION

Pipe is frequently manufactured by welding in developed countries. A system of making welded pipe in diameters up to 1200 millimeters from two semi-cylinders was recently put into operation in the Soviet Union (45).

Equipment for making electric-welded straight seam pipe of 406 to 1066 millimeters diameter and by twelve meters long from plate up to 16 millimeters thick is in operation in the United Kingdom. After planing the edges, the plate is fed into a 3,500 ton press and then is transferred to a 16,000 ton press. Flux-welding is performed first inside and then outside. After welding the pipe is hydraulically expanded, with the pipe diameter increasing by 1.3 per cent. All pipe is ultra-sonic and x-ray inspected (46). Also in the United Kingdom helical-welded pipe is produced from plate 1525 millimeters wide in a shop designed for

making oil and gas pipe. Annual capacity is 30,000 tons of pipe to 1066 millimeter diameter, up to 16.5 meters long, and with wall thickness of 12.7 millimeters (47).

In Hanaur (India) a works has annual capacity of 12,000 tons of galvanized and plain steel pipe up to 150 millimeter diameter. At this plant two resistance-weld pipe mills and facilities for galvanizing and finishing pipe are installed. Pipe from 32 to 150 millimeter diameter is welded at speeds of 70 meters per minute in one mill and up to 25 millimeter diameter at speed up to 50 meters per minute in the other (48).

In a number of countries various mills are used for seamless pipe production. Some developing countries have complete rolling equipment including section and plate mills and cold sheet mills, along with lines for producing tin plate and galvanized sheet. The technical level of this equipment in enterprises such as Hindustan Steel's Bhilai (India), Altos Hornos (Mexico), Usinas (Brazil), to name a few recent installations is equal to the best in the world.

REFERENCES

1. Informazia Instituta "Chermetinformazia", 1966.
2. Bulleten Instituta "Chermetinformazia", 1968.
3. Mining and Minerals Engineering, 1967, v. 3, No. 11, pp. 414-17.

4. Skillings' Mining Review, 1968, v. 57, No. 1, pp. 1, 6, 7, 21.

5. Bulleten Instituta "Chermetinformazia", 1968.

6. Ibid.,1968, No. 8, p. 15.

7. Informazia Instituta "Chermetinformazia", 1966.

8. Bulleten Instituta "Chermetinformazia", 1968.

9. Ibid.,1968, No. 2, pp. 16-20.

10. Ibid., 1967, No. 6, pp. 27-29.

11. Koks i chimia, 1967, No. 2, c. 46-48.

12. Annales des mines, 1968, No. 3, pp. 39-60.

13. Nenryo kyokaishi, 1967, v. 46, No. 484, pp. 619-28.

14. Bulletin Institua "Chermetinformazia", 1968.

15. Informazia Instituta "Chermetinformazia", 1968.

16. Iron and Steel Engineer, 1967, No. 11, pp. 178, 182.

17. Revue de metallurgie, 1968, No. 12.

18. Skillings' Mining Review, 1967, v. 56, No. 43, p. 14.

19. Metal Bulletin, Special Issue, 1969, p. 15.

20. Blast Furnace and Steel Plant, 1968, No. 6, p. 532.

21. Steel Times, 1965, V. 190, No. 5042, pp. 312-15.

22. Informazia Instituta "Chermetinformazia", 1965, ser. 3, No. 4.

23. Mezdunarodni congress po proizvodstvu i ispolzovaniu vosstanovitelnich rud, M., "Chermetinformazia", 1968.

24. Iron and Steel Engineer, 1968, No. 9, pp. 101-13.

25. L.D. Process Newsletter, Kaiser Engineers, Nov. 4, 1969.

26. Iron Age, 1965, v. 196, No. 17, pp. 28,29.

27. Journal of Metals, 1962, No. 8, pp. 579-83.

28. Iron and Steel Engineer, 1968, No. 1, pp. 75-86.

29. Blast Furnace and Steel Plant, 1968, v. 56, No. 9, pp. 777-88.

30. Journal of Metals, 1967, v. 19, No. 87, pp. 84-86.

31. Stal, 1968, No. 1, pp. 14-18.

32. Iron and Steel Works of the World, London, 1969, pp. 307-8.

33. Ibid., pp. 123-43.

34. Ibid., p. 284.

35. Annales des mines, 1969, No. 6, pp. 41,42.

36. Iron and Steel Works of the World, London, 1969, p. 297.

37. Economic Aspects of Continuous Casting, United Nations, New York, 1968, pp. 53-74, and 33 Magazine, various issues 1969 and 1970.

38. Iron and Steel, 1968, No. 1, pp. 37-38.

39. Draht-Welt, 1963, No. 7, S. 290.

40. Metal Bulletin, 1965, pp. 13-16.

41. Stahl und Eisen, 1968, No. 1.

42. Ibid., 1964, No. 11, S. 692-95.

43. Klepaig Fachbertichte, 1966, No. 6, S. 250.

44. Stahl und Eisen, 1966, No. 14.

45. Tchernaia metallurgia SSSR, 1917-67, M., 1967, pp. 178-192.

46. Pipes and Pipelines International, 1967, v. 12, No. 2, pp. 21-24.

47. Metal Bulletin, 1967, No. 5251, p. 21.

48. Ibid., 1966, No. 2079, p. 13.

CHAPTER 3

THE IRON AND STEEL INDUSTRY OF AFRICAN COUNTRIES

Africa is the second largest continent of the world. Its land area is 30.2 million square kilometers on which lives a population exceeding 330 millions (1969). At present there are 49 nations in Africa of which 41 are sovereign states. Many of these have worked out programes of industrial development. The programes include intensification of exploration for mineral resources and construction of basic industries including iron and steel works.

Even though mineral resources of many African countries have not been thoroughly explored, it is known that Africa has extensive deposits of iron and manganese ores. Total known reserves exceed 24,000 and 300 million ton respectively (1). In 1967 iron ore output of African countries was 44.1 million tons equal to 7 per cent of world's total. Of this total Liberia produced 19 million tons, Mauritania eight million, Algeria and Sierra Leone each over two million tons. Nearly all iron ore produced is exported, primarily to Western Europe, the United States and Japan. Iron ore output of African countries is expected to exceed 60 million tons in the early 1970's (4).

Deposits of chromium, molybdenum, nickel ores and other mineral resources needed for completely balanced production of ferrous materials have been discovered in Africa. Potential reserves of coal in the countries of the African continent are about 88,000 million tons with some 76,000 million tons of this located in the Republic of South Africa (1). Proved reserves of oil in Africa amount to 5,600 million tons (1). Many african countries are rich in hydrosources from such rivers as the Nile, Congo, Niger, Zambezi and others, although power development is still minimal. Capacity of both thermal and hydroelectric power stations in developing countries of Africa is estimated at 5.3 million kilowatts. Power generated (1966) was nearly 18,000 kilowatt-hours (5). When additional hydroelectric power stations are constructed in African countries favorable conditions will exist for the production of iron, steel and ferroalloys in electric furnaces.

The low levels of industrial activity in most of the recently created nations of Africa has a restrictive influence on their developing an iron and steel industry, or even expanding their domestic ferrous metal markets. For example, as shown in Table 1, steel consumption in the African continent is the lowest in the world, averaging eight kilograms per capita compared to nearly 300 in industrially developed countries. United States per capita steel consumption is more than 600 kilograms. Likewise, African per capita annual income in its developing coun-

TABLE 1
SELECTED STEEL INDUSTRY DATA OF AFRICAN COUNTRIES

	KNOWN (1) RESERVES Millions, metric tons				PRODUCTION Thousands, metric tons					Consumption of Crude Steel per capita (4)
	Iron Ore	Manganese Ore	Petroleum	Coal	Iron Ore	Manganese Ore	Petroleum	Coal	Electric Energy (2) (3)	
		(5)								
Algeria	1	-	878	100	2300	-	38250	50	1119	15
Botswana	-	1	-	558	-	8	-	-	-	-
Cameroon	150	-	-	-	-	-	-	-	1008	-
Central African Republic	-	-	-	-	-	-	-	-	25	-
Chad	-	-	-	-	-	-	-	-	22	-
Congo (Brazzaville)	200	-	1	-	-	-	3500	-	46	5
Congo (Kinshasa)	5000	10	...	1650	-	485	-	116	2519	-
Dahomey	-	-	-	-	-	-	-	-	20	-
Ethiopia	-	-	-	-	-	-	-	-	238	-
Gabon	2000	200	48	-	-	1148	-	-	49	-
Ghana	260	30	-	-	-	491	-	-	807	5
Guinea	2700	-	-	-	90	-	-	-	-	-
Ivory Coast	3	13	-	-	-	149	-	-	-	-
Kenya	-	-	-	-	-	-	-	-	346	6
Liberia	1600	-	-	-	19000	-	-	-	339	-
Libya	720	-	3367	-	-	-	83500	-	182	-
Madagascar	130	-	-	317	-	-	-	2	190	-
Malawi	-	-	-	14	-	-	-	-	67	1
Mali	-	10	-	-	-	-	-	-	33	-
Mauritania	410	-	-	-	8000	-	-	-	-	-
Morocco	170	50	2	160	90	296	100	470	1431	15
Niger	-	-	-	-	-	-	-	-	20	-

TABLE 1 SELECTED STEEL INDUSTRY DATA OF AFRICAN COUNTRIES (Continued)

	KNOWN (1) RESERVES Millions, metric tons				PRODUCTION Thousands, metric tons					Consumption of Crude Steel per Capita (3) (4)
	Iron Ore	Manganese Ore	Petroleum	Coal	Iron Ore	Manganese Ore	Petroleum	Coal	Electric Energy (2) (3)	
		(5)								
Nigeria	300	-	402	500	-	-	15500	97	1279	6
Rwanda-Burundi	-	-	-	-	-	-	-	-	48	-
Senegal	140	-	-	-	-	-	-	-	222	-
Sierra Leone	400	-	-	-	2200	-	-	-	-	-
Somali	440	-	-	-	-	-	-	-	14	6
Sudan	-	10	-	-	...	-	-	-	262	-
Tanzania	45	-	-	800	-	-	-	-	267	-
Togo	100	-	-	-	-	-	-	-	40	-
Tunisia	55	-	48	-	96	-	2500	-	574	24
Uganda	40	-	-	-	-	-	-	-	6350	6
United Arab Republic	950	9	202	190	500	186	7000	20	5895	27
Upper Volta	-	11	-	-	-	-	-	-	22	-
Zambia	267	1	-	27	-	25	-	100	602	4

(1) Countries with known reserves usually have considerably larger potential reserves.
(2) Millions of kilowatt-hours
(3) 1966 statistics
(4) Apparent consumption per capita in kilograms
(5) Symbols used - magnitude zero ... magnitude less than 1

tries is one-tenth to one-twenth-fifth that of the developed countries. Not surprisingly, in African countries there are very few metal consuming industries such as machine-building and metal-fabricating plants. These consume approximately two-thirds of the ferrous metal output in developed countries (6). Developing countries of Africa use of ferrous metals is about 40 per cent in construction, 30 per cent in containers for agricultural goods and 30 per cent in tubing for the oil and gas industry and for irrigation. In some countries the mining industry is the major consumer.

Some thirty iron and steel plants are in operation in the developing countries of Africa including two fully-integrated works in the United Arab Republic and Tunisia. Eight are under construction in Algeria, Kenya, Morocco, the United Arab Republic, Uganda and Zambia. Steel plants now in operation produce mostly heavy and light sections and reinforcing rods. Some plants producing tubing and hot-rolled and galvanised sheets have been built or are under construction (7).

Development of iron and steel works in many African countries has been initiated by their governments which also provide the major share of capital investments. In some countries governments have encouraged private companies (both domestic and foreign) to build iron and steel works by granting import privileges, financial credits, and other incentives. Developed countries assist in

creating iron and steel works in the developing countries of Africa by providing financial and technical assistance in the construction and operation of the plants. To finance intra-African trade and regional projects the Bank of Economic Development of Africa (BEDA) with $250 million capital was organised in Abidjan (Ivory Coast) in 1966. Twenty-three sovereign states of Africa are share-holders of the bank.

In May 1963 the African Unity Organization (AUO) was created in Addis Ababa with the aim of coordinating efforts of various countries in solving their development problems. A commission of the African Unity Organization on economic and social problems of the region is cooperating with the United Nation's Economic Commission for Africa (8). The African Planning Institute in Dakar (Senegal) is also involved in cooperative projects. This institute has prepared, among other things, a proposal for the creation of an integrated iron and steel industry in the countries of West Africa.

Regional cooperation of the Magrib countries (Algeria, Libya, Morocco, and Tunisia) has also been proposed. In 1968 the Center of Industrial Investigations was created in Tripoli (Libya) for the purpose of guiding cooperation of the Magrib countries in industrial spheres. This center will be engaged in general economic planning and in coordination of measures for development of industry in the

Magrib countries (9).

A report on prospects of industrial development of the African countries, was made at a conference of manufacturers and financiers held in Addis Ababa in January, 1967. Four regions in which the developing countries of Africa are located are considered in the report.

The countries of East Africa, according to the report, consume annually some 450,000 tons of ferrous metals of which only about 67,000 tons are supplied by local works. Average yearly increment in ferrous metal consumption has been 3 per cent since 1960. By 1980 the demand of the region for ferrous metals is expected to increase to 1.6 million tons (8, 10). The countries of West Africa consume about 500,000 tons of ferrous metals annually. It is expected that consumption in these countries in the early 1970s will be 1 million tons and in 1980 will have risen to 2.4 million tons. Average annual consumption of ferrous metals was 1.1 million tons in the countries of North Africa in the early 1960s. It is expected that their demand for ferrous metals will increase to 2 million by 1975 and to 4.5 million tons by 1980. Cold-rolled sheet consumption will expand from 1960's 220,000 tons to 1.8 million tons in 1980. In total, East, West and North African countries combined will need 8.5 million tons of iron and steel in 1980.

According to other sources, total requirements of steel

for the African continent will be 10.5 million tons in the mid-70s, even excluding indirect imports in machines and equipment. These will add about 3.5 million tons to the total (10). The United Nation's Economic Commission for Africa has predicted ferrous metal demand of the African countries will be 12 million tons in 1980 with indirect imports at 3.6 million tons (6).

The major needs for ferrous metals of African developing countries are still supplied by imports. Some details of these for 1967 are given Table 2, which shows that sections, tubes and fittings and sheets make up the bulk of imported steel.

In order to meet the projected demand, some countries including Algeria, Morocco, and Tunisia are constructing new iron and steel works. Others, including Ethiopia, Nigeria and Senegal are planning iron and steel plants of some 250,000 tons annual capacity. It is expected that most new plants will use local raw materials and fuels.

The major problems in creating such plants for the developing countries of Africa involve the lack of financial resources and of skilled manpower. In plants built to date, many workers and specialists come from abroad under contracts that result in substantial increase in costs of the iron and steel works. In order to achieve 75 per cent domestic production of ferrous metals by 1980 the developing countries of Africa will have to spend more

TABLE 2
STEEL IMPORTS BY SELECTED AFRICAN COUNTRIES, Thousand, metric tons

	Ingots and Semis	Rail-way track mate-rials	Heavy and light sec-tions	Wire rods	Strip	Plates	Sheets	Steel tubes and fit-tings	Wire	Tin-plate	Axles tyres and wheels	Total
Algeria	2	3	32	8	9	13	19	43	7	8	1	144
Congo (Kin-shasa)	-	1	18	1	1	6	15	4	1	2	1	50
Ethiopia	5	1	6	...	...	1	20	4	...	-	-	36
Ghana	...	5	12	1	...	1	9	3	1	...	1	34
Guinea	-	-	2	-	-	...	...	1	...	-	-	3
Liberia	-	2	8	-	-	3	6	3	1	-	1	22
Libya	-	-	73	2	...	9	11	159	5	...	-	259
Madagascar	-	1	15	...	-	1	12	2	2	2	-	36
Malawi	-	-	...	-	-	...	3	...	-	-	...	4
Morocco	1	1	35	22	1	11	20	13	10	29	1	142
Nigeria	2	5	58	8	3	9	54	57	3	8	1	207
Rwanda-Burundi	-	-	1	-	-	-	2	...	-	-	-	3
Sudan	-	39	19	...	2	5	18	8	...	6	2	98
Togo	-	...	3	-	...	...	2	.	-	-	-	6
Tunisia	11	4	17	-	...	8	13	14	5	2	-	75
United Arab Republic	50	9	83	38	24	18	15	26	4	14	2	282
Zambia	-	4	5	-	...	1	7	2	...	-	...	19
Total	70	73	386	79	40	87	225	340	41	72	10	1422

Symbols used: - magnitude zero ... magnitude less than 1

than 2 billion dollars in capital investment. In order to minimize capital requirements, the United Nations Economic Commission for Africa has recommended subregional iron and steel works in the eastern, western and central areas of the continent, along with specialization of the iron and steel works in the northern area (6).

ALGERIA

Energy and Mineral Resources

Algeria is an agrarian country with a substantial petroleum industry. Agriculture employs over 75 per cent of the country's population. Potential reserves of iron ores in Algeria are estimated at 1.35 billion tons including 620 million tons of proved reserves with 50 per cent iron content. The largest iron ore deposit of Algeria was discovered in 1952 in Gara-Djebilet (south-western part of the country). Proved reserves in this deposit are estimated at 350 million tons with 57 per cent iron. Another major iron ore deposit is in Quense (north-western part of the country. Here reserves of 52 per cent ores are estimated at 100 million tons. A new iron ore deposit was discovered in Garaetel-Gabel in 1963. Iron ore output has been increasing, and was over 3 million tons in 1968. Algerian iron ore (mainly from Quensa deposit) is exported to Belgium, Bulgaria, Italy and the United Kingdom.

Manganese ore deposits occur in the western part of the country (Colon-Beshara region). Coal output is rather negligible, 50,000 tons in 1967 (2, 16, 21).

Proved oil reserves in Algeria are estimated at 878 million tons with major fields in Central Algeria and Fort Polignac. In 1967 oil output was 38.2 million tons, most of which was exported, mainly to France (1, 22).

Potential reserves of natural gas are estimated at over 1,400 billion cubic meters. Major gas-bearing fields are concentrated in Hassi-r'Mel, Fort Polignac, Hassi-Taureg and Gassi-Touil. In 1966 natural gas production in Algeria exceeded 2000 million cubic meters, most of which was exported to the United Kingdom and France (1, 21).

Iron and Steel Industry

There are three iron and steel plants in Algeria along with a works under construction. The "Asilor" works commissioned in 1941 consists of a small open-hearth shop, a rolling and wire mill. Steelmaking capacity is 30,000 tons per year, rolling capacity is 50,000 tons annually. Several wire-drawing and a spot-welding wire-net machine have an annual capacity of 3,600 tons (19). The Reghaia Works of the Altumec Company operates two pipe-welding units making pipe up to 175 millimeter diameter (19).

Construction of a fully-integrated iron and steel works was started in 1960 in El-Hadjar (near Annaba) with the assistance of the French company Societe Bonoise de Siderurgie. In 1963 the construction was stopped, and in 1964 an agreement with the Soviet Union was concluded to complete construction. A sinter plant, blast furnaces, an oxygen converter shop, continuous casting, rolling mills, pipe-welding units, and a power station are being built. Iron ore is supplied to this plant from Quenza mines and coke is imported. Plant cost is estimated at more than $200 million (7). First blast furnace of 400,000 tons annual capacity was to be started in 1970 with steel production in 1971. Steel production is planned at 350,000 to 450,000 tons annually. First stage of the works includes sheet rolling mills and a plate mill, both to be supplied by the Innocenti Company (Italy). Pipe producing equipment is to be supplied by the Hoesch Company, Federal Republic of Germany. Pipe will be made on four spiral-weld mills in diameters up to 1066 millimeters. Capacity of the shop will be 100,000 tons per annum. The shop was to be put into operation in 1969 (23, 24).

A second stage of the El-Hadjar works is planned to include a cold rolling mill, a section mill and tinning and galvanizing lines. These could be built by the mid-1970s.

It has been reported that the Hoesch Company has contracted to build a pipe plant of 100,000 tons capacity in

the vicinity of Constantin, to supply the petroleum industry of Algeria. Cost of the plant is estimated to be $11.5 million (25).

Iron and Steel Trade

Crude steel output in Algeria has recently been reported at 17,000 tons per year, with rolled products at 18,000 tons and pipe at 9,000 tons. Steel imports in 1967 totalled 144,200 tons, comprised of heavy and light sections at 32,000, plates at 13,300, sheets at 18,800 tons, and steel pipe and fittings at 43,100 tons. These came mainly from the Federal Republic of Germany, France, Japan, United Kingdom and the United States (12).

BOTSWANA

Energy and Mineral Resources

Manganese ore reserves amount to 0.5 million tons, with major deposits in the vicinity of Bangwaketse and Bamalete. In 1960 a benefication plant was built at the Bangwaketse deposit and in 1962 one of 5,000 tons concentrate monthly capacity was built at the Bamalete deposit. Concentrate produced is of 46 per cent manganese content. In 1966 merchantable iron ore output was 8,000 tons (1, 22). Potential coal reserves of the country are estimated at 558 million tons with proved reserves of 408 million tons.

Iron and Steel Industry

Botswana has no iron and steel industry at the present time.

Iron and Steel Trade

Imports of iron and steel products have been negligible.

CAMEROON

Energy and Mineral Resources

Mineral resources of the country have been very little prospected. Chaines des Mamelles iron ore deposit reserves are estimated at 150 million tons at 45 per cent iron content.

Iron and Steel Industry

It has been reported that a Japanese company plans to build a corrugated galvanised sheet plant in Douala (47).

Iron and Steel Trade

Imports of iron and steel have been negligible.

CENTRAL AFRICAN REPUBLIC

Energy and Mineral Resources

Installed power generating capacity in 1965 was 8,300

kilowatts, of which 6,600 was in hydro-stations. Power production in 1965 was 21.4 million kilowatt hours, almost entirely hydro-electric.

Iron and Steel Industry

In 1961 construction at Benga of a foundry was proposed. Equipment would include a cupola operating on iron scrap and charcoal, with annual capacity of about 400 tons of iron.

Iron and Steel Trade

Imports of iron and steel products varied from 68,000 tons in 1950 to 145,000 tons, 1955, and 34,000 tons in 1965. About half the imports have consisted of sheets and a quarter of sections. Imports in 1965 included: sections at 9,700, steel tubes and fittings at 8,800, sheet at 7,800, railway track material at 3,400 tons and plate at 3,100 tons. Main suppliers were Belgium-Luxembourg, France, the United Kingdom and the United States.

CHAD

Energy and Mineral Resources

Installed power generating capacity in 1965 was 9,800 kilowatts, and production was 18 million kilowatt-hours.

Iron and Steel Industry

Chad has no iron and steel industry at the present time.

Iron and Steel Trade

Imports of steel products in 1965 totalled 2,800 tons, including 1,000 of sheets, plates and strip, 1,500 of merchant bars and 300 tons of tubes.

CONGO (BRAZZAVILLE)

Energy and Mineral Resources

Prospecting of the country's mineral reserves has just been started. In 1961 in the vicinity of Sanaga (north-west of Brazzaville) a high grade iron ore deposit was discovered. Potential reserves of this deposit are estimated at 200 million tons of 65 per cent iron content ore.

Iron and Steel Industry

Congo (Brazzaville) has no iron and steel industry at the present time.

Iron and Steel Trade

Imports of iron and steel products have been negligible.

CONGO (KINSHASA)

Energy and Mineral Resources

The Democratic Republic of the Congo (Kinshasa) is a country with a well-developed mining industry. Potential reserves of iron ores with an average iron content of 45 per cent are estimated at 5 billion tons. In the north-eastern part of the country (in the upper reaches of the Uturi River) deposits are estimated to contain 1.3 billion tons of 68 per cent iron ores. Reserves of manganese ores with 52 per cent manganese are estimated at 10 million tons. In 1965 manganese ore output was 378,000 tons. Various non-ferrous ores are also mined in the country. For example, Congo (Kinshasa) is one of the two major suppliers of high grade tantalum concentrates (along with Brazil). Available reserves of niobium and tantalum are estimated at 400,000 tons. Potential reserves of carbonaceous fuel are estimated at 1.65 billion tons with proved reserves amounting to 50 million tons, of which high grade coal accounts for 750 million and 50 million tons respectively. Balance of the reserves consist of brown coal and lignite. High grade coal production in 1967 was 116,000 tons (7).

Installed power capacity of the country, 1965, was 659,000 kilowatts, nearly 90 per cent in hydraulic power stations. Power generation in that year was 2.519 billion kilowatt-hours (13).

Iron and Steel Industry

Projected steelworks include a plant of 200,000 tons electric furnace steel capacity. To be located near Kimjako. The plant would supply steel for the Republic of Congo (Kinshasa), and for the Republic of Congo (Brassaville), the Central African Republic and the Republic of Chad. The plant is to be completed by 1972, at an estimated cost of $120 million (7). For the mid 70s an integrated iron and steel works in Inga is proposed. Its initial capacity could be 300,000 tons of crude steel and 275,000 tons of rolled products (7).

Iron and Steel Trade

In 1967 imports of ferrous metals into Congo (Kinshasa) were 50,200 tons, consisting of heavy and light section at 18,000, sheets at 14,600, plates at 5,800 tons and steel pipe and fittings at 4,300. These originated for the most part in Belgium-Luxembourg, and the Federal Republic of Germany (12).

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Energy and Mineral Resources

Installed power generating capacity (1963) was at 8,200 kilowatts with power production of 15.5 million kilowatt-hours in the same year.

Little mineral prospecting has been done. Reserves of lignite exist near Love, and a deposit of tungsten ore containing reserves of some 250 million tons (with a high silicon content) has been found along the river Niger.

Iron and Steel Industry

Dahomey has no iron and steel industry at the present time.

Iron and Steel Trade

Iron and steel imports by Dahomey have been about 9,000 tons per year. More than 90 per cent of these came from France.

ETHIOPIA

Energy and Mineral Resources

Ethiopia is known to have mineral resources but these have been explored very little so far. A small iron ore deposit of 54 per cent iron content exists in the vicinity of Kafa. Minor deposits of coal, manganese and wolfram ores are also known (7).

Iron and Steel Industry

An electric furnace plant using local scrap, having some 15,000 tons annual capacity was put in operation in

Akaki (near Addis Ababa) in 1962. Cost of the plant construction was $1 million. In 1966 a plant making galvanized sheets was completed in Akaki. This plant of 12,000 tons initial capacity was built at the cost of $1 million (7).

Sabean Metal Products formed by Nippon Kokan Company and Marubeni-Iida (Japan) and Sabean Utility (Ethiopia), plans to build a plant making electric-welded pipe of 13 to 100 millimeters diameter. Plant capacity is to be 12,000 tons of pipe annually with construction cost estimated at $1 million. The plant is to be completed by 1971 (39).

Iron and Steel Trade

In 1967 Ethiopia imported 36,300 tons of steel, including sheets at 19,600, heavy and light sections at 6,300, ingots and billets at 4,500, and steel pipe and fittings at 3,900 tons. The imports came mainly from Belgium-Luxembourg, the Federal Republic of Germany and Japan (12).

GABON

Energy and Mineral Resources

Iron ore reserves are the third largest of African countries, and are estimated at 2.0 billion tons. The Mekambo deposit estimated at 860 million tons contains ore of about 64 per cent iron content. The Bok-Boka deposit (to the west of Mekambo) contains about 200 million tons

also of 64 per cent iron content as is the Batoula deposit of some 100 million tons. In the south of the country, in Tchibanga-Millingi, a deposit exists of 43.5 per cent iron content ore estimated at 100 million tons. Prospecting and preparation for mining major iron deposits of Gabon are being carried out by the Somifer Company (Society des Mines de Fer de Mekambo) a consortium of Bethlehem Steel Corporation, some French and other Western European companies. A pelletising plant is planned for construction in the port of Owendo, with an annual capacity of 2 million tons of oxide pellets.

Gabon possesses vast reserves of manganese ores of which 200 million tons with manganese content of 50 per cent are centered in the Moanda deposit located in the vicinity of Franoville. This deposit has been mined since 1962 by the Komilog Company whose share-holders are French (51 per cent) and American (49 per cent) private companies. Manganese ore output in Gabon in 1966 amounted to 1.268 million tons, all of which was exported (1, 5).

Iron and Steel Industry

Gabon has no iron and steel industry at the present time.

Iron and Steel Trade

At present all steel used in Gabon is imported. In

1965 imports amounted to 13,000 tons which came from Belgium-Luxembourg, the Federal Republic of Germany and France.

GHANA

Energy and Mineral Resources

Ghana is an agrarian country with mining its other major industry. An ore deposit of 40 per cent iron content is known in the vicinity of Shiene, with reserves estimated at 100 million tons. Iron ore reserves in Opon-Manso (in the western part of the country) amount to about 150 million tons (7, 17). Potential reserves of manganese ores in Ghana are estimated at 30 million tons with proved reserves amounting to 12 million tons. All manganese ore reserves which average 50 per cent manganese content are located in the Neuta-Dagvin deposit, which has been mined since 1916. Ghana's manganese ore production (by Mn-content) in 1966 was 277,000, and in 1967 was 250,000 tons. The ore is exported to Canada, Norway, the United Kingdom and the United States (1).

Iron and Steel Industry

In 1964 a semi-integrated steel plant having two electric arc furnaces and 3,000 tons of annual steel capacity was built in Tema near Accra at a cost of $1.5 million. The plant produces heavy and light sections and reinforcing

rods and in 1969 shipped 7,309 tons rolled from 13,424 tons of crude steel. Shipbreaking is the main source of raw materials for this works, although it is hoped to use local iron ores in the future. When full capacity is attained it is hoped this plant will supply more than half the requirements of Ghana (7, 29).

Plans for the early 1970s include construction of an iron foundry costing about $30 million. When construction of the hydraulic power station on the Volta River being built by Kaiser Engineers, United States, is completed, it is also planned to build two ferroalloy plants for producing ferromanganese and ferrosilicon.

Iron and Steel Trade

Import of ferrous metals to Ghana in 1967 was about 34,000 tons consisting of heavy and light sections at 12,000 sheets at 8,700, and railway materials at 5,300 tons. Imports came mainly from Belgium, the Federal Republic of Germany and the United Kingdom (12).

GUINEA

Energy and Mineral Resources

Guinea is an agrarian country with a large mining industry potential. Indicated reserves of iron ores in Guinea are estimated at 2.7 million tons with major

deposits located on the Kalum Peninsula and in the Nimba and Simandu mountains. Proved reserves in the latter areas are 1.7 billion tons of 65 per cent iron ores. The Kalum deposit reserves are estimated at 1.0 billion tons with proved reserves of 200 million tons of 50 per cent iron content. A benefication plant has been built in Guinea with an initial output of 1.2 tons of concentrate annually. Iron ore output for the past decade has been 300,000 metric tons, or more, on the basis of iron content (1, 7). The iron ore is exported to Czechoslovakia, the Federal Republic of Germany, the German Democratic Republic, Poland and the United Kingdom.

No mineral fuel deposits have as yet been discovered in Guinea. The country has eight rivers with total hydropower potential of over 60 billion kilowatt-hours annually.

Iron and Steel Industry

Guinea has no iron and steel industry at the present time. Development plans include the possibility of constructing an iron and steel works of 700,000 tons annual capacity in Conakry.

Iron and Steel Trade

In 1967 Guinea imported 3,300 tons of steel mainly from Japan and the Soviet Union (12).

THE IVORY COAST

Energy and Mineral Resources

The Ivory Coast is an agrarian country with 95 per cent of its population engaged in agriculture. Potential iron ore reserves of 40 per cent iron content are estimated at 3 billion tons. An iron ore pelletizing plant is to be built in San Pedro.

Reserves of manganese ores are 13 million tons. Mining of manganese ores was started in 1960 in Grand-Lahu. Proved reserves of this deposit are 1.4 million tons with manganese content varying from 36 to 52 per cent. Some 3 million tons of ores with manganese content of 25 per cent have been found in Yauru. Four million tons or ores of the same quality have been discovered in Korogo, and in Siemugula (near Odienne) a deposit of upwards of six million tons of high-grade manganese ores was discovered in 1962 (1, 7).

Manganese ore output by the Ivory Coast in recent years has been around 70,000 tons annually. The ore is exported to Canada, the Federal Republic of Germany, France, and the United States.

Iron and Steel Industry

At present only one small iron foundry is in operation in the country. A galvanised sheet plant is planned for

Abidjan. A semi-integrated plant is also planned, starting with a rolling mill of 30,000 ton annual capacity. At a later stage a 15 ton electric furnace would be installed, to be followed with a medium section mill, a second 15 ton arc furnace and continuous casting machines. The proposed plant was designed by Companie d'etude et de gestion industrielle (France), with construction date uncertain.

Iron and Steel Trade

Imports of ferrous metals to the Ivory Coast have been some 50,000 tons annually, most of the imports coming from France.

KENYA

Energy and Mineral Resources

Small deposits of iron ore are known in Kenya but no mining is being done.

Iron and Steel Industry

Kenya at present has several steel-processing plants. One for producing 25,000 tons annually of galvanized sheet was commissioned in 1962 in Changamwa (near Mombasa). This plant was built by Japanese Kawasaki Steel Company and Kenyan Sheet Manufacturing Ltd. The latter also owns a corrugated glavanized sheet producing plant in Shimangi.

A small semi-integrated steel plant is proposed and will probably be built in the early 1970s.

Iron and Steel Trade

Steel imports supply Kenya's industry and were 84,000 tons in 1966(7).

LIBERIA

Energy and Mineral Resources

Liberia is an agrarian country with a well developed mining industry. It is a major supplier of iron ore to the world market. Potential reserves of Liberian iron ore are estimated at 1.6 billion tons with proved reserves of 600 million tons of 60 per cent iron content.

Iron ore deposits in the Mano River region (to the north of Bomi-Hills) are estimated at 53 million tons of 56 per cent iron content. Mining was started in 1961. A large scale joint venture (Lamco) of the Liberian government, Swedish and American companies has developed the Nimba Mountains deposit of 250 million tons (proved reserve) of 65 per cent iron ores. A benefication plant of more than 8 million tons annual capacity was completed in 1962 (1). A pelletising plant of 2,000,000 tons annual capacity was put in operation by Lamco in the port of Buchanan in November, 1967, at a cost of $51,000,000 (32,33).

In addition, an iron ore washing plant of 10 million ton annual capacity is in operation in Buchanan (34).

A deposit exists in the Bong Range Hills (also north of Monrovia) with reserves estimated at 300 million tons of 38 per cent iron content. In 1965, the first stage of an iron ore benefication complex of 3 million tons of concentrate annual capacity was put in operation. The second stage of the complex (2 million tons annual capacity) is to be completed in the early 1970s (31). The Liberian government has conducted negotiations with Bong Mining Company on construction of a $23 million pelletizing plant at the Bong Range iron ore concentration complex. This will be the second pelletising plant in Liberia. Exports of iron ore from Liberia now exceed 20 million tons per year. Most of this is shipped to the Federal Republic of Germany, Netherlands, United Kingdom and the United States (6).

Iron and Steel Industry

A regional integrated iron and steel works with annual capacities of 500,000 tons of iron and 700,000 tons of steel has been proposed to be located in Liberia at Buchanan. Various countries of West Africa would participate in the cost of construction and share in steel output. No actual agreement on such a regional plant has yet been concluded (7).

Iron and Steel Trade

Liberia's recent demands for iron and steel have considerably increased as iron mining has developed. In 1967 Liberia imported 22,100 tons, consisting of heavy and light sections at 7,600, sheets at 6,000, steel pipe and fittings at 2,800 tons, and other items. Imports came from Belgium-Luxembourg, the Federal Republic of Germany and the United States (12).

LIBYA

Energy and Mineral Resources

Libya is an agrarian country with a developed petroleum industry. An ore deposit was discovered in 1961 near Sebh (in the vicinity of Brak), with reserves estimated at 720 million tons of 50 per cent iron content. Proved oil reserves of the country are estimated at 3.9 billion tons, mainly concentrated in the Tripoli and Kirenaika oil fields. In 1967 oil production amounted to 83.5 million tons, all of which was exported (22). Potential reserves of natural gas in Libya are estimated at 105 billion cubic meters. It has been reported that Standard Oil (United States) has concluded a contract to supply Libyan natural gas to Italy and Spain (7).

Iron and Steel Industry

The Libyan Metal Industry plant for rolling reinforcing

bars was put in operation in 1965. Annual capacity is 20,000 tons, and plant cost was $400,000 (7, 19).

Iron and Steel Trade

Imports of ferrous metals by Libya in 1967 totalled 259,000 tons including heavy and light sections at 73,400, sheets at 10,700, and steel pipe and fittings at 159,000 tons. Imports came mainly from Belgium-Luxembourg, the Federal Republic of Germany, France, Japan and the United Kingdom (12).

MADAGASCAR

Energy and Mineral Resources

Madagascar is an agrarian country with 90 per cent of its population engaged in agriculture. Small reserves of variable iron ores are known, estimated at 130 million tons with proved reserves of 20 million tons (1). Chrome ore reserves are estimated at 4.5 million tons with several deposits likely to be developed. The biggest chrome ore deposits with proved reserves of 1 million tons are in the vicinity of Adriamena. The Ugine-Kuhlman Company (France) mines a small deposit in Ramomena, whose reserves are estimated at 250,000 tons of 48 per cent chromium-oxide content. Output of Madagascar chrome ores was about 1,000 tons of chrome oxide in 1965 (43). Potential coal reserves of the country are estimated at 317 million tons with

proved reserves of 100 million tons including brown coal reserves of 17 million tons. Coal output in 1967 was 2,000 tons. Power production in 1965 was 152 million kilowatt-hours, about half from hydro stations.

Iron and Steel Industry

A sheet processing plant was put into operation in 1966, with some 12,000 tons annual capacity (7).

Iron and Steel Trade

Madagascar imported 36,000 tons of steel in 1967, composed mainly of heavy and light sections and plates. Belgium-Luxembourg and France are the main suppliers (12).

MALAWI

Energy and Mineral Resources

Malawi has no developed sources.

Iron and Steel Industry

Lloyds Malawi Ltd. has proposed a small steel plant in Blantyre.

Iron and Steel Trade

Imports of iron and steel products have been negligible.

MALI

Energy and Mineral Resources

Mali has no developed sources.

Iron and Steel Industry

Mali has no iron and steel industry at the present time. A semi-integrated steel plant of 200,000 tons annual capacity has been proposed (27).

MAURITANIA

Energy and Mineral Resources

Cattle breeding is the major economic activity. A mining industry is being developed. Potential reserves of iron ores are estimated at 410 million tons with proven reserves of 200 million tons. Major iron ore resources are in the Fbrt-Gouraud deposit where mining was started in 1963. Iron ore output was 8 million tons in 1967, all of which was exported.

Iron and Steel Industry

Mauritania has no iron and steel industry at the present time. a 500,000 ton capacity plant has been proposed for Port-Etienne, to use Fort Gourand ore (27).

Iron and Steel Trade

Imports of iron and steel products have been negligible.

MOROCCO

Energy and Mineral Resources

Morocco is an agrarian country with a developing mining industry. Potential iron ore reserves of the country are estimated at 170 million tons. In the north of the country (Uixan region, 25 kilometers from the port of Melilia), reserves are estimated at 35 million tons of 62 per cent iron content hematite ores. At Tidzi, Tasila, Imin-Turza, Karadid and Kenitra iron ore reserves of 100 million tons exist with iron content varying from 18 to 53 per cent.

Potential reserves of manganese ores are estimated at 50 million tons. The Imini deposits have reserves estimated at 5 million tons with manganese content varying from 50 to 56 per cent. The ore is mined underground, and most is agglomerated at a sinter plant in Sidi-Maruf on a Dwight-Lloyd type machine.

Potential coal reserves of Morocco are estimated at 160 million tons with proved reserves of 100 million tons.

In recent years Morocco's annual output of iron ore has exceeded 900,000 tons, manganese ore output has been nearly 300,000 tons; and coal output has been over 450,000 tons.

Iron ore is exported to the Federal Republic of Germany, France, Spain and the United Kingdom. Manganese ore is shipped to France and the United States.

Iron and Steel Industry

Morocco's 1960-1964 five year program allotted $100 million for the construction of an iron and steel works (7). British and West Germany companies (Koppers Company, United States, participated in the original studies) designed a fully-integrated iron and steel works which is currently under construction in Ras-Kob-dan (near Nador). First stage steel capacity of the works will be 180,000 tons annually. Cost of the plant is $150 million. The Ras-Kob-dan works will produce heavy and light sections, plates, galvanized sheets as well as 20,000 tons per year of ferro-manganese. The works will be supplied with local iron ores and imported coke (7).

A steel pipe plant of 19,000 tons of annual capacity, and a plant specializing in cold rolled and galvanized sheets is planned for Casablanca. Japanese and Moroccan private companies plan to participate (19, 27).

Iron and Steel Trade

In 1967 Morocco imported some 142,000 tons of steel, including heavy and light sections at 35,000, sheets at 20,000, wire rods at 21,600, tin plate at 28,300, steel

pipe and fittings at 12,600 tons and wire at 10,300 tons (12). Steel imports came mainly from the Federal Republic of Germany, France, Japan, the United Kingdom and the United States.

NIGERIA

Energy and Mineral Resources

Nigeria is an agrarian country with an established mining industry, and abundant mineral resources which have as yet been only partially explored. Potential reserves of the iron ore are estimated at 300 million tons, with proved reserves amounting to 90 million tons. Reserves near Enugu are estimated at 47 million tons of ores with up to 45 per cent iron content. Reserves of a deposit on the Agbadja plateau near Lokadja are estimated at 30 million tons of ores containing up to 51 per cent iron.

Nigeria possesses some of the world's largest deposits of niobium-containing ores (columbites). In 1965, Nigeria produced nearly 50 per cent of the world's output of these minerals. Columbites have been mined in Nigeria since the beginning of the eighties of last century and at present its output is about 2,500 tons per year. Most of the processed columbites are exported to the United Kingdom and the United States (1).

Nigeria is third on the African continent in production of coal, following the Republic of South Africa and Rhodesia.

In 1967 Nigeria's output was 97,000 tons. Nigeria's potential reserves of coal are approximately 500 million tons, 300 million of non-coking bituminous and 200 million of brown coal and lignites. Major reserves are concentrated in the Enugu basin in the eastern part of the country. Some work has been done to develop methods for producing metallurgical coke from Enugu Basin coals (7).

Major oil fields are located in the eastern part of the country, with potential reserves in 1967 estimated at 482 million tons. An oil refinery in Ales-Elem (25 kilometers from Port-Harcourt) of 1.45 million tons annual capacity was put in operation in 1964 (28). Oil is exported to Canada, the Federal Republic of Germany, and the United Kingdom. Potential reserves of natural gas in Nigeria are estimated at more than 10 billion cubic meters. Production of natural gas in the mid-1960s amounted to 1.4 million cubic meters per day, with plans developed to double this amount (28).

Iron and Steel Industry

At present several small plants exist in Nigeria producing rolled steel and processing galvanized sheets. A scrap melting-rolling mill combine of 10,000 tons annual capacity was commissioned in 1962 at Enugu. Construction of this mill by Italian firms was financed by the Nigerian government (49 per cent) and foreign companies (51 per cent) (19).

In 1963 Fao Ltd. was formed with 20 per cent government capital, the balance from French and Japanese companies. This company has built a plant in Ikehe of 20,000 tons capacity for processing galvanized sheets (7). In 1964 a plant also of 20,000 tons capacity with two galvanising lines was built in Lagos. Four Japanese and two British companies participated in the construction of this plant. Sheets for galvanising are being supplied by Nippon Kokan Steel, Ltd (Japan) (7). In 1966 a small plant for the production of galvanised sheets (6,000 tons per year) was commissioned in Eastern Nigeria.

The government of Nigeria has been planning an integrated iron and steel works for ten years, with one possibility being a regional plant of 500,000 to 1,000,000 tons annual capacity. Nigerian iron ore and possibly coal are expected to be used. Studies were conducted originally as a consortium effort by Koppers and Westinghouse International of the United States. A small fee was donated by Rockefeller Brothers, Incorporated. Later, at the request of the Nigerian government, Ferrostahl and Demag (Federal Republic of Germany) and Wellman (United Kingdom) were brought in. Originally the plant was to be in Ohitcha, (Eastern Region Biafra) the ore to come by barge from Lokoja (Northern Region). The Nigerian government then proposed that the plant be divided with primary facilities at Lokoja and rolling mills at Onitcha. A further study was under-

taken by the Soviet government which sent a study team into Nigeria in 1966. However, no action had been taken on any specific plan, although Nigeria is planning to construct an integrated iron and steel plant in the near future.

Iron and Steel Trade

Nigeria's steel imports are comparatively large, amounting in 1968 to over 250,000 tons. Product breakdown of 1967's imports is: sheets at 54,000 tons, pipe and fittings at 56,800 tons, heavy and light sections at 56,100 tons, wire rods at 8,200 tons, and tin plate at 7,900 tons. Imports came mainly from Belgium-Luxembourg, the Federal Republic of Germany, France, Japan, the United Kingdom and the United States (12).

RWANDA-BURUNDI

Energy and Mineral Resources

Wolframite, columbite and beryl deposits in Rwanda-Burundi are exploited on a limited scale. In the vicinity of the Kivu Lake a natural gas field with reserves estimated at 50 billion cubic meters has been discovered (45).

Iron and Steel Industry

Rwanda-Burundi has no iron and steel industry at the present time.

Iron and Steel Trade

Imports of iron and steel products have been negligible.

SENEGAL

Energy and Mineral Resources

Senegal has no developed sources.

Iron and Steel Industry

Senegal has no iron and steel industry at the present time. A four-plan for developing Senegal's economy envisages construction of a semi-integrated plant near Dakar. This would be an electric furnace, rolling mill combination of about 100,000 tons annual capacity. Imported and local scrap as well as iron ore imported from Mauritania could to used (7, 27).

Iron and Steel Trade

Annual imports of steel have been as high as 40,000 tons, consisting of sheets, railway materials, pipe and reinforcing rods. Imports come mainly from Belgium-Luxembourg, France, Japan and the United Kingdom.

SIERRA-LEONE

Energy and Mineral Resources

Sierra-Leone is an agrarian country with 90 per cent of its population engaged in agriculture. Mining is the other important industry. Iron ore reserves are centered in the Marampa deposit which contains some 400 million tons of ore with 57 per cent iron content. The Marampa deposit is mined by the Sierra-Leone Development Company. Ore is treated at three beneficiation plants with total annual capacity of 2 million tons of 67 per cent iron concentrates (1). A deposit with up to 55 per cent iron ore has been discovered in the vicinity of Pudjekup (35, 36), and another with 57 per cent iron ore has an estimated 100 million tons reserve in the vicinity of Tonkilili (37).

Sierra-Leone iron ore output during the 1960s has increased to more than 25 million tons. All ore is exported, mainly to the Federal Republic of Germany, Netherlands, Norway and the United Kingdom (7).

Chrome ore reserves in Sierra-Leone are estimated at 1.5 million tons with deposits of 45 per cent chromium-oxide content located on the Kambui hills. These deposits are also mined for export mainly by British companies.

Iron and Steel Industry

Sierra-Leone has no iron and steel industry at the

present time.

Iron and Steel Trade

Imports of iron and steel products have been negligible.

SOMALIA

Energy and Mineral Resources

Potential reserves of 55 per cent iron content ores in Somalia are estimated at 440 million tons.

Iron and Steel Industry

In 1965 Fonso Mala SRL Company put in operation a small semi-integrated steel plant using local scrap with an annual capacity of 6,000 tons. Domestic scrap supplies should be sufficient to keep the plant operating for ten years.

Iron and Steel Trade

Imports of iron and steel products have been negligible.

SUDAN

Energy and Mineral Resources

Potential reserves in Sudan of manganese ores of 34

per cent manganese content are estimated to be 10 million tons. Chrome ore deposits exist in Engenesse (Blue Nile Province). Manganese ore output was 14,000 tons (manganese-content) and chrome ore output was 30,000 tons in 1965. All production was exported to countries of Western Europe (1, 7).

Iron and Steel Industry

Sudan has no iron and steel industry at the present time.

Iron and Steel Trade

Imports of iron and steel products have been negligible.

SWAZILAND

Energy and Mineral Resources

Swaziland has considerable mineral reserves, including iron ore, asbestos and coal. In 1967 the country exported nearly 2 million tons of ore containing 60 per cent iron.

Iron and Steel Industry

Swaziland has no iron and steel industry at the present time.

Iron and Steel Trade

Imports of iron and steel products have been negligible.

TANZANIA

Energy and Mineral Resources

Tanzania is an agrarian country. Potential iron ore reserves are estimated at 45 million tons with 48 per cent iron content. Coal reserves are estimated at 800 million tons with proved reserves of 500 million tons. In 1967 coal output was 2,000 tons (1, 3).

Iron and Steel Industry

In 1963 a works for production of flat and corrugated galvanized sheets of 25,000 ton annual capacity was commissioned in Dar-es-Salaam. Sheets for this plant are supplied by Tawata Seitetsu Company, Japan (7, 19). National Steel Rolling Mill Ltd. assisted by Daniel Company, (Italy) plans to build in 1970 in Tanga a non-integrated works equipped with a 10,000 ton annual capacity rolling mill.

Iron and Steel Trade

In 1965 Tanzania imported some 64,000 tons of steel, including strip, sheets, sections, skelps and coils, railway materials and wire (7).

TOGO

Energy and Mineral Resources

Potential reserves are estimated at 550 million tons of low-grade iron ore. Major deposits are centered in the regions of Buem and Bangeli (48).

Iron and Steel Industry

Togo has no iron and steel industry at the present time.

Iron and Steel Trade

Imports of iron and steel products have been negligible.

TUNISIA

Energy and Mineral Resources

Tunisia is an agrarian country with some mining industry. Potential reserves of iron ores are estimated at 55 million tons. At present the biggest known deposit of iron ores is in Djerissa in the western part of the country with proven reserves to 50-54 per cent iron content (1). Iron ore production has been approximately one million tons annually, exported to Czechoslovakia, Federal Republic of Germany, France, Italy, Poland and the United Kingdom.

Iron and Steel Industry

A fully-integrated iron and steel works of the El-Fouladh Company was put into operation in 1966 in Menzel-Bourgiba. (The comment has been made that this company's plant is probably one of the best examples of a fully-integrated small steel plant in the world, using blast furnace technology.) Iron ore is supplied by rail from Djerissa. The works comprises: an ore dressing complex, a sinter plant of 500 tons daily capacity, a 300 ton mixer, two 15 ton oxygen converters of 100,000 tons annual steel capacity, two double-strand continuous casting machines and a combined medium and light section mill. Initial annual production capacity of the works was to be 70,000 tons of sections, with expansion to 120,000 tons planned. The existing plant cost $40 million and employs 1250 persons. Projected additions include equipment for manufacture of steel pipe and of wire (7, 20).

Iron and Steel Trade

In 1967 Tunisia imported 74,900 tons of steel including sections at 16,700 tons and pipe and fittings at 14,300 tons. Steel imports originated mostly from France, with smaller amounts from Belgium-Luxembourg, Federal Republic of Germany, Italy, the Soviet Union, and the United States (12).

UGANDA

Energy and Mineral Resources

Uganda is an agrarian country. Potential reserves of iron ore are estimated at 40 million tons with several deposits of 65 per cent iron content. Iron ore mining is not yet done (7).

Iron and Steel Industry

In the fall of 1962 Steel Corporation of East Africa Ltd. started up in Jinja a semi-integrated steel plant whose cost was $2.5 million. Equipment consists of a 12-ton arc furnace and a rolling mill with expected output of 24,000 tons annually (7, 19).

In 1965, Uganda Baati Company commissioned a plant in Kampala of 25,000 tons capacity of galvanized sheets at a cost of $12. million (19, 40). Uganda Steel Company is building a galvanized sheet plant of 15,000 tons annual capacity at a cost of $750,000 (7). Uganda's current plan (1966 to 1971) envisages building an integrated steel plant of 100,000 tons annual capacity and using local iron ores. Construction cost is estimated to be $20 million (7).

Iron and Steel Trade

Uganda imports about 16,000 tons of steel annually, including sheets and strips at 7,000, pipe at 3,000,

heavy and light sections at 3,500 and wire at some 1,000 tons (7).

UNITED ARAB REPUBLIC

Energy and Mineral Resources

The United Arab Republic has both an agrarian and an industrial economy. Potential iron ore reserves are estimated at 950 million tons including 600 million tons in Aswan, 300 million tons in Baharia Oasis (Western Desert), and 50 million tons on the coast of the Red Sea (Vadi Kerim) (15, 16). Ores of the Aswan deposits are hematitic with 47 per cent iron content and up to 3.5 per cent phosphorus. Ores mined in Aswan are shipped to the Helwan Iron and Steel Works by railway. Barge shipment from Aswan on the Nile is planned. Hematite iron ore mining at Baharia Oasis was begun in 1963. It is expected in the early 1970s that output will be 4 million tons per year in this region, as the main ore base for the Helwan iron and steel works (7). During the 1960s, iron ore output in the United Arab Republic has been about 500,000 tons per year (2, 3, 14).

Potential reserves of manganese ores in the United Arab Republic are estimated at 9 million tons, including 2 million tons of known and probable ores. The main manganese ore deposit is in the southern Sinai Peninsula in the Umm Bogma Region. Ores of this deposit contain

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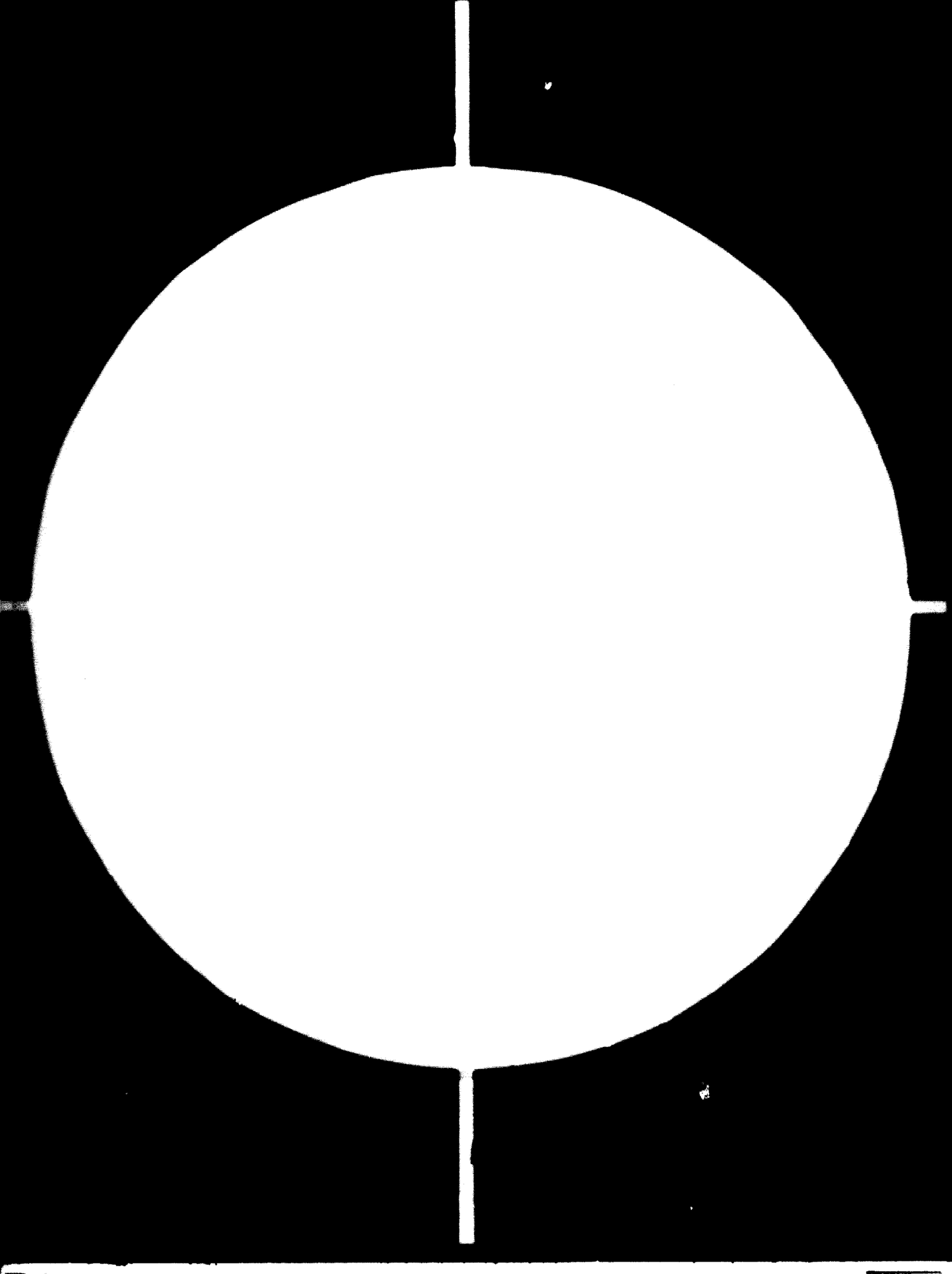

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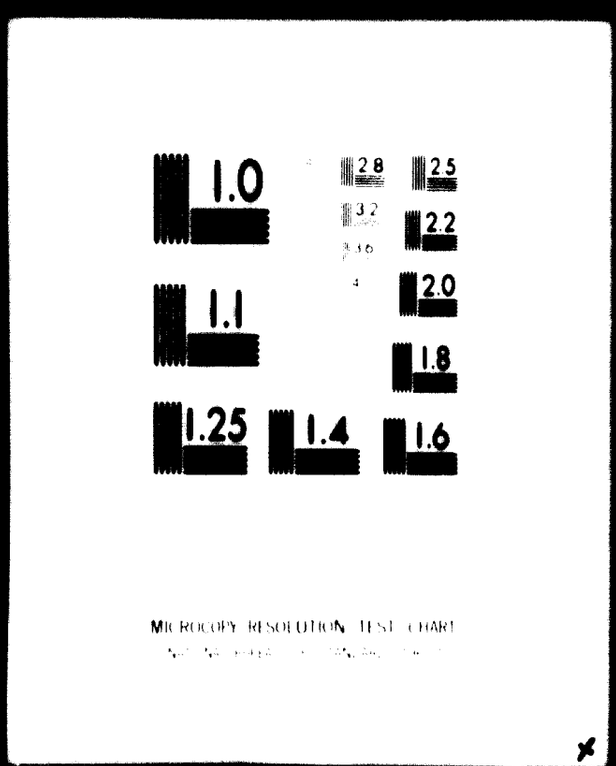
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16. Neue Hutte, 1967, No. 4.

17. "Annales de Mines", 1966, No. 9, p. 37.

18. "Dalil as - Sinaat", 1969 (in Arabic).

19. "Iron and Steel Works of the World", 1969, Fifth Edition.

20. "British Steelmaker", 1966, 32, No. 7, p. 38.

21. "Mines et Metallurgie", 1967, No. 11, p. 380.

22. Gluckauf, 1968, No. 15, p. 31.

23. "Blech", 1968, No. 3, S. 151.

24. "Metal Bulletin", 1968, No. 5355, p. 17.

25. "Metal Bulletin", 1967, No. 5241.

26. "Metal Bulletin", 1967, No. 5258, pp. 24-25.

27. "Continental Iron and Steel Trade Reports", Special edition, 25 Aug. 1967, p. 14.

28. "Mirovaya ekonomika i mezhdunarodnie otnoshenia", 1967, No. 5, pp. 123-125.

29. "Mining Journal", 1967, No. 6899, p. 28.

30. "Skillings Mining Review", 1967, No. 56, No. 29, p. 9.

31. "Annales des Mines", 1966, No. 3, p. 239.

32. "Mining Journal", 1968, 270, No. 6923, p. 336.

33. "BIKI", 1968, No. 69, p. 5.

34. "Mining Journal", 1968, 270, No. 6920, p. 267.

35. "Steel", 1967, No. 160, No. 19, p. 13.

36. "Mines et Metallurgie", 1967, No. 7, p. 242.

37. "Mining Magazine", No. 115, No. 3, p. 223.

38. "Steel Times", 1966, No. 5119, p. 176.

39. "BIKI", 1968, No. 132, p. 6.

40. "Ekonomika promishlennosti", Abstract Journal, 1962, No. 12, Abstract A-72.

about 22 per cent manganese, and are the major source of manganese ore output of the country. Output of manganese ore has been nearly 200,000 tons annually, most of which is exported mainly to the Federal Republic of Germany, Japan and the United Kingdom (2, 3, 14).

The United Arab Republic also produces non-ferrous ores, refractory clays, limestone, dolomite and other materials required for production of iron and steel (7). A few coal deposits are known. Mining of coal in Maghara (the Sinai Peninsula) was started in 1964, with output expected to reach 300,000 tons (7). The major part of the country's requirements of coal including coking coals, are imported mainly from Poland and the Soviet Union

Reserves of oil in the United Arab Republic in 1967 were estimated at 202 million tons. Oil output in the country during the 1952-1961 period increased from 2.4 to 7.0 million tons, with major oil fields on the Red Sea coast and Sinai Peninsula.

Power generated was 5.9 billion kilowatt-hours in 1966. When construction of the Aswan High Dam hydroelectric station is completed total power generated in the United Arab Republic should climb to 14 billion kilowatt-hours.

The United Arab Republic has gone from a net steel scrap exporter (prior to 1940) to a net importer as its domestic steelmaking increased. The country now imports

some 50,000 tons per year.

Iron and Steel Industry

In the early 1940s several small semi-integrated works with steelmaking and rolling shops of 150,000 tons annual capacity and a few iron foundries and wire manufacturing plants were built in the vicinity of Cairo and Alexandria. These plants produce up to 150,000 tons of heavy and light sections, reinforcing bars, a small amount of wire and nails and some steel and iron castings.

During the 1950s, under governmental sponsorship, capital investments in the iron and steel industry was $300 million. During this period construction was done of a ferroalloy plant in Abou-Zemina (Sinai penisula), a welded pipe plant in Helwan, plus modernization and expansion of existing plants was achieved. About $180 million were spent on the iron and steel works in Helwan alone (7, 13). In order to fulfill the first and second development programes of the 1950s the government invited domestic and foreign private capital to participate in financing, due to shortage of its own financial resources (13).

Subsequent to these first two plans the government changed its policy to one of expansion of the state sector in the economy as a whole and in the iron and steel industry in particular. All iron and steel plants in the United Arab Republic are now under state control.

The gross value of the iron and steel production increased from $12 million in 1952 to $40 million in 1966 with per capita steel production going from 5 to 10 kilograms during the period (14). At present annual capacity of the United Arab Republic iron and steel industry is about 500,000 tons of crude steel. Projected capacity by the mid-70s is 1,500,000 tons.

Iron and steel is being made at five steel plants in the United Arab Republic, along with the ferroalloy plant previously mentioned. The largest of these is the integrated iron and steel works at Helwan, there is a specialty steel plant, two carbon steel plants, and a pipe-making plant. The oldest is the National Metal Industries semi-integrated plant located 20 kilometers from Cairo. This works has two 25 ton open hearth furnaces of 50,000 tons annual capacity, and a rolling mill producing structural sections and wire. Modernization of the works is planned to increase its capacity to 160,000 tons per year, by installing a 30 ton arc furnace and a continuous casting machine (7, 14).

Delta Steel Mill SAA in Mostorad (near Cairo) has an annual capacity of 50,000 tons of standard and special steel bars, along with some steel and iron castings.

The Egyptian Copper Works (near Alexandria) has a steelmaking capacity of 65,000 tons from 25 ton open-hearths. (Besides rolled steel products the plant also produces copper,

aluminum and lead rolled products, pipes and wire made of these non-ferrous metals.) Reinforcing bars are the main product. Plans to modernize the works with electric arc furnaces and continuous casting would raise capacity to 150,000 tons annually.

The largest and most important steel works in the United Arab Republic is the government-owned Egyptian Iron and Steel Company. The company's original fully-integrated iron and steel works was commissioned in Helwan in 1958. Management of this works and iron ore mines in Aswan was put under the Egyptian Iron and Steel Company, established with 80 per cent of its capital belonging to the United Arab Republic and 20 per cent to Demag Company, Federal Republic of Germany (17). Annual capacity of Helwan was initially estimated at 265,000 tons of steel and 200,000 tons per year (14). Expansion of the Helwan works is under way with financial and technical assistance of the Soviet Union. New equipment being supplied includes a third blast furnace, two 100 ton oxygen converters, continuous casting units, and galvanising facilities. Existing (1969) facilities of the Helwan complex are as follows: Iron ore mines (in Aswan), a sinter plant, two 1033 cubic meter blast furnaces, three 15-ton basic Bessemer converters, two 12-ton electric furnaces. Rolling mills can produce merchant bars, sections and rails, plate, 1200 millimeter strip both hot and cold rolled and tin plate. Approximate annual capacities are 250,000 tons of sinter, 260,000 tons of pig

iron, 300,000 tons of raw steel and rolled products.

Equipment now under construction at the Helwan works include a semi-continuous hot strip mill, a cold sheet mill, tinning and galvanizing lines. Hot rolled sheet production is scheduled to go to 340,000 tons per year, with cold-rolled and finished sheet production at somewhat lower tonnage levels.

This long range development of the Helwan Iron and Steel work will require expenditures of $350 million and will result in increasing annual capacities to: sinter plant to 3.5 million tons, blast furnaces to 1.5 million tons, crude steel to 2.0 million tons with an oxygen converter shop with continuous casting and new rolling mills (19).

The United Arab Republic's ferroalloy plant in Abou-Zenima, was constructed at the cost of $40 million with the assistance of Norwegian experts. The capacity of this 1965 plant is 10,000 tons of ferro-manganese and 27,000 tons of iron a year.

Iron and Steel Trade

Recent annual output of ferrous metals in the United Arab Republic has been: pig iron 200,000 tons, crude steel approximately 300,000 tons, rolled and other products for further processing including castings at 350,000 tons (7, 14).

Steel uses in the United Arab Republic are: for construction 80 per cent of total consumption; railways about 10 per cent, industrial and agricultural purposes about 10 per cent. Imported ferrous metals of 282,000 tons in 1967 supplied about 40 per cent of total consumption. (In 1952 83 per cent of steel consumed was imported.) Recent imports originate in both Western and Eastern European Countries, and in Japan. Exports of steel from the United Arab Republic are negligible.

Per capita steel consumption (including imports) was 27 kilograms in 1966 and is projected to rise to 50 kilograms in the early 1970s.

UPPER VOLTA

Energy and Mineral Resources

Mineral resources of the country have been very little explored. Potential reserves of manganese ores are estimated at 11 million tons, most in the Gambao region with 10 million tons containing 52 per cent manganese. Recently an inter-national concern has been formed by American, British and Japanese companies to investigate the possibility of developing the country's manganese ore deposits (49).

Iron and Steel Industry

Upper Volta has no iron and steel industry at the present time.

Iron and Steel Trade

Annual imports of steel by Upper Volta have been up to 8,000 tons.

ZAMBIA

Energy and Mineral Resources

Zambia is an agrarian country, although mining activity accounts for 46 per cent of its gross national product. Potential reserves of iron ore of 58 per cent iron content are estimated at 265 million tons. Manganese ore reserves of 50 per cent ore are estimated at 1 million tons with proved and potential reserves 0.5 million tons (1). Total coal reserves of Zambia are estimated at 27 million tons with proven reserves 11 million tons. Coal output was 100,000 tons in 1967.

Iron and Steel Industry

A fully-integrated iron and steel works is planned with annual crude steel capacity of 70,000 tons, at an estimated cost of $25 million (41). In 1967 a galvanized sheet plant was put in operation in Lusaka (19). Riteway Steel Pipe Manufacturing, Ltd. in 1967 commissioned a pipe plant in Kitwe. Output of 22,000 feet of 12-inch pipe monthly is projected, made from steel coming from Iscor of the Republic of South Africa.

Iron and Steel Trade

In 1967 Zambia imported 19,200 tons of steel, comprised of heavy and light sections at 4,600, railway materials at 3,700, sheets at 7,000, and steel pipe and fittings at 2,200 tons. The Federal Republic of Fermany, Japan, Swedan, and the United Kingdom have been major suppliers (12).

REFERENCES

1. "Mineralnie resursi kapitalisticheskih stran, Ministry of Geology of the USSR, Moscow, 1964, 1968.
2. "Metal Bulletin", 1969, No. 5363, p. 23.
3. "Stahl und Eisen", 1969, No. 7.
4. "Draht", 1968, No. 4, S. 252-56.
5. "Statistical Year-book", United Nations, 1967.
6. "Second Interregional Symposium on the Iron and Steel Industry, Moscow, USSR, 19 Sept.- 9 Oct. 1968, paper A-4.
7. "Mirovaja torgovlya staliju i spros na stal v razvivajushihsya stranan", European Economical Commission, United Nations, New York, 1968, Vol. II.
8. Nodachenko A., "Ekonomicheskie nauki", 1967, No. 1, pp. 67-74.
9. "BIKI", 1968, No. 133, p. 2.
10. "Draht", 1967, No. 4, S. 238-41.
11. "Ekonomika promishlennosti", Abstract Journal, 1968, No. 3, abstract 3A-46.
12. "Statistics of World in Steel", United Nations, New York, 1968.
13. "BIKI", 1966, Supplement II.
14. "Federation of Industries in the United Arab Republic", Year book, 1966-67.
15. Matjuhin I.S., "OAR. Ekonomika i vneshnja torgovya", Izdatelstvo "Mehzdunarodnye Otnoshenija,"1966.

41. "BIKI", 1966, No. 70, p. 4.

42. "Blech", 1967, No. 3, S. 130.

43. "Journal de Four Electrique", 1967, No. 7, p. 192.

44. "BIKI", 1967, No. 105, p. 5.

45. "Ekonomika promishlennosti", Abstract Journal, 1967, No. 11, Abstract IIA-58.

46. "BIKI", 1967, No. 112, p. 5.

47. "BIKI", 1968, No. 21, p. 2.

48. "Mines et Metallurgie", 1968, No. 8, p. 271.

49. "BIKI", 1967, No. 88, p. 5.

CHAPTER 4

THE IRON AND STEEL INDUSTRY OF ASIAN COUNTRIES

Among the developing countries of Asia and the Far East, only India has large integrated iron and steel works. Small integrated works are in operation in Thailand and Malaysia. There are semi-integrated works in several of the countries (Pakistan and others). Most of the small steel plants in the region produce merchant bars.

Many of the countries possess considerable mineral resources as shown on page 102. For the most part these resources are not yet fully explored (1). Iron ore deposits exist in nearly all the countries; manganese ore deposits have been found in India, Indonesia and the Philippines; chromium ore deposits in the Philippines and Pakistan; coking coal in India, Afghanistan, and some others. Oil and natural gas resources have been developed in some including Afghanistan, India and Malaysia. Many countries have extensive hydro-power resources which are still underutilized.

In most countries of this region agriculture is the major industry, with mining and manufacturing still underdeveloped and at relatively low productive levels. Before World War II only India had fully-integrated iron and steel

TABLE 3 SELECTED STEEL INDUSTRY DATA OF ASIAN COUNTRIES, 1967

	KNOWN (1) RESERVES Millions, metric tons				PRODUCTION Thousands, metric tons							
	Iron Ore	Manganese Ore	Petroleum	Coal	Iron Ore	Manganese Ore	Petroleum	Coal	Electric Energy (2)	Iron Output	Steel Output (3)	Crude steel per capita (4)
Afghanistan	2,500	-	14	80	-	-	-	100	350	-	-	-
Burma	45	-	5	6	...	-	550	-	396	-	-	5
Cambodia	-	-	-	-	-	-	-	-	-	-	-	-
Ceylon	-	-	-	-	-	-	-	-	522	-	-	8
India	22,000	180	202	138000	27	1,400	5,556	69200	37,900	7,200	6,600	14
Indonesia	-	10	1205	500	-	1	25,500	400	1,520	-	-	1
Laos	-	-	-	-	-	-	-	-	-	-	-	-
Malaysia	150	-	82	50	3	2	5,000	-	24	-	-	40
Nepal	30	-	-	-	-	-	-	-	30	-	-	-
Pakistan	400	1	7	190	...	1	500	1,500	3,903	-	12	5
Philippines	920	6	...	35	.	53	.	100	4,959	-	32	26
Singapore	-	-	-	-	-	-	-	-	1,236	-	-	-
Thailand	29	...	....	112	1	71	-	100	1,816	-	-	19

(1) Countries with known reserves usually have considerably larger potential reserves.
(2) Millions of kilowatt-hours
(3) 1966 statistics
(4) Apparent consumption per capita in kilograms
(5) Symbols used - magnitude zero ... magnitude less than 1

works. In the post-war years new integrated iron and steel works were built in India as well as in countries like Malaysia using charcoal furnaces to produce pig iron.

The developing countries of Asia in recent years have produced upwards of 8 million tons of crude steel per year with India accounting for nearly 7 million. Per capita crude steel consumption in the developing countries of Asia has been less than 20 kilograms, compared to considerably more than 400 kilograms per capita in the developed countries and a world average of 149 kilograms (2). In the early 1960s the apparent consumption of steel in the countries of this region increased from 7.3 to 12.2 million tons per year (1960 to 1965) for a yearly increase of 8.9 per cent. Of 1965's apparent consumption of 12.2 million tons of crude steel India accounted for 7.5 million tons (2). In that year India's domestic production was 88 per cent of its requirements. All other countries in the region produced only 21 per cent of domestic consumption.

Thus, imports supply somewhat more than three-fourths of steel used in the developing countires of Asia, outside of India. Details on the types of steel products imported are given on the table on the following page. In summary, sheets, heavy and light sections, billets and semis, and tin plate accounted for 80 per cent of such imported products in 1967.

TABLE 4 PRODUCT BREAKDOWN OF 1967, STEEL IMPORTS INTO SELECTED ASIAN COUNTRIES
Thousand, Metric Tons

COUNTRIES	BILLETS AND SEMIS	RAILWAY TRACK MATE-RIALS	HEAVY AND LIGHT SEC-TIONS	WIRE RODS	STRIP	PLATES	SHEETS	STEEL TUBES AND FIT-TINGS	WIRE	TIN-PLATE	WHEELS TYRES AND AXLES	TOTAL
Afghanistan	-	-	7.8	0.6	-	-	3.5	0.1	-	-	-	12.0
Burma	17.1	0.9	4.3	0.1	0.1	2.6	7.8	13.4	11.4	2.0	0.6	60.3
Ceylon	28.4	0.6	20.0	0.3	0.9	6.2	15.8	2.8	9.8	0.9	1.1	86.8
India	26.4	0.1	104.3	50.8	45.7	71.4	165.9	29.3	18.6	88.9	17.9	619.3
Indonesia	0.1	2.6	31.3	0.5	3.7	8.8	46.1	29.5	20.5	9.7	0.5	153.3
Laos	-	-	0.6	-	-	-	2.2	-	0.1	-	-	2.9
Malaysia	11.7	7.5	69.7	5.7	2.5	41.3	61.8	30.2	5.7	17.4	0.9	254.4
Pakistan	283.0	28.3	53.4	4.5	22.0	33.1	158.1	24.6	10.6	32.4	4.7	654.7
Philippines	182.8	17.7	90.8	20.8	36.4	79.2	245.3	41.0	10.3	111.2	0.1	835.6
Thailand	12.9	5.8	144.9	43.5	32.8	39.8	172.3	26.3	42.0	31.6	-	551.4
Others	45.1	4.5	87.3	30.3	28.5	61.5	137.5	30.5	26.1	-	-	520.3
Total	607.5	68.0	644.1	157.1	172.6	343.4	1016.3	227.3	155.1	362.9	26.4	3751.0

By 1975 apparent consumption of crude steel in the developing countries of Asia could amount to nearly 20 million tons, of which India will produce more than 11 million tons. Domestic production will probably meet 65 per cent of this requirements at 13 million tons, including India's 11 million tons, with the remaining 7 million tons covered by imports (3).

At the 1965 conference in Manila, Philippines, a 20 year program was outlined for development of the iron and steel industry in Asian countries. As a prerequisite to effective growth of the industry, regional cooperation was deemed a necessity. To this effect, the Asiatic Council of Industrial Development was formed to discuss and coordinate plans for such development, particularly in South-east Asian countries. This council and United Nation's studies suggest the desirability of creating several integrated iron and steel works in the area designed for subregional markets.

AFGHANISTAN

Energy and Mineral Resources

Afghanistan is an agricultural country noted for animal breeding. The country has considerable iron ore resources with potential reserves of hematites of its Hanigak deposit amounting to 2.5 billion tons (5). Reserves of recently discovered deposits in Hakrez Kandagar, Jabal-us-Siraj, Herat and in other regions, amount to more than 20 million

tons of 64 per cent iron ores (44). Potential coal reserves are estimated at 80 million tons, including available reserves of 20 million tons. The main coal fields are in the Karkar, Ishpushta and Dar-es-Suf regions. In 1966, available reserves of oil were estimated at 13.5 million tons. Natural gas reserves in the Nibergan region amount to 2.8 billion cubic meters, with present production of natural gas amounting to 109 million cubic meters annually. In 1965 electric generating capacity was 89,000 kilowatts with power production in 1966 of 350 million kilowatt-hours (61).

Iron and Steel Industry

In 1968, Afghanistan's first steel plant started operations near Kabul. Its annual production has been 3,000 tons of reinforcing rods.

Iron and Steel Trade

Imports in 1967 were 12,000 tons including heavy and light sections at 7,800 sheets at 3,500, wire rods at 600 tons and steel pipe and fittings at 100 tons (29, 30).

BURMA

Energy and Mineral Resources

Burma is an agricultural country, in which light industries such as for foodstuff and textiles have just started

to develop. Potential reserves of iron ore in the country are estimated at 45 million tons, with proved reserves of 10 million tons. Of these, 2 million tons exist in the northern and 8 million tons in the southern part of the country. The ores are chiefly limonitic of from 40 to 60 per cent iron content. In 1965 production of iron ore was 5,000 tons. Reserves of brown coal and lignites are estimated at 6 million tons, with proved reserves at 3 million tons. Deposits of coking coal are found in the Kalewa region, of which 24,000 tons were mined in 1967. Proved reserves of petroleum are about 5 million tons, with 1966 production at 600,000 tons. Also in 1966 output of natural gas was 109 million cubic meters (1, 12, 15). Installed power capacity was estimated for 1967 at 193,800 kilowatts including hydro-plants at 84,500 kilowatts (31).

Iron and Steel Industry

Since 1957, a small state-owned iron and steel works has been in operation in the Ywama region (Insein) situated some 19 kilometers from Rangoon. Built at a cost of just under $1 million, the plant has a crude steel capacity about 25,000 tons per year. Equipment includes a 14 ton arc furnace operating on imported scrap and ferroalloys, a rolling mill for light sections and rods. There are two separate plants, one with equipment for making 8,000 tons of galvanised corrugated sheet a year and a second for manufacturing nails. It is planned to increase capacity of the plant to 50,000 tons of rolled products a year.

Iron and Steel Trade

In 1967, Burma imported 60,300 tons of steel, mostly from Japan. Product breakdown of these imports is given in Table 4, on page 104.

CAMBODIA

Energy and Mineral Resources

Installed capacity of power plants in 1963 was 37,000 kilowatts with electric energy production over 80 million kilowatt-hours (1965).

Iron and Steel Industry

Cambodia has no iron and steel industry at the present time.

Iron and Steel Trade

Imports of iron and steel products amounted to 62,000 tons in 1965 consisting of: sections at 22,000, plates and sheets at 13,000, railway track material at 9,400, wire at 6,300 tons, and cast iron and steel pipe at 11,000 tons.

CEYLON

Energy and Mineral Resources

Ceylon is an agricultural country with well-developed trade. Proved reserves of iron ores in Ceylon are estimated at 7.5 million tons, including those of the Dela deposit at 2.5 million and those of Vilagedera-Panirendva at 5 million tons. Potential reserves of a limonite deposit in southeast Ceylon are 6 million tons, containing about 50 per cent iron. Magnetite deposits have been discovered in Chilaw, the potential reserves of which are estimated at 3.5 million (44). Ceylon imports its coal. Installed power capacity was 220,000 kilowatts in 1965, and in 1966 522 million kilowatt-hours were generated.

Iron and Steel Industry

Ceylon is 1967 started up the rolling mills of the state-owned Ceylon Steel Corporation in what is hoped will eventually become an integrated steel plant. The plant is located at Aruwela and has an initial capacity of 40,000 tons of merchant bars, wire rods and wire at 12,000 tons. It was built with assistance of the Soviet Union. Later stages of the plant envisage installation of iron and crude steelmaking facilities, using indigenous ores and imported coal.

The Ceylon Galvanising Industries Ltd., formed by two

Japanese companies and the Ceylon Development Finance Corporation have built (1968) a plant for making galvanized sheets, with a capacity of 12,000 tons per year (51, 54). The Ceylon Letscha Industries Company plans a similar plant also with participation of Japanese companies (55).

Iron and Steel Trade

Ceylon still imports most of the steel it uses, amounting in 1967 to 86,800 tons. Product breakdown of these imports is given in Table 4, on page 104.

CHINA (TAIWAN)

Energy and Mineral Resources

In 1965, hard coal production amounted to 5.1 million tons, crude oil output 19,000 tons and natural gas production to 310 million cubic meters. Also in that year installed generating capacity was 1,276 million kilowatt hours, including 628,000 kilowatt of hydro power. Electric power production amounted to 6.6 million kilowatt hours, of which nearly a third were hydro power.

Iron and Steel Industry

There are a great number of small iron and steel plants in the country: 17 of these make cast iron products, 23 produce crude steel and 42 roll merchant bars and small

sections. Only one plant is an integrated works. Total crude steel from these plants has been some 250,000 tons annually. Steelmaking furnaces include numerous arc, some Bessemer converters and two small (5 ton) oxygen converters.

Rolling capacity in the country is 300,000 tons per year of bars, small sections and wire rod. A three-high plate mill was constructed in 1966, the only flat-product mill in the country. Coated sheets and welded pipe are made from imported flat-rolled. In 1965 4,000 tons of tinplate, 11,500 tons of galvanized sheets, and 33,500 tons of welded tubes were produced. Pig iron is made in two small blast-furnaces with aggregate capacity of 25,000 tons, as well as in an electric smelting and a number of hot-blast cupolas.

Plans are being developed for building an integrated iron and steel plant to supply semi-finished products to the existing small plants and to produce flat steel to meet the country's rapidly growing demand. It is envisaged to build the plant in two stages. In the early 1970s a primary reversing hot-strip mill and cold-rolling mills and related equipment is to be built. Output of several hundred thousand tons of blooms and billets, plates, sheets, and coated flat-rolled will be based on imported steel. At a later date blast furnaces of 1 million tons annual capacity, oxygen converters of over 1 million tons capacity and continuous casting equipment are to be installed.

Coking coal and iron ore will be imported. Production of about 850,000 tons of finished steel products is planned. The plant is to be located at the Free Port Zone of Kaoshiung.

Iron and Steel Trade

In 1965, about 250,000 tons of finished steel products were imported, consisting of 42,400 tons of sections, 181,000 tons of plates and sheets, 12,800 tons of hoop and strip and 16,800 tons of pipe. Japan was the source of more than 90 per cent of the imports.

INDIA

Mineral and Energy Resources

India is an agricultural-industrial country with well-developed but inadequate processing and mining industries. The country possesses considerable reserves of iron and manganese ore and to a lesser extent those of coking coals. Potential reserves of high-grade iron ore in India are estimated at 29 billion tons; reserves of manganese ore at 180 million tons; and of coal at approximately 13.8 billion tons (5).

Iron ore production is approaching 30 million tons of which about 45 per cent is being exported, mainly to Japan. Oxide pellets will also soon be exported on a large scale,

almost all to Japan.

Export of ore from India is done mainly from ports of Paradleep, Visakhapatnam, Marmagde, and Mangalore, which can handle ships of 60,000, 32,000, 34,000 and 30,000 DWT, respectively. Principal Indian iron ore fields and mines are at Barsera, Bailladilla, and some others.

The main deposit of manganese ore exists in the Nagpur-Bhandara-Balaghat area. Nearly half of the ores of this deposit contain 48 per cent manganese. Mining is done mostly in the states of Madhya Pradesh, Maharashtra, Mysore and Orissa. The major part of the manganese ore is exported, in amounts of more than 1 million tons per year.

Main coal reserves are located in the Jaria district (about 5.8 billion tons) and in Bokaro. In East Bakaro there are some 4.4 billion tons and in West Bokaro about 550 million tons. These districts are the principal suppliers of coking coals for India's iron and steel works (6). In 1967 total qualtity of coal mined in India was 69.2 million tons (in 1950 the amount was 32.8 million tons). Coking coal production in recent years has been 17 million tons annually. Total coal production is planned to reach 106 million tons annually in the near future.

India's coking coals are of very high ash, frequently producing up to a 25 per cent ash coke. This has a detrimental effect on blast furnace operations. For example,

at Hindustan Steel's Bhilai works even with some washed coals the specific coke rate was 792 kilograms per ton of iron in blast furnaces of 1,200 tons per day capacities. At the company's Durgapur and Rourkela works the rates were 885 kilograms per ton. In the private sector Tata's Jam Shedpur plant had a rate of 831 kilograms, while at the works of the Indian Iron and Steel Company where there are four blast furnaces of less than 1,000 tons per day capacity each the rate was 977 kilograms of coke per ton of iron.

Potential petroleum reserves in the country are estimated at 202 million tons; production totaled 5.6 million tons in 1967. It should be noted that the relatively high prices of fuel oil in India do not favor its extensive application in blast furnaces, although it has been successfully tried.

Installed capacity of electric power stations in India in 1966 was over 12 million kilowatts and the quantity of power generated was 38.4 billion kilowatt-hours.

Iron and Steel Industry

Increasing domestic iron and steel production has been a major effort in the development of India's national economy. Expansion of pig iron increased from 1.7 million to 7.1 million tons; of crude steel from 1.5 million to 6.6 million tons, and of rolled products from 1.0 million to 4.3 million tons (4). Similar major increases in production of

ferroalloys and finished steel products such as tubes occurred in the period since 1950.

Rapid development of India's iron and steel capacity was made possible by allocation of high capital investments to the industry. These amounted to $1 billion in the years 1956 to 1961, amounting to 50 per cent of all capital investments in industry and approximately 10 per cent of all capital investments in the economy. The amount was reduced to less than $1 billion in the 1961 through 1966 years, then amounting to 25 per cent of all capital investments made in industry but only 5.1 per cent of capital investments made in the economy (6). Construction of three new works for India's state-owned Hindustan Steel Company, Ltd., in Bhilai, Rourkela and Durgapur accounted for more than 70 per cent of all capital investments in the iron and steel industry (6).

Construction of these three plants was started almost simultaneously in the mid-1950s. The Bhilai Works was built with the assistance of the Soviet Union, those at Durgapur with the assistance of the United Kingdom government and private companies, and those at Rourkela with Federal Republic of Germany governmental and private company finance and technical assistance. Initial capacity of each of the plants was planned for 1 million tons of crude steel per year. Bhilai Works reached its rated capacity in 1962-1963, Durgapur Works in 1963-1964 and Rourkela Works in 1964-1965. Enlargement of each to approximately

1.8 million annual tons was begun immediately. These increases in production facilities were completed in 1967 and further expansions are again underway particularly for the tonnage steels made at Bhilai Works (7).

Iron ore for Bhilai Works (state of Madhya Pradesh) come from the Rajhara deposit 90 kilometers from the works. Average iron content of the ore is 64 per cent. Bhilai's present facilities, with capacity of 2.5 million tons of crude steel annually include: a sintering plant, a coke and by-product plant, five blast furnaces; an open-hearth shop of five 250 ton furnaces and five 500 ton furnaces; and blooming, billet, rail, light section, and a wire-rod mill. Further expansion of this works to more than 2.5 million tons of steel per year has been started.

The Durgapur Iron and Steel Works (state of West Bengal) is supplied with iron ores mined at Balana and other deposits situated at a distance of 420 kilometers from the works, the ores containing about 60 per cent iron. At 1.6 million ton capacity, Durgapur Works include: a sinter plant, coke ovens, four blast furnaces, an open-hearth shop with seven 200 ton furnaces and one 110 ton furnace, blooming, billet, heavy section, light section and a strip mill; and shops for production of sleepers, axles and wheels (6).

Rourkela Works (state of Orissa) are supplied with 60 to 62 per cent iron ore mined at three deposits; Barsud

deposit situated at a distance of 80 kilometers from the works; Baradjanda and Banspani deposit located 225 kilometers from the works. Rourkela equipment includes: a sinter plant, a coke and by-product plant, four blast furnaces, an open-hearth shop with four 80 ton furnaces; an oxygen converter shop with five 60 ton vessels; slabbing mill; plate mill; a continuous hot strip mill; cold rolling mills, and a welded pipe shop (6).

Hindustan Steel also operates a quality steel plant at Durgapur with an annual capacity of 100,000 tons of crude steel, 57,000 tons of rolled products and 3,400 tons of forgings. This plant includes: steelmaking shop No. 1 with two 50-ton arc furnaces, shop No. 2 with a 10-ton arc furnace, three induction furnaces, two of 2-ton capacity each and one of 0.5 ton, a blooming mill, a slabbing mill, a sheet-bar and billet mill and a light section mill. The works also has a forging shop equipped with both presses and hammers. This plant was constructed with the assistance of Canadian and Japanese companies.

Hindustan Steel's fourth fully-integrated iron and steel works is now being constructed in Bokaro (state of Bihar) with financial and technical assistance of the Soviet Union. Announcement of the agreement between the governments of India and the Soviet Union was made in 1964. The Bokaro plant's eventual capacity is planned for 4 million tons with the present works capable of 1.7 million tons of flat products (plates and sheets).

Mysore Iron and Steel Company, owned by Mysore State, operates a fully-integrated plant at Bhadravati, designed to produce about 80,000 tons of pig iron, 70,000 tons of crude steel, and 50,000 tons of finished rolled products per year. Equipment includes: a sinter plant, four electric iron-smelting furnaces, a charcoal blast furnace with daily capacity of 80 tons; a ferrosilicon plant, a steel-making shop having two 25 ton open-hearth furnaces, a blooming mill combined with a three-stand billet mill, a section mill, and a strip mill (6).

In India's private sector there are several small semi-integrated steelmaking plants, some producing high alloy steels, as well as numerous plants of rerollers using pure based billets, both domestic and imported. Most important in the private sector are the large fully-integrated iron and steel works of the Tata Iron and Steel Co., Ltd., and the Indian Iron and Steel Co., Ltd.

The Tata Company was founded in 1907 and is situated in Jamshedpur, the state of Bihar. Tata's plant has been enlarged several times and presently has a capacity of 2 million tons of crude steel annually. Tata is supplied with iron ore mined in deposits at Noamundi, Gorumahisani and Ioda (states of Bihar and Orissa) at a distance of 65 to 150 kilometers from the works. The mines are owned by the company. Ores of these deposits contain about 64 per cent iron ore content. In addition to the ore mines, Tata

also own coal mines at the Jaria basin, quarries of limestone and dolomite and manganese ore deposits.

Equipment in Tata's Jamshedpur plant includes: a sinter plant, six coke oven batteries and a by-product plant, six blast furnaces, three steel-making shops, including open hearth, Bessemer converters and electric furnaces; rolling mill shops including widely varied types of rolling mills that can produce blooms, billets, rails, heavy and light sections, plates, sheets, wire, pipe and finished flat rolled including tin-plate (6). In addition, Tata makes railway equipment as well as other manufactured products.

The Indian Iron and Steel Co., Ltd. (IISCO) in Burnpur (state of West Bengal), was founded in 1939 although its iron-making was started in 1875. IISCO's plant uses 60 per cent iron ore from company-owned mines situated in Goa and Monokharpur, the latter being at a distance of 350 kilometers from the works. The company also owns coal mines in the Jaria and Raniganj basins, quarries of manganese ore and limestone.

The IISCO's Burnpur steel works has an annual crude steel capacity of 1,300,000 tons, including 100,000 of electric furnace steel from a shop soon to be built. Present equipment of the works comprises: a coke and by-product plant, four blast furnaces, steelmaking by means of three Bessemer converters and seven open-hearths, rolling mills including blooming, sheet bar and billet, section, rod and sheet mills.

The company produces merchant bars, light and heavy structural sections, rails and other railway material, and flat-rolled black and galvanized sheets.

Small non-integrated works of India in recent years produced from 300,000 to 1,000,000 tons of rolled products. From 1955 to 1967, production of rolled products doubled at these small works, all the increase coming from the non-integrated works having only rolling mill shops, in which the production of rolled products increased from 210,000 tons in 1955 to 680,000 tons in 1965-1966. During the same period the production of rolled products at small semi-integrated steel works dropped from 200,000 tons to 120,000 tons. These plants are equipped with electric furnaces and produce much of India's high alloy steels, for instance, in 1965-1966 some 72,000 tons.

New small plants are still being built. For example, one is being constructed with Soviet technical assistance at Arkanam (state of Madras). Equipment includes: a 25 ton arc furnace and a four-strand continuous casting machine with capacity of 50,000 tons annually.

Steel pipe and tubing is produced in India at several plants. Hindustan Steel's Rourkela Works has a shop for producing electric weld pipe at about 100,000 tons a year of pipe 220 to 510 millimeters in diameter (6). A new tube works of the Bharat Steel Tube Company in Ganandra, state of Punjab, with annual capacity of 120,000 tons was

put in operation in 1966. Resistance welded tubes up to 150 millimeters in diameter are made on two mills, with additional equipment in the plant for galvanizing and finishing (7).

In the 1965-1966 fiscal year India produced over 140 thousand tons of ferroalloys, of which some 58,000 tons of ferromanganese was exported. Other ferroalloys are also made, most of which are used domestically.

Iron and Steel Trade

Recent annual apparent consumption of ferrous metals in India has been equivalent to 7,500,000 tons of crude steel, equal to 14 kilogram per capita. Nearly 90 per cent of this steel is being produced domestically, with recent annual imports having dropped below 800,000 tons. These imports are now primarily of flat-rolled products and special alloy steels.

Some estimates of steel consumption increases in India during the next decade are for crude steel needed to be 20 million tons by 1980 (11). Demand for rolled products in the country could increase by 5 per cent per year. Domestic alloy steel production deficit is expected to be as much as 160,000 tons annually by the end of the decade. To meet these expected deficits in ferrous metals, it is planned: to complete the construction of Hindustan Steel's Bokaro Works; to construct another fully-integrated iron

and steel works having the capacity of 4,000,000 tons of steel a year; to enlarge the tonnage capacity of the two major private sector plants; to enlarge alloy steel production capacity in all sectors of India's steelmaking economy.

India's domestic capability for enlarging its steel industry has been aided by creation of a large design office in the state-owned Hindustan Steel Company. The Minu Dastur and Company major Indian private consultants, are also influential, for example, as participants in the design of Hindustan Steel's Bokaro Works. Likewise, Indian industries' share in the construction and enlargement of iron and steel works is steadily increasing. While foreign purchases amounted to over 50 per cent of the total cost of the first stages of the Bhilai, Durgapur and Rourkela works recent enlargement of these works required less than 38 per cent of foreign currency expenses (6, 12). For the first stage of the Bokaro Works it is expected that nearly 60 per cent of the required mechanical equipment will be made in India at heavy engineering works, both state-owned and private (13).

In summary, India's imports of ferrous products will continue to decline in the future, while the country's exports of steelmaking raw materials will increase.

INDONESIA

Energy and Mineral Resources

Indonesia is an agricultural country with some processing and mining industries the latter engaged mainly in production of petroleum and tin ores. Large ore deposits containing iron nickel and chromium are found in the central part of Celebes and on Borneo with total reserves estimated at 500 million tons. Analyses of these ores average 49 per cent iron content, with up to 1 per cent nickel. Other iron ore deposits of Celebes are situated in the districts of Pamali, Lingga Kona, Karispman and Bone-Putiye. In the central part of the island of Java reserves of iron ore containing 60 per cent iron amount to 35 million tons. In the Gunung Ratai deposits on the island of Sumatra potential reserves of iron ore are estimated at 10 million tons. Iron ore also exists in the regions of Punung Besi, Bukit Raja, and Raja-Basa. In Kuala-Boe and Tfotplui regions, magnetite sands are found which average 54 per cent iron content with 0.16 per cent phosphorus (1). No commercial iron ore mining is presently being done in Indonesia.

Known reserves of ores containing 47 per cent manganese amount to 10 million tons. There are also some known nickel ore of up to 1.5 per cent nickel content, and some small deposits of cobalt ore. Indonesia's known coal reserves amount to 500 million tons, including those in Ombilin of 200 million tons, in Bukit Asame of 150 million tons and in

Mexakato, Palau and Prapatin (island of Kalimantan) of 100 million tons. Coal mined at the Ombilin deposit is suitable for metallurgical coke. In 1966, 400,000 tons of coal was mined, 70 per cent from the Bukit Asame fields.

Reserves of oil were estimated at 1,234 million tons in 1966, making Indonesia the major southeast Asian country with regard to oil reserves. Production in 1967 was 25.5 million tons. Reserves of natural gas total more than 56 billion cubic meters, with major fields on the islands of Sumatra and Borneo. Production in 1966 was 3.5 billion cubic meters (31).

Water power resources of Indonesia are very large, and have been estimated at nearly 3 million kilowatts still largely undeveloped. Present thermal power capacity is approximately 340,000 kilowatts, with electric power generation at about 1.5 million kilowatt-hours.

Iron and Steel Industry

The country has a small non-integrated steel works in the Jakarta region, with a capacity of 20,000 tons of merchant bar products annually. The Tombgh Mas Company has a plant making 8,000 tons of galvanised sheets annually (58). A Japanese tube mill for 1/2 to 2 1/4 inch pipe was started in 1966 and a second Japanese tube mill is currently starting up.

In 1964 construction of a 100,000 ton steelworks was started at Tjiligon, 70 miles west of Jakarta, with the aid of the Soviet Union. Initial production was to be based on Indonesian scrap melted in open hearths and rolled to merchant bars, principally reinforcing steel. It was planned for eventual integration using iron ore from South Sumatra. Equipment to the value of $30 million was brought onto the site, when Soviet assistance was stopped in 1966. The Indonesian government has since tried to interest other countries in adiing in finishing the project with no success to date. In 1968 the Granite City Steel Company (United States) conducted a year long study of the possibility, but in 1969 decided not to participate.

Iron and Steel Trade

Indonesia imported 153,000 tons of steel in 1967 primarily of sections, sheets, tubes and fittings and wire products (29, 30).

LAOS

Energy and Mineral Resources

Laos is an agricultural country with some tin ore mining.

Iron and Steel Industry

There are no known resources for an iron and steel industry, nor any early prospects for starting any iron and steel plants.

Iron and Steel Trade

Imports of iron and steel products have been negligible.

MALAYSIA

Energy and Mineral Resources

Malaysia is an agricultural country with a major mining industry mainly of iron and tin ores. Potential reserves of iron ore are estimated at 150 million tons with proved reserves at 120 million tons. Large deposits are found in the regions of Ulu-Rompin, Tashbun, Bukit Besi, Kota Tinggi, Sri Medan, and Luana Kap.

Mining of the Ula-Rompin deposit was started in 1962, with present output at 2 million tons a year. Mining is by open pit method; with the ore crushed, washed and screened, then shipped to the port of Kuala Rompoin. Reserves are estimated at 20 million tons. The deposit at Bukit Besi is also mined in open pits, and is shipped from Suru. Due to comparatively intense mining Malaysia's output of iron ore will decrease in the mid-70s due to exhaustion of its deposits. Total output from 27 Malaysian mines in 1967 was

3.1 million tons in terms of iron content. Nearly all ore mined is exported, mostly to Japan (37). Potential reserves of coal (all non-coking) in the country are estimated at upwards of 50 million tons, with the coal fields located in various regions of the country. Some coal suitable for production of metallurgical coke is to be found in the Batu Arang region. In 1966, 2,000 tons of manganese ore were mined.

Proved reserves of oil in the country are estimated at 70 million tons, with 1967 production at 5 million tons. Power capacity in 1966 was 26,000 kilowatts, generation of electric power was 2,390,000 kilowatt-hours.

Iron and Steel Industry

Malaysia has a small integrated steel works, and several steel processing plants. In 1962, the Federal Iron Works Company with the assistance of Japanese companies started production of galvanised sheets in a plant with capacity of 28,000 tons a year.

Malayawata Steel Ltd., which operates the integrated works, was founded in 1966, with capital stock 51 per cent owned by the Malaysian government and local companies, the balance owned by Japanese companies headed by Yawata Iron and Steel Company. Malayawata's plant in Prai City includes a sintering strand, a charcoal blast furnace having a capacity of 62,000 tons a year, a 12 ton oxygen converter,

and merchant bar mill. Malayawata's plant capacity is to be doubled with the addition of a second blast furnace. The charcoal fuel is made from rubber trees which are no longer productive.

The Malaysian Galvanised Iron Pipe Company in 1967 started up a plant in Pataling Jaya, for production of galvanised steel pipe and fittings. Initial capacity was 30,000 tons per year, which may later be doubled.

In 1968, the Steel Pipe Industries of Malaysia Company started construction of a welded-pipe plant with capacity of 3,000 tons per year (42, 43).

Iron and Steel Trade

Most of steel used in Malaysia is imported, in 1967 in the amount of 254,400 tons. These consisted mostly of sections, plates and sheets, and tubes and fittings.

NEPAL

Energy and Mineral Resources

Nepal is a mountainous country with its economy based on agriculture. Reserves of a high-grade iron ore in the Hitaura region are estimated to be 30 million tons. The country's power generating capacity in 1966 was estimated at 11,750 kilowatts, with power generated in the same year at 30 million kilowatt-hours (15).

Iron and Steel Industry

This country is reported to have a non-integrated plant in Nepal producing 20,000 tons of rolled products per year. Billets are imported from India.

Iron and Steel Trade

Steel is imported into Nepal in amounts up to 30,000 tons per year.

PAKISTAN

Energy and Mineral Resources

Pakistan is largely an agricultural country with some mining and agricultural processing industry. Potential iron ore reserves in Pakistan are estimated at 400 million tons, with proved resources of 125 million tons. Deposits of 35 per cent iron exist in the Kalabagh district. Large deposits containing up to 65 per cent iron have been discovered in the Chittral district. Deposits are also found in Langrial, Galdsmin,Abbotabad, Kilat and Ziarat, each with reserves of from 10 million to 40 million tons. Manganese ore reserves with up to 56 per cent manganese are estimated at 500,000 tons. Manganese ore deposits are found in the Kohat and Las Bela districts, with a recent discovery in Dora (14). Chrome ore reserves are estimated at 20 million tons of up to 47 per cent of chromium with one deposit known

in the Baluchistan region.

Potential reserves of coal amount to 190 million tons located in four principal coal fields in West Pakistan; namely, in Makerwal, in the area east of Mianwalik, in Sharing-Deghari and in the area northwest of Karachi. Coal fields in the regions of Jimpir, Bogra and Radjshabi (East Pakistan) have also been explored (1). Coal output of Pakistan in 1967 was 1.5 million tons.

Proved oil reserves of Pakistan were estimated at 6.8 million tons, with a 1967 output of 500,000 tons. In the years 1961 to 1966 Pakistan's Oil and Gas Company discovered fourteen oil fields in East and West Pakistan with the assistance of Soviet Union specialists. Potential reserves of natural gas are estimated at 575 billion cubic meters, in West Pakistan in the regions of Sui (170 billion cubic meters), Mari (99 billion cubic meters) and in East Pakistan in the Chattagh region (15). Pakistan's power generating capacity was 1.2 million kilowatts with 3,902 million kilowatt-hours generated in 1966.

Iron and Steel Industry

Pakistan at the present time has no fully integrated iron and steel works. The country has several small semi-integrated works and some 130 rolling mills processing imported billets. Their combined capacity is 275,000 tons of bars. There are also two plants for manufacturing wire

rods, with capacity of 15,000 tons a year, and a number of plants for tubemaking with capacities totalling 13,000 tons per year. Castings and forging capacity in the country is about 50,000 tons a year.

Work[1] is now in progress in the country in expanding the iron and steel industry to the level required to meet internal demand. Two fully-integrated plants are planned: one near Karachi in West Pakistan, with an annual capacity of 500,000 tons of crude steel, the other at Chittagong in East Pakistan with an annual capacity of 150,000 tons.

The West Paksitan plant near Karachi is to be built by National Steel of Pakistan and is to have an initial capacity of 100,000 tons of crude steel. Finished products are to include sheets, railway track material and other items. The cost of the whole project is estimated at over $150 million. Most of the funds required for construction and for purchase of equipment are to be obtained in the form of loans and credit from the United States. A Pakistan Steel Consortium, comprising seven Pakistan industrial firms will invest upwards of $20 million. It is planned to increase capacity of the plant to 500,000 tons at a later date.

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[1] The sum of $21 million had been allocated for the modernization of existing steel plants during the period 1955-1960 and later the additional sum of $260 million for the construction of new plants. This latter includes $180 million in foreign currency.

The second integrated iron and steel plant, at Chittagong by the early 1970s will have seven open-hearth furnaces with total annual capacity of 250,000 tons, steel rolling equipment including a blooming mill, a plate mill, a sheet mill, a merchant-bar mill and also a galvanizing line and a foundry. A total of 3,000 men are to be employed at the plant. With the exception of fluor-spar and dolomite, all raw materials such as pig iron, scrap and ferroalloys are imported.

Several plants of smaller capacity usually only with rolling mills are now under construction or in the design stage in Pakistan. These are being built with the aid of a number of countries. Steel Corporation of Pakistan, Ltd., has a works in Karachi with two section mills with capacity of 35,000 tons of rolled products a year, and mills for rolling wire and flat hoop iron (11). A tube-welding mill with yearly capacity of 10,000 tons of welded tubes is planned for Dacca. Tube rolling mills are also planned for Lahore and Karachi.

In 1966 an agreement was concluded with Japanese companies equipment for a works with annual capacity of 6,000 tons of stainless sheets, the cost of this project amounting to approximately $13,000,000 (22). In the same year, an agreement was signed for construction in West Pakistan of a works to manufacture up to 11 inch welded pipe. The annual capacity is to be 150,000 tons on two

production lines. A tube mill for small pipe is to be erected at Chittagong Pipe Mills works, with the mill coming from the Federal Republic of Germany (23.25).

In 1968 the Walibai Kamruddin Company ordered from Japan electric furances, rolling and related equipment for a plant in Valika Nagar near Karachi. The plant is to produce 20,000 tons of specialty steels a year, equipment cost is estimated at $15 million and the plant is to be operating in 1971. Imported scrap will be used. Valika Special and Alloy Steel Plant Company will operate the plant with some 100 Pakistans who have been trained in Japan (26, 28).

With completion of the large integrated works in Karachi and Chittagong Pakistan expects to supply 70 per cent of its steel by domestic production, as compared to 20 per cent domestic steel supply in the 1960s. Steel consumption in the 70s could be as high as 2 million tons (21).

Iron and Steel Trade

Pakistan imported 654,700 tons of steel in 1967. Most of this came from the United States and the United Kingdom, with smaller amounts from the Federal Republic of Germany, Japan, the Soviet Union and other countries.

PHILIPPINES

Energy and Mineral Resources

The Philippines are primarily an agricultural nation

with a substantial mining industry. The country possesses considerable resources of iron ore with potential reserves estimated at 920 million tons, including proved reserves of 590 million tons. Iron ore is mined in the region of Lusong and on the islands of Samar, Marinduque, and Mindanao. Reserves of the Lusong deposit are estimated at 20 million tons, with ore being mined at the Larap mine. Production of 50 per cent ore is some 1 million tons a year. Reserves of 57 to 62 per cent iron ore at the Bukukan deposits are also estimated at 20,000,000 tons.

Mining in the Philippines is both by open pit and underground techniques. Until recent years output has been natural ore, most of which has been exported. Because reserves of high grade natural ores are diminishing, the use of ore-beneficating is steadily increasing including oxide pellet plants. The Philippine Iron Mines Company in 1967 put a pelletizing plant on stream which was built with the assistance of Japanese companies. Cost of equipment installed at the plant and in the mines of this company is estimated at $20 million. Capacity of the plant will exceed 880,000 tons of pellets annually.

Production of iron ore was 1.4 million tons in 1966, and by 1975 this should be more than doubled. Philippine iron ores are exported mainly to Japan. In return, Japan assists the Philippines in developing iron ore projects, and also in the country's overall steel industry.

Manganese ore reserves are estimated at 6 million tons, including proved reserves of 1.5 million tons. The main regions for these ores are in the northern part of Lusong, on isles of Sikutor and Busuanga. In 1966 production amounted to 52,600 tons. Chromium ore reserves are estimated at 20 million tons, reserves of nickel-containing ores at over 1 million tons.

Reserves of coal in the Philippines are estimated at 35 million tons, including proved reserves of 3 million tons. The coal fields are situated in Lusong, Mindanao, and in central Wisayas. A deposit of coking coal was recently discovered in the Malangas region, the reserves of which are estimated at 10 million tons. Coal production in 1966 was 100,000 tons (45). In 1965, Philippine installed power capacity was slightly more than 1 million kilowatts, with generation of electric power at 5 billion kilowatt-hours a year.

Iron and Steel Industry

The Philippines are building an integrated steel works, to be completed in the early 1970s. In addition, the country has five semi-integrated plants with a combined capacity of 180,000 tons of crude steel and somewhat more rolled products annually and about ten non-integrated works producing various types of rolled and finished products. They include a non-integrated plant with capacity of 100,000

tons a year, a tin-plate plant with capacity of 80,000 tons of steel pipe and fittings a year.

The Marcelo Steel Corporation produces wire rod and concrete reinforcing bars from an electric furnace-rolling mill plant with an annual capacity of 24,000 tons. The Maria Christina Chemical Industries produces a small quantity of ferroalloys in an electric furnace. The National Shipyards and Steel Corporation produces pig iron in a low shaft furnace of 12,000 tons annual capacity.

The Elizalde Iron and Steel Company operates a tin-plate plant put into operation in 1962 in the Rizal province. The plant has four hot tinning lines having capacity of 15,000 tons a year, and one electrolytic tinning line of a capacity of 48,000 tons a year (48). Sheets for the operation are furnished by the Samar Mining Company which obtains them from Japan in exchange for iron ore. In 1967, the plant produced 46,000 tons of tin plate. A cold-rolling mill with the capacity of 150,000 tons a year will shortly be added to the operation (49).

Several other planned works include: a Philippine Company which in 1969 announced plans to install a cold-rolling mill with the capacity of 240,000 tons a year (49). In 1966, a project was announced for building a pipe plant in Manila. This plant to be constructed by Philippine companies in conjunction with a group of Netherland and other foreign companies (50).

Construction of the Philippine's first integrated iron and steel works was started in 1965 at Iligan City, in Lanar del Vorte Mindaneo province. Named the Iligan Integrated Steel Mills Incorporated, the project started under the general direction of Koppers Company (United States) and is scheduled for completion in the early 70s. Iligan Integrated Steel Mills will have an initial capacity of 350,000 tons of crude steel and 275,000 tons of finished steel, including merchant bars, pipe skelp and sheet products. Cost of the plant is estimated at $120 million, including $84 million in foreign currency. It is estimated that the plant will supply over 50 per cent of domestic Philippine iron and steel requirements. It is planned to equip the plant with electric reduction furnaces for pig iron, two 60-ton oxygen converters, a blooming-slabbing mill, a reversing strip mill, a cold-rolled medium section mill, a temper mill, and equipment for making tin-plate and galvanized sheets. Electric power will be supplied from a hydro-station four miles from the plant at a cost of 0.15 cents (United States) per kilowatt-hour.

A second integrated iron and steel works at Laguna de Bay, near Manila is planned with an annual capacity rated at 250,000 tons. The plant is to be built by Santa Ines Steel, which is at present working the iron ore deposits at Santa Ines in Rizal Province. Crude steel is to be processed in the works itself and shipped to those rolling mills presently using imported materials. The plant will have a blast furnace, coke-oven batteries, a 30 ton oxygen

converter and continuous casting equipment. Cost is estimated at $60 million, of which half would be foreign capital, possibly from Japan.

Iron and Steel Trade

Philippine's needs for ferrous metals are still supplied mostly by imports. In 1967 these amounted to 835,000 tons. Most of the imports came from Japan, a substantial part coming from Australia and with smaller amounts from Western European countries and the United States.

SINGAPORE

Energy and Mineral Resources

Singapore's 600 square kilometer area is too small to develop raw materials, hence it does not have a raw materials base for the development of an iron and steel industry. Power capacity was 344,000 kilowatts in 1965, and electric power generated in 1966 was 1,236,000 kilowatt-hours.

Iron and Steel Industry

Singapore's strategic location makes it a natural area for conversion of raw materials to manufactured products. A number of small plants producing steel pipe and rolled sections were constructed after the country became independent in the 1950s. There have recently been discussions

regarding the building of a major plate-making plant, with financing to be supplied in part by Bethlehem Steel Corporation (United States).

In 1964, the National Iron and Steel Mills Ltd., started up in the Jurong District a steelmaking plant having two arc furnaces and three merchant bar mills. Steelmaking capacity of the plant currently is 120,000 tons annually (10). Increases to 180,000 tons a year are planned, as well as the possibilities of an integrated works with facilities for rails, beams and channels (56).

In 1965 the Malaysia Steel Pipe Manufacturing Co. started a welded-tube plant of 12,000 tons capacity, along with a plant making galvanized sheets with 18,000 tons annual capacity. Cold-rolled sheets are imported from Japan. Simalypan Steel Industries Ltd., has been formed with Singapore, Japanese and Swiss capital to operate a pipe plant with annual capacity of 10,000 tons of up to 4 inch pipe and 5,000 tons of spiral weld large diameter pipe.

Iron and Steel Trade

Singapore imports as much as 200,000 tons of steel a year, of which sheets comprise 45 per cent, sections 30 per cent, and pipe 25 per cent. Most steel is supplied from Japan, with increasing amounts in recent years from Australia and Western Europe. Because of Singapore's manufacturing status, the country reexports much of the

steel that is imported.

THAILAND

Energy and Mineral Resources

Agriculture is the basis of Thailand's economy. Potential reserves of iron ore are estimated at 29 million tons, with proved reserves of 10 million tons of high grade ores. One ore deposit located 200 kilometers north of Bangkok has been mined since 1963. Several mines have started at a newly discovered deposit located in the Khao Tan Kuwai region 160 kilometers from Bangkok. Reserves are estimated at 7 million tons of high grade ore. In 1966, 691,000 tons of iron ore were mined and exported to Japan (15). Manganese ore reserves are estimated at 300,000 tons. Some 20 million tons of tungsten ore are known, with proved reserves of 10 million tons of ores containing up to 2 per cent tungsten (15).

Some coal exists in Thailand, none of it suitable for coek. In 1966, 100,000 tons of low-grade coal was mined. Power generating capacity was over 500,000 kilowatts in 1965, with power generated amounting to 1,816 million kilowatt-hours (31).

Iron and Steel Industry

There is one small integrated iron and steel works and a number of non-integrated works in the country. The Siam Iron and Steel Company operates the integrated iron

and steel works, which is located in the Ta Luang region. The plant has three charcoal blast furnaces, three arc furnaces, six induction furnaces, an open-hearth furnace with combined capacities of 20,000 tons annually of pig iron and crude steel. The present merchant mill has a capacity of 6,000 tons a year. Iron is made from local ore (10). Annual capacity is to be increased both for pig iron and crude steelmaking, both to be in the 100,000 ton per year range. Continuous casting is to be used, with increases in rolling capacity. The increased production will be supported in part by imported scrap.

The G.S. Steel Company, Ltd., has a works near Bangkok with an annual crude and finished steel capacity of 120,000 tons. The plant was built with financial and technical assistance of Japanese companies which own 60 per cent of the stock (32, 33).

Several plants were constructed in Thailand in the early 1960s for production of welded and galvanized tubes (100,000 tons a year), helical welded tubes of large diameter (about 15,000 tons a year), structural steel (10,000 tons a year), and galvanized sheets. Most of these plants use semfinished steel imported from Japan.

The Sintani Industry Company operates a plant started near Bangkok in 1967 for annual production of 10,000 tons of finished wire products (36).

There are also numerous plans for further development of the iron and steel industry in Thailand. Bangkok Iron and Steel is planning a plant to make over 100,000 tons of structural sections a year. Other plants for production of pipe and galvanized sheets are also contemplated.

Iron and Steel Trade

In 1967 Thailand imported 551,400 tons of steel products, over three-quarters of which came from Japan. While Thailand's domestic production of steel is expected to increase, its consumption will probably increase faster, requiring high levels of imports for many years.

REFERENCES

1. Problems of Economics, 1968, No. 11.
2. Materials of the Second United Nations Interregional Symposium on the Iron and Steel Industry, Moscow, 19.9-9.10, 1968, Report A-5.
3. BIKI, 1968, No. 70, p. 5.
4. Mineralni resourci stran capitalisticheskogo mira, Moscow, 1968.
5. Stahl und Eisen, 1969, No. 9, S. 505.
6. Statistics for Iron and Steel Industry in India, Hindustan Steel Ltd., Ranchi, 1967, pp. 1-179, 1964, pp. 1-50.
7. Iron and Steel Review, Calcutta, 1966/67, No. 1-2.
8. Metal Bulletin, 1966, No. 5079, p. 13.
9. Journal du Four Electrique, 1967, No. 7, p. 122.
10. Iron and Steel Works of the World, 1969.
11. BIKI, 1968, No. 70, p. 5.

12. Construction. A quarterly journal of Hindustan Steel Ltd., 1967, 5, No.1, pp. 1, 3, 9-15, 4, No. 4, pp. 203-206.

13. Continental Iron and Steel Trade Reports, 3.367, No. 14536.

14. Far East Trade and Development, 1968, 23, No. 4, p. 322.

15. Mining Development in Asia and the Far East Mineral Resources Development Series, No. 27, United Nations.

16. Mining Journal, 1968, No. 270, p. 202.

17. L'Usine Nouvelle, 1967, No. 28, p. 40.

18. Mineral Trade Notes, 1967, 64, No. 6, p. 20.

19. Continental Iron and Steel Trade Reports, 1967, No. 14649.

20. Mineral Trade Notes, 1967, No. 64, No. 5, p. 20.

21. Tekkokai, 1967, v. 17, pp. 52-57.

22. American Metal Market, 1968, XXII, No. 231, p. 7.

23. Japan Metal Bulletin, 1966, No. 1954, p. 2.

CHAPTER 5

IRON AND STEEL INDUSTRY OF LATIN AMERICAN COUNTRIES

GENERAL SURVEY

Major growth of domestic ferrous metal production in the countries of Latin America began only in post World War II years. In the years from 1950 to 1967 steel output increased from 1 million tons to about 10 million tons reflecting growing demand for ferrous metals in the home markets of these countries. The most important consumers of ferrous metals in Latin America are construction, agriculture, mining and the transportation industries. Some general data related to the steel industry in Latin America are given in Table 5 on the following page.

In creating and developing a domestic iron and steel industry Latin American countries have had to overcome great difficulties particularly the lack of sufficient domestic capital. Most of the steel works presently in existence in Latin America have been financed through foreign loans and credits. These paid for preliminary operations and services of foreign experts, the purchase of machines and equipment and the expenses of training local technical personnel and skilled workers. The need to train skilled workers remains a continuing expense on the operations of Latin American steelmaking enterprises.

TABLE 5 SELECTED STEEL INDUSTRY DATA OF LATIN AMERICAN COUNTRIES, 1967

	KNOWN (1) RESERVES Millions, metric tons				PRODUCTION Thousands, metric tons							Consumption of Crude Steel per capita (4)
	Iron Ore	Manganese Ore	Petroleum	Coal	Iron Ore	Manganese Ore	Petroleum	Coal	Electric Energy (2)	Iron Output	Steel Output (3)	
Argentina	254	100	393	270	...	...	16	...	15	1	1	84
Boliva	-	20	68	-	-	-	2	-	1	-	-	...
Brazil	30050	150	135	2220	24	2	7	3	33	3	4	49
Chile	447	22	24	60	10	...	2	...	7	1	1	72
Colombia	301	-	230	210	1	...	10	3	6	...	...	28
Costa Rica	-	-	-	-	-	-	-	-	NA	-	-	-
Cuba	2615	...	-	-	...	...	-	-	NA	-	...	7
Dominican Republic	43	-	-	-	-	-	-	-	NA	-	-	...
Ecuador	-	-	2	-	-	-	...	-	1	-	-	...
El Salvador	-	-	-	-	-	-	-	-	NA	-	-	...
Guatemala	-	-	-	-	-	-	-	-	NA	-	-	...
Guyana	-	...	-	-	-	-	-	-	NA	-	-	...
Haiti	-	-	-	-	...	-	-	-	NA	-	-	...
Honduras	8	-	-	-	-	-	-	-	NA	-	-	...
Jamaica	-	-	-	-	-	-	-	-	NA	-	-	...
Mexico	586	7	388	500	10	...	19	1	19	1	3	67
Nicaragua	8	-	-	-	-	-	-	-	NA	-	-	...
Panama	-	-	-	-	-	-	-	-	NA	-	-	...
Paraguay	-	-	-	-	-	-	-	-	NA	-	-	...
Peru	967	54	-	-	8	...	3	...	4	...	...	33
Uruguay	28	-	-	-	-	-	-	-	2	-	...	18
Venezuela	2097	-	2354	28	17	-	185	...	9	...	1	122

(1) Countries with known reserves usually have considerably larger potential reserves.
(2) Millions of kilowatt-hours (3) 1966 statistics (4) Apparent consumption per capita -kilogram
(5) Symbols used - magnitude zero, ... magnitude less than 1, NA Information not available

A shortage of coal in Latin America also is a problem in developing an iron and steel industry. Almost all coking coals are imported, creating an adverse affect on balance of payments of Latin American countries.

Because of the vast areas of many Latin American countries and the frequently difficult terrain, transportation facilities have been costly to provide and are still inadequate. Raw material transportation is therefore unduly costly, which in some cases makes it economically difficult to exploit known iron and manganese ore deposits and coal fields.

These conditions raise the cost and sometimes adversely affect quality of ferrous metals. Steel users frequently prefer to buy imported steel products because of lower prices and frequently, better quality, or unavailability in the domestic market. In order to assist domestic steel industries, most Latin American countries have legislation aimed at decreasing imports.

The countries of Latin America contain many large iron ore deposits, with reserves estimated in 1968 at 86,700 million tons, a major part of the world's supply. Largest and richest deposits of iron ore are located in Brasil, Chile, Peru and Venesuela (Table 5) (1, 7).

In 1967 iron ore production in Latin America was more than 65 million tons with Brasil's share being 24

million tons, Venezuela 17 million tons, Chile 10 million tons and Peru 7 million tons. Domestic ore consumption was comparatively small. In 1966, the total consumption of iron ore in Latin America was 10.8 million tons out of a total production of 59 million tons. Domestic iron ore consumption is expected to increase to 30 million tons by 1980 with total production expected to be 108 million tons in the same year (8).

Reserves of manganese ores are estimated at 350 million tons, also a substantial part of known world reserves. Manganese content in these ores varies from 25 to 50 per cent. Brazil has the largest reserves and the highest production of manganese ore among the countries of Latin America. Latin American countries also have deposits of steel industry alloying minerals, with major known deposits in Brazil and Peru.

Even though comparatively large resources of coal are available in some countries of Latin America, reserves of coking coal are almost non-existent. Coal mined in Brazil, Mexico, Argentina and Chile is used for coke production, by being blended with imported coking coals (40 per cent of indigenous and 60 per cent of imported coals). Coking coal is imported mostly from the United States. Colombia's metallurgical coal is all indigenous.

Proved petroleum reserves of Latin America amount to more than 3,500 million tons, of which more than 2,300

million tons are concentrated in Venezuela. This country is amongst the first six major world oil producers.

Considerable resources of hydro-power exist in Latin American countries, mostly still under-utilized. In 1966 electric energy production was about 100,000 million kilowatt hours, of which 50 per cent was hydro-electric. Electric energy is widely used in the iron and steel industry of Latin America with electric furnace iron smelting in Brazil, Peru and Venezuela and with ferroalloy and electric furnace steelmaking in Argentina, Brazil, Chile and Mexico.

In Mexico direct iron ore reduction using natural gas as the reductant has been applied on a large tonnage basis. This process is economic in Mexico due to extensive resources of both iron ore and natural gas.

Countries of Latin America differ widely not only in area and population but also in industrial development, particularly that of the iron and steel industry. Nevertheless, eight countries produce some iron and steel, as shown in Table 6 on the following page. From this table it can be seen that Argentina, Brazil, and Mexico produce the largest part of the iron and steel made in Latin America. Not surprisingly most of the 20 integrated iron and steel works in Latin America are in the same three countries: ten in Brazil, four in Mexico, two in Argentina and one each in Venezuela, Chile, Colombia and Peru (11).

TABLE 6 IRON AND STEEL OUTPUT OF SELECTED LATIN AMERICAN COUNTRIES (1)
Thousand metric tons

	PIG IRON PRODUCTION			RAW STEEL PRODUCTION		
	1967	1968	1969	1967	1968	1969
Argentina	617	574	584	1326	1552	1697
Brasil	2963	3349	3705	3665	4424	4902
Colombia	-	198	202	-	251	257
Chile	498	442	485	631	570	647
Mexico	1285	1972	2098	3023	3258	3421
Peru	31	111	176	80	105	192
Uruguay	-	-	-	13	9	14
Venezuela	422	539	520	690	861	840
TOTALS	6019	7184	7770	9687	11038	11969

(1) Statistics from Ilafa

In recent years, the share of these integrated works in total iron and steel output of the region was more than 90 per cent.

Estimates of future annual steel output in the countries of Latin America are 18.5 million tons by 1975 and 23 million by 1980. These are significant increases from 1969's 12 million tons. It is probable that imports will still supply about one-third of Latin American consumption.

Per capita apparent steel consumption varies widely, from Uruguay's level of 18 kilograms to Venezuela's 122 kilograms. A near balance between steel production and steel consumption has been reached in Brazil, Chile and Mexico. For Latin America as a whole, the increases in consumption are being supplied largely by domestic production increases, with proportions of imports remaining the same. A product listing of imports for 1967 is given in Table 7 on the following page.

Most Latin American countries are encouraging major growth in their domestic iron and steel industries. Steps being taken include a large measure of state ownership and control, with government-backed financing. Some guaranteed loans for private development are also being made. The major integrated iron and steel works in Latin America are nearly all already completely or partly state-owned. A few in Mexico and Brazil, particularly, are privately owned, mostly by nationals. In any event, most

TABLE 7 PRODUCT BREAKDOWN OF 1967, STEEL IMPORTS INTO SELECTED LATIN AMERICAN COUNTRIES
Thousand, Metric Tons

COUNTRIES	INGOTS AND SEMIS	RAILWAY TRACK MATERIALS	HEAVY AND LIGHT SECTIONS	WIRE RODS	STRIP	PLATES	SHEETS	STEEL TUBES AND FITTINGS	WIRE	TIN-PLATE	WHEELS TYRES AND AXLES	TOTAL
Argentina	213.9	1.2	40.7	0.2	6.1	40.5	127.7	40.0	1.8	88.8	3.8	564.7
Boliva	-	0.2	6.7	-	0.1	1.4	9.2	5.2	1.4	1.6	0.1	25.9
Brazil	0.5	54.1	14.7	3.3	6.8	13.6	100.0	8.1	19.1	35.4	3.4	259.0
Chile	-	9.9	7.4	-	0.4	0.9	4.3	5.6	0.7	-	0.4	30.3
Colombia	2.3	-	5.2	1.1	3.1	13.8	27.4	32.3	1.2	15.5	-	101.9
Dominican Republic	0.2	0.1	27.8	-	-	1.5	11.5	4.9	2.6	2.8	0.2	51.6
Ecuador	7.5	0.1	21.8	6.1	1.4	1.8	11.7	10.0	9.4	5.4	-	75.2
Guatemala	13.4	-	7.0	3.7	1.4	4.0	26.2	2.1	1.9	4.5	-	64.2
Haiti	-	0.1	3.9	-	0.1	-	2.6	0.4	0.3	0.2	-	7.6
Honduras	6.5	-	3.6	-	0.4	2.2	2.7	3.7	1.5	-	-	20.6
Mexico	13.5	26.6	23.7	0.1	3.3	2.7	16.7	27.6	7.9	10.3	20.3	152.7
Panama	15.3	-	6.7	1.2	0.2	3.8	2.2	3.1	1.9	3.7	-	38.1
Paraguay	-	-	1.4	-	0.1	0.1	1.0	0.3	0.6	3.3	-	6.8
Peru	2.1	9.2	17.7	5.3	13.1	31.3	58.9	19.3	3.0	12.8	1.6	174.3
Uruguay	-	0.6	31.5	0.1	0.3	13.0	24.5	32.7	5.2	9.1	-	117.0
Venezuela	16.8	1.3	63.9	3.1	5.1	46.3	158.1	21.4	19.4	44.9	0.1	380.3
West-Indies	-	0.2	2.5	1.9	-	1.1	4.0	0.6	-	3.1	-	13.4
Other countries	39.9	1.8	74.0	13.7	4.0	22.4	58.9	19.3	3.0	12.8	1.6	251.4
Total	331.9	105.4	360.2	39.8	45.9	200.4	647.6	236.6	80.8	254.9	31.5	2335.0

existing steel plants in Latin America have been developed largely with outside aid, especially from the United States. Japan in recent years has been increasing financial and technical assistance mainly for developing iron ore deposits. Japan in a number of countries of Latin America has also aided in constructing some plants, to date, mostly for the production of galvanized sheet.

Two integrated iron and steel works are presently under construction or just finished: one of Cia. Propulsora Siderurgica in Ensenada, Argentina, to have an annual capacity in its first stage of 500,000 tons, the other of Hojalata y Lamina, S.A. in Puebla, Mexico currently capable of making over 400,000 tons of rolled products per year. Altogether, more than 30 iron and steel works have been announced in the countries of Latin America. The largest of them are to be in Argentina, Brazil, and Mexico. These new iron and steel works are expected to produce enough steel to enable the respective countries to export.

ARGENTINA

Energy and Mineral Resources

Potential reserves of iron ore in Argentina total 750 million tons with known and probable reserves of 300 million tons (1). The average iron content of the ores is 45 per cent. The largest deposits are in the provinces of Rio-Negro and Jujui, in the north-west and in the

eastern parts of the country. The ore reserves in the territory of Rio-Negro are estimated at 200 million tons with an average iron content of 55 per cent, those in the territory of Jujui at 110 million tons of 45 per cent iron ores. Iron ore deposits are also found in the provinces of Salta and Sierra Grande.

Production of iron ore in Argentina is still insufficient for domestic blast furnace production. Pig iron production in 1967 was more than 600,000 tons while iron ore production was only 150,000 tons. The balance of iron ore required is imported mainly from Brazil (over 500,000 tons) Chile, Peru and Venezuela.

Total resources of manganese ore in Argentina are estimated at 100 million tons. Most of the deposits are small and of low quality ores containing 20 to 30 per cent of manganese. The most important deposits are in the provinces of Catamarca, Mendoza and Salta. The manganese ore is mined underground. Tungsten ore deposits exist in the central part of the country.

Brown coal deposits are estimated at 4.5 million tons. The principal reserves of low quality coal are concentrated in the basin of Rio-Turbio in the province of Santa-Cruz. Domestic coal production does not meet the requirements of the country, in 1965 some 1,657,000 tons of coal and 82,000 tons of coke were imported into Argentina.

Iron and Steel Industry

Argentina has many iron and steel plants, with two integrated iron and steel works, ten plants having steelmaking shops and nearly 50 with rolling mills. Their combined potential capacities in 1967 were for 830,000 tons of pig iron, over 700,000 tons of crude steel and over 2 million tons of rolled products (53). Among the Latin American countries Argentina is in fourth place in per capita production of steel and second place (behind Venezuela) in per capita consumption.

Open-hearth steelmaking still accounts for three-quarters of steel made in the country. The largest open-hearth furnaces exist in the iron and steel works of SOMISA in San Nicolas (nine 335-ton open hearth furnaces with the total capacity of 850,000 tons per year). In recent years electric steelmaking has been developing rapidly, its share in the total steel production almost doubling in the period of 1963-1967.

The principal electric steel producers in the country are Dalmine Siderca, Altos Hornos Zapla, and Establimientos Metalurgicos Santa Rosa, S.A. Two 15-ton electric furnaces were put on-stream at the steelmaking plant of Santa Rosa in Buenos Aires in 1967 (54).

Oxygen converters will be used more extensively in

Argentina. It is planned to build two 100-ton converters at the plant of ASINDAR in Villa Constitucion and 2 160-ton vessels in the works of SOMISA in San Nicolas. This shop will have a capacity of more than two million tons of steel per year (55).

The largest metallurgical companies of the country are Altos Hornos Zapla, Sociedad Mixta Siderurgia Argentina (SOMISA), Industria Argentina de Aceros, S.A. (ASINDAR).

Altos Hornos Zapla operates an integrated iron and steel works in Palpala having four charcoal blast furnaces with daily productivity of 60-150 tons, three Thomas converters, two 12-ton electric furnaces and rolling mills. Annual steel capacity of this works is about 150,000 tons (56).

In 1966 annual production of SOMISA totalled 650,000 tons of iron, 890,000 tons of steel and 750,000 tons of rolled products (53). SOMISA operates an integrated iron and steel works in San Nicolas constructed in 1962. The works currently has a blast furnace, five open-hearth furnaces with a total annual capacity of 1,125,000 tons of steel (11), and a tinplate shop. The company plans to enlarge the works in San Nicolas and to raise the steel production to 2.5 million tons by 1974. To do this it is planned to build a second blast furnace, a second coking plant, an oxygen converter plant (two 160-ton oxygen con-

verters), and a continuous casting installation. Capital investment for these facilities will be nearly $200 million (58, 60). The enlargement of the works will be in stages. First stage: Construction of a sinter plant with daily production of 1,600 tons and modernization of rolling equipment. Second stage: Construction of an oxygen converter plant, a degassing unit and the continuous steel casting installation. Third stage: Putting in operation equipment for charge preparation, construction of the second blast furnace and a coking plant.

Along with SOMISA the companies of ACINDAR, Propulsora Siderurgica and Dalmine Siderca are also engaged in enlargement of their enterprises. ACINDAR is planning to convert its works in Rio Parana near Villa Constitucion into an integrated iron and steel works. A blast furnace, an open-hearth furance (with a capacity of 70,000 tons per year), a basic oxygen converter plant and rolling mills are planned. Cost of construction is estimated at $77 million.

Construction of a new integrated iron and steel works was started by Propulsora Siderurgica in Ensenada (the province of Buenos-Aires) in 1967. The cost of construction is $230 million (6). A cold strip rolling mill with a productivity of 300,000 tons per year will start in 1971, a hot strip mill with a productivity of 1 million tons per year to start in 1973, a blast furnace and an oxygen converter plant by 1975. The initial capacity of this works

will be 500,000 tons of cold rolled strip per year, with ultimate crude steel capacity of 1.3 million tons per year (64).

Dalmine Siderca put into operation a four-strand continuous steel casting unit in July, 1968. The company will increase its steel capacity to 230,000 tons per year by the addition of a third electric furnace (61, 62).

A summary of company by company expansion plans for the Argentina steel industry is given in Table 8 on the following page.

Iron and Steel Trade

In 1967 Argentina imported 564,700 tons of steel products, principally from Brazil, Federal Republic of Germany, Japan, the United Kingdom and the United States.

BOLIVIA

Energy and Mineral Resources

Bolivia has some known reserves of iron ore but they are not mined. There are also tungsten ore reserves and in 1967 tungsten concentrate export totalled 1,600 tons. Some 2 million tons were produced in 1967 (1, 3).

TABLE 8 EXPANSION PLANS OF ARGENTINE STEEL PLANTS, INTEGRATED AND SEMI-INTEGRATED FOR THE PERIOD 1969-1974

FIRM		1968 PRODUCTION Tons per Year	INCREASE Tons per Year	PRODUCTION FORECAST FOR 1974 Tons per Year
Sociedad Mixta Siderurgia Argentina	(1)	850,000	1,650,000	2,500,000
Propulsora	(i) (4)	--	1,300,000	1,300,000
Dalmine Siderca	(1)	170,000	60,000	230,000
La Cantabrica	(2)	65,000	40,000	105,000
Gurmendi	(2)	--	250,000	250,000
Santa Rosa	(2) (6)	150,000	37,000	187,000
Acindar	(3)	100,000	--	100,000
Tamet	(1)	55,000	30,000	85,000
Lucini	(1)	--	126,000	126,000
Cura	(1)	25,000	25,000	50,000
Marathon	(1)	15,000	--	15,000
Zapla	(5)	153,000	--	153,000
Acerias Bragado	(2)	--	(7)	--
TOTAL		1,583,000	3,518,000	5,101,000

(1) Expansion plan approved by Fabricaciones Militares, the government approval authority.
(2) Plan submitted for approval.
(3) Plan submitted and rejected.
(4) Have presented a new plan to reach a production of 2,500,000 t/steel in 1974.
(5) Plan approved for the installation of a rolling plant for special steels; cost $25 M.
(6) Object of expansion is to produce special steels and improve installations.
(7) Have presented a joint plan with Lucini S.A. to produce 100,000 t/year. Only one of the projects has been considered.

Iron and Steel Industry

Bolivia has no iron and steel industry at the present time.

Iron and Steel Trade

Ferrous metal import totalled 44,000 tons in 1966 and 25,000 tons in 1967 (5), mainly tubes and fittings, sections and wire. The principal suppliers are Belgium-Luxembourg, the Federal Republic of Germany, Japan and the United Kingdom.

BRASIL

Energy and Mineral Resources

Brasil is the largest country of Latin America, has the largest steel production, but ranks fifth in per capita steel consumption. Total iron ore reserves of Brasil are amongst the largest known in the world, with 80,000 million tons of probable ore and proved reserves of 10,000 million tons. The ores are of high quality with an average iron content of 55 per cent (1). The largest deposits are in Itabira and in Congolias. They are located in the state of Minas Gerais (reserves of 16,200 million tons with iron content to 69 per cent). Iron ore deposits exist also in the states of Mato Grosso (reserves of 1,300 million tons) and of Bahia (50 million tons) but they have not yet been mined) (17). All present iron ore production in the country

is concentrated in the state of Minas Gerais. Iron ore deposits to date are being exploited by only three companies, Cia. Vale do Rio Doce, Cia. Siderurgica Nacional and Mineira. The state-owned Cia. Vale do Rio Doce's share in total iron ore output in the country is roughly 60 per cent. The company operates some mines in Itabira (100 kilograms from Belo Horizonte) as well as in Cayo, Conceicao and Dos Corregas where the iron ore mining is completely mechanized. Iron ore production at the mines of Cia. Vale do Rio Doce in recent years has been nearly 15 million tons annually (21). Due to the increasing quality requirements for iron ore, Cia. Vale do Rio Doce has been increasing its facilities for producing agglomerated iron ore. In 1966 this company made a contract with VOEST, AG (Austria) for constructing a pellet plant with an annual capacity of first stage, 2 million tons going on-stream in 1969. A second plant of similar capacity is being constructed, final capacity of 6 million tons per year is projected (28). Iron ore mining capacities in Brazil are expected to increase to over 30 million tons per year in the early 1970s and to 77 million annually tons by 1975. Annual pellet producing capacities should be 9 million tons in the early 1970s and 18 million tons by 1975. Included in mining plans are the large iron ore deposits in the Paraopeba Valley.

Brazil has large deposits of manganese ores with total reserves estimated at 150 million tons (1). The largest

of them are situated in Mato-Grosso. Recently manganese ore deposits have been discovered in the north-west part of the territory of Amapa. In Minas Gerais where mining has been done for a long time the deposits have been exhausted to a considerable extent.

Reserves of chrome ore are estimated at about 5 million tons with principal deposits in Bahia. Reserves of tungsten ore are estimated at 20,000 tons, almost half known and probable. The ore contains up to one per cent of tungsten oxide. Brazil has also the reserves of ores containing niobium and tantalum. Most alloy metal ores being mined are exported to the United States.

Potential reserves of coal in Brazil are estimated at 6,000 million tons including known reserves of 2,200 million tons. The principal coal deposits are in the states of Santa Catarina and Rio Grande do Sul. In spite of high content of ash and sulphur this coal is used to produce coke by blending with imported coking coal (40 per cent of indigenous and 60 per cent of imported coking coals). For For this purpose, Brazil imports from the United States some 1.5 million tons of coal annually.

Forest resources have had a great importance in developing the iron and steel industry of Brazil since many blast furnaces operate with charcoal (1967 charcoal iron proportion was 34.3 per cent of pig iron produced).

Natural gas resources in Brazil are estimated at 10 billion cubic meters. Petroleum reserves are some 135 million tons. The principal petroleum fields are in Agya Grandi which account for 63 per cent of total oil output in the country (1).

The installed capacity of electric power stations was 7.5 million kilowatts in 1966 (4).

Iron and Steel Industry

The iron and steel industry of Brazil includes ten integrated works and twenty semi-integrated works with steelmaking and rolling shops. Other non-integrated works have either steelmaking or rolling shops.

An outstanding feature of the Brazilian iron and steel industry is its territorial concentration. Most iron and steel works (including the ten largest ones) are situated in three states in the Eastern part of the country, namely in Minas Gerais, Sao Paulo and Rio de Janeiro. The share of these states in all ferrous metal production in the country is more than 90 per cent (14). The concentration of nearly all iron and steel industry in such small area is due to the availability there of raw materials and fuels, the nearness of the large harbours of Rio de Janeiro and of Vitoria as well as the locally well developed transportation.

More than 50 companies are engaged in ferrous metal

in the country. The largest of them are Companhia Siderurgica Nacional, Siderurgica Paulista (COSPIA) and Usinas Siderurgica de Minas Gerais (USINIMAS).

The largest integrated iron and steel works in the country is the Companhia Siderurgica Nacional in Volta Redonda, with iron production of one million tons per year, that of steel at 1.4 million tons per year. This plant has four coke batteries, two blast furnaces, eight 200 ton open-hearth furnaces, an oxygen plant with a capacity of 30 tons per day, two electric furnaces, two crucible furnaces, a slabbing mill, two plate mills, one continuous hot strip mill, two cold strip mills, two electolytic tinning lines and two galvanising lines in this works (11). In 1968 all works of this company produced 926,000 tons of iron and 1,344,000 tons of steel (90).

COSIPA founded in 1960 has an integrated iron and steel works at Cubatao (320 kilometers southwards of Rio de Janeiro). Production capacities of this works commissioned in 1966 were 500,000 tons of pig iron and 600,000 tons of steel per year. Final crude steel capacity of the works is planned to be 2.5 million tons per year. The plate has two coke oven batteries, the largest blast furnace in Brazil with a daily production planned for 2,000 tons, two 75-ton oxygen converters, an 1,100 millimeter slab mill, plate and hot and cold strip mills (11, 31). In 1968 COSIPA produced 489,000 tons of pig iron and 557,000 tons of crude steel (90).

Construction of the integrated iron and steel works of USIMINAS started at Ipatinga in 1956. The first stage of this works was completed in 1958. The works has two coke batteries, two blast furnaces, two oxygen converters with an annual capacity more than 600,000 tons of steel and some rolling mills. In 1968 USIMINAS produced 605,000 tons of iron and 649,000 tons of steel (90). Increased capacity to 1.2 million tons per year and later to 2.4 million tons per year is planned (29). The same company plans to build a cold strip mill at the plant in Belo-Horizonte.

A new special steel plant of Acos Anhanguera, S.A. was commissioned in Mogi das Cruses in 1966. The plant's capacity is planned for eventual 200,000 tons per year (32).

A plant for USIBA with a capacity of 200,000 tons of rolled products per year and a plant for COSINOR with a capacity of 120,000 tons of steel per year are to be constructed. A project to build a plant of Metamig Company in Parapeoba Valley has been prepared and approved, its capacity being 2 million tons of sections per year. The cost of construction is $250 million (29).

There are 38 blast furnaces that produce iron in the country (the majority of them have small working volumes and operate on charcoal). About 3 million tons of iron were produced in 1967. Before World War II iron was produced in small blast furnaces operated on charcoal but since 1946 coke was used in some furnaces and by 1964 more

than half of total iron produced in the country was obtained from blast furnaces operated on coke. Nearly 1.7 million tons of coke was produced in Brazil in 1967. Nearly 90 per cent of blast furnace production is iron for steelmaking.

Brazil is one of a few countries of Latin America producing ferroalloys, production of which was over 57,000 tons in 1967. Ferroalloys are produced mainly at plants in Nova Iguaca and Honorio Gurgel and at the plant of Companhia Siderurgica Nacional in Lafayette.

Brazil plans to increase its total steelmaking capacity to 7.5 million tons by 1972 from 1968's 4.5 million (18). Most steel is currently produced in open-hearths, with oxygen converter production sharply increasing, in 1966 being 2 million tons per year. The first two oxygen converters were installed in Brazil at the Cia. Siderurgica Belgo Mineira plant in Monlevade in 1957. Presently six large companies have oxygen steelmaking plants.

Sheets and plates share of total output of rolled steel in the country has also been increasing and was 56 per cent of total in 1966 (19). The largest producers of flat products in Brazil are Cia. Siderurgica Nacional, COSIPA and USIMINAS and the principal producer of tubes is Cia. Siderurgica Mannesmann.

Iron and Steel Trade

Brazil presently makes 100 per cent of pig iron domestically and 80 per cent of the country's rolled products requirements. Most imported steel still consists of sheets and plates. The main suppliers of rolled products are the Federal Republic of Germany, Japan, the United Kingdom, the United States and Yugoslavia. Brazil also exports some steel mainly to other Latin American countries. The Government of Brazil has set up regulations which tend to limit steel imports and to increase exports. Brazil is also one of the world's major producers and exporters of iron ores, with total production of 30 million tons expected to double in the 1970s.

CHILE

Energy and Mineral Resources

High quality iron ore exists in Chile with total reserves estimated at 1,000 million tons (1). The largest deposits are at El Laco, Algarrobo, and Santa Fe with combined reserves of nearly 500 million tons of high grade ore (17). A newly discovered deposit at Bequeron Chanar has reserves of 80 million tons of high quality ore and 70 million tons of low quality ore. The principal iron ore deposits being mined are in the provinces of Atacama and Cocimbo. These deposits are mined by three companies (Minera Santa Fe, Bethlehem Chile Iron Mines and Acero de Pacifico) which together produce 80 per cent of all iron

ore in the country. Deposits in Cocimbo, Capiaop and Chaniaral are mined by Minera Sante Fe. This company's El Laco deposit is situated in an area with difficult access and is not yet mined. The deposits of El Romeral and El Tofo have been mined by Bethlehem Chile Iron Mines for 70 years, and the latter deposit is consequently exhausted. A concentrating plant with capacity of 60 tons per hour was started at the El Tofo mine in 1965 to process ores from the mine's dumps (68). Bethlehem is investing $20 million in the development of El Romeral mine to increase its production from 3 to 4.5 million ton of iron ore annually. Included is a new beneficating plant to start in 1972 with capacity of about 1.6 million tons of concentrates per year. Overall iron ore production in Chile is expected to be nearly 20 million tons per year in the early 1970s (29). Almost 90 per cent of iron ore produced is exported, mainly to the Federal Republic of Germany, Japan, and the United States.

Total reserves of manganese ores are 22 million tons (including 1 million tons of proved, balance probable ores). The principal deposits are located in the province of Cocimbo, with a content of manganese varying from 27 per cent to 53 per cent. Annual production is approximately 40,000 tons, a small part of which is exported, the balance being used to produce ferromanganese (1).

Coal reserves of Chile are estimated at 700 million tons

including proved reserves of 60 million tons. Nearly 80 per cent of all coal mined in the country comes from near Hauchipato and is used primarily for domestic steel production. In recent years coal production was 1.7 million tons per year, and some coking coal has been imported (19).

Iron and Steel Industry

In 1966 Chile was second in per capita steel production in Latin America and third in per capita steel consumption.

An integrated iron and steel works of the Cia. de Acero del Pacifico (CAP) is situated in Hauchipato. Its construction was started in 1947 and have been followed by several series of expansions. Presently CAP's plant has the following equipment: 70 coke ovens; two blast furnaces with hearth diameters of 6.3 meters and capacities of 950 and 1,100 tons per day, (the larger uses oil injection) (70); two 100-ton and two 200-ton open-hearth furnaces; a blooming mill and rolling mills producing bars, plates, sheets; two galvanising lines and five hot dip tinning lines. Further expansion plans include a third blast furnace, two oxygen converters, two continuous casting machines, a light-section mill, an electroplating tinning line and a third galvanising line. Crude steel capacity will be increased to 1 million tons annually (11).

Cia. de Productos de Acero makes electric welded tubes in a plant at Hachiuato. Production in 1967 was 10,000 tons of tubes and 3,000 tons of cold-rolled shapes. The company plans an increase in capacity to 22,200 tons per year by 1974.

Chile has five smaller steelworks, four using electric furnaces to make both special quality and merchant bar steels. Total steelmaking capacity is less than 75,000 tons of crude steel, with somewhat higher finishing capacity. The plant of Carburo y Metalurgia is located in Santiago. It produces ferromanganese, silicomanganese, ferrosilicon and other alloys, with 1967 production of 9,900 tons.

Iron and Steel Trade

Ferrous metals imported mostly from Japan and the United States average less than 100,000 tons per year, consisting mainly of railway materials, tubes and fittings (19).

Chile also exports up to 30,000 tons of steel products per year to other Latin American countries.

COLOMBIA

Energy and Mineral Resources

Colombia possesses relatively small reserves of iron

ore, adding up to 120 million tons including 50 million tons of proved and probable reserves with an average iron content of 47 per cent (1). Resources of Paz del Rio deposit situated at the north of the country are estimated at 100 million tons of ore containing an average 48 per cent of iron (17). Iron ore deposits are known in the vicinity of Medellin.

Small deposits of manganese ore exist in the country but are not yet mined. Recently two large deposits of nickel bearing ores were discovered in the department of Cordoba. Capital investment to exploit these deposits was estimated at $44 million (72).

Potential reserves of coal in Colombia are estimated at 12,500 million tons including proved reserves of 210 million tons. There are some probable deposits of coking coal as yet not completely studied. Principal coal deposits are located north-east of Bogota. Output of coal is at a 3 million tons per year level, the highest coal production of any country of Latin America.

Known petroleum reserves total 230 million tons, with principal fields in the basin of the river Magdalena and Lake Maracaibo. In 1969 40 million tons of petroleum were produced, a large part of which was exported.

Iron and Steel Industry

The integrated iron and steel works of Acerias Paz del Rio in Belencito accounts for 90 per cent of domestic ferrous metal production. Equipment includes a sinter plant, coke ovens, a blast furnace, three 20 ton basic Bessemer converters, one 20 ton electric furnace and rolling mills producing billets, heavy and light sections, rails, flat-rolled, a galvanizing line and wire products. Current steelmaking capacity of 250,000 tons of crude steel is to be increased to 500,000 tons by the mid-1970s, with a new blast furnace, oxygen converters and related raw materials and finishing equipment (74).

Siderurgica del Pacifico operates a 30,000 ton per year steel plant with electric arc furnaces and rolling mills producing merchant bars and some special steels. In 1967 Empresa Siderurgica put into operation electric furnaces, rolling mills and two welded tube mills. The company plans to install another electric furnace, continuous casting and a tinning line in its non-integrated iron and steel works.

Construction of three new iron and steel works is foreseen in Colombia (18, 73). An integrated iron and steel works at Tibate (near Medellin) with a steelmaking capacity of 300,000 tons per year, an iron and steel works at Barranquilla (a harbour in the north of the country) with a capacity of 100,000 tons of plates and sheets per year

and an iron and steel works with a capacity of 100,000 tons of steel per year at Sinacura (near Bogota) might be built. In 1970 Acerias de Colombia started operation of a galvanized sheet plant.

Iron and Steel Trade

At the present time, steel products are still imported. In 1967, 101,000 tons of steel came into Colombia, mainly from the Federal Republic of Germany, Japan, the United Kingdom and the United States.

ECUADOR

Energy and Mineral Resources

Ecuador has potentially large mineral resources, still very little developed.

Iron and Steel Industry

Ecaudor's only steel producing plant belongs to Acerias Nacionales del Ecaudor, located in Guayaquil, and has a rolling mill with 25,000 tons per year capacity of reinforcing bars.

Iron and Steel Trade

Import of ferrous metals totalled 75,200 tons in 1967, the principal supplier being Belgium-Luxembourg and France.

MEXICO

Energy and Mineral Resources

Mexico has the highest national income in Latin America and is second to Brazil in population and in ferrous metal production. The country is rich in iron ores, with potential reserves estimated at 900 million tons (1). The largest deposit is Sierra de Marcado (the state of Durango) with reserves estimated at 150 million tons of ore containing over 60 per cent iron. Recently a large deposit of iron ore was discovered in Pena Colorado on the Pacific seacoast (the state of Colima), with estimated reserves of 130 million tons of 69 per cent iron (27). Other deposits are at Las Truchas, which has 145 million tons of 50 per cent iron ores and Nuevo Leon with 100 million tons at 58 per cent iron (17). A new mine in Pena Colorado will have 2 million tons of iron ore output annually (36). Total production of iron ores in Mexico has been about 3 million tons annually.

Total reserves of manganese ore are estimated at 7.2 million tons. Only the deposit at Autlan (in the state of Jalisco) is now being mined with ores of up to 45 per cent manganese. Mining the manganese ore deposit of Molango (the state of Hidalgo) was to be started in 1968. Manganese ore production has been about 60,000 tons per year. Almost all iron and manganese ore produced is consumed in Mexico, with only a negligible part exported,

mainly to the United States.

Total coal reserves in Mexico are estimated at 4,000 million tons with known reserves of 500 million tons. The principal coal deposits are situated in the states of Oaxaca, Cohuila, and Sonora. Reserves of natural gas are estimated at 283,200 million cubic meters, with the principal reserves concentrated in the north-eastern part of the country. Mexico is the fifth country in the world in natural gas production, with some of the gas produced exported. Proved petroleum reserves amount to 338 million tons, with the principal fields concentrated near the Gulf of Mexico. The state-owned company Pomex controls oil production and refining.

Iron and Steel Industry

The iron and steel industry of Mexico consists of nearly 60 companies, of which four are integrated, several are non-integrated, and the balance having rolling or finishing mills. More than half steel products rolled consist of sheets and reinforcing bars. Steel tube output of Mexico accounts for two-thirds of total tube production in Latin America.

The four largest steel companies Cia. Fundidora de Fierro y Acero de Monterrey, S.A., Altos Hornos de Mexico, S.A., Hojalata y Lamina, S.A., and Tubos de Acero de

Mixico, A.S. (TAMSA) produce 90 per cent of Mexico's steel. Only the Cia. Fundidora de Fierro y Acero de Monterrey, S.A. existed prior to World War II.

Altos Hornos de Mexico, S.A. is a state-owned company. In 1967 the iron and steel works of this company produced nearly 70 per cent of total iron and more than 40 per cent of total steel in the country. The company has three iron and steel works located in Monclova, Pedras Negras and Mixico, DF. The iron and steel works in Monclova is integrated. Equipment includes a coke plant, sinter plant, three blast furnaces, an eight furnace open-hearth shop making 1.4 million tons per year, a blooming-slabbing mill, a hot strip mill, plate mill, cold strip mills, hot dip tinning lines and one glavanising line. Expansion is under way with a fourth blast furnace, a blooming mill, an oxygen converter plant having two 60 ton oxygen converters with annual capacity of 500,000 tons (to be increased to 1 million tons later) (39). Steel production of Altos Hornos de Mexico, S.A. was nearly 1.35 million tons in 1967 and is to be increased to 3 million tons in the early 1970s, and to 4 million tons by 1980. Expansion plans include building a new iron and steel works in Las Truchas in one of the most important iron ore producing areas (the state of Michoacon). A sinter plant, ten electric ore reduction furnaces, an oxygen converter plant and some rolling mills are projected to be built at this location (41).

The iron and steel works of the Fundidora de Fierro y Acero de Monterrey, S.A. has three blast furnaces (including one producing ferromanganese), eight open-hearth furnaces (four 90 tons and four 225 tons), a blooming-slabbing mill, rolling mills, a billet mill, a plate mill, a continuous hot strip mill, a rail and structural mill, three cold strip mills and a continuous galvanizing line (11). A 1320 millimeter continuous cold strip mill was put in operation in 1968. In 1966 the company's crude steel production was 563,000 tons. Its steel capacities are planned to be 1.5 million tons by 1975 and 2 million tons by 1980.

Hojalata y Lamina, S.A. is probably the world's largest producer of sponge iron. It has an iron and steel works in Monterrey having a sponge iron producing plant, a steelmaking and a rolling plant. Iron ore is delivered to the works from the mines at El Ensina. Sponge iron is produced in two direct reduction units using natural gas and with daily production of 200 and 500 tons. The iron-content in the finished sponge is about 85 per cent (44). Sponge iron is charged in seven arc furnaces with a total crude steel capacity of 450,000 tons per year. Charge consists of 50-75 per cent sponge iron and 25-50 per cent scrap. The Monterrey plant includes two hot strip mills, two cold mills, a temper mill, a hot dip tinning line and an electrolytic tinning line with capacity of 60,000 tons per year. Hojalata y Lamina, S.A. has a capacity of

500,000 tons of crude steel per year (46). The company has recently put a new integrated iron and steel works on-stream in Puebla at the distance of 115 kilometers from Mexico City. This plant also uses sponge iron in an electric furnace shop having a capacity of 300,000 tons crude steel. The plant operates two four-strand continuous casting machines ahead of a rolling mill producing bars, sections and wire rods (47). Investment costs are estimated at $42 per annual ton (48). Current crude steel capacities of the Hojalata y Lamina, S.A. group are about 800,000 tons, to be increased to 1.5 million tons per year by 1975 and to 2 million tons per year by 1980.

Tubos de Acero de Mexico, S.A. (TAMSA) has an iron and steel works in Vera Cruz of 250,000 tons crude steel capacity from three 50 ton electric furnaces, followed by three rolling mills specializing in seamless tube production. The third direct reduction sponge iron plant in Mexico was put on-stream in this works in 1967, making 500 tons per day (49). Steel production capacities of TAMSA are 250,000 tons per year, with planned increases to 600,000 tons by 1975 and to 800,000 tons by 19..

The Government of the State of Colima has announced its decision to build a new integrated iron and steel works with the capacity of 1 million tons per year, using the iron ore deposit of Pena Colorado (34).

Iron and Steel Trade

Current domestic steel production in Mexico supplies about 80 per cent of total consumed. Major exporters to Mexico are Canada and the United States. Part of Mexico's iron and steel production is exported, again mainly to the countries of Latin America. In 1966, exports amounted to 156,000 tons (50).

PERU

Energy and Mineral Resources

The country has high quality iron reserves estimated at 1,170 million tons, including proved reserves of 500 million tons having 56 per cent iron content. The principal deposits are concentrated in the department of Ica. Proved reserves in this area total 200 million tons of ore with iron-content of 60 per cent (1). Major iron ore production started in Peru in 1955 when 1.7 million tons of ore of up to 58 per cent iron content was mined.

A deposit at Marcona is mined by Marcona Mining Company, which has also built a major iron ore complex near the harbour of San Nicolas. These include a concentrating plant, the first South American pellet plant with a capacity of 1 million tons per year, and a second pellet plant with a capacity of 2 million tons per year. Hematite and magnetite iron ore are treated at these plants and the iron content of the pellets is 67-68 per cent (76). Some

7 million tons of iron ore including 3 million tons of pellets were shipped from Jarcona in 1966 (75). Peru's total iron ore output is expected to be 12 million tons by 1971, most of which will be exported to Japan and the United States (77).

Manganese ore deposits exist in Peru but have not been explored thoroughly, and only a negligible quantity of manganese ore is produced at one mine. Coal reserves of 600 million tons exist, consisting of both bituminuous and anthracite qualities. Some coking coal deposits are known. Annual coal production amounts to 170,000 tons, coke production is nearly 40,000 tons per year.

Iron and Steel Industry

In 1958 Peru started creating the integrated iron and steel works of a state-owned Sociedad Siderurgica de Chimbote whose capacity is currently more than 300,000 tons of steel per year. The iron and steel works in Chimbote, situated on the seacoast in the area of coal and iron mining is supplied power from a hydroelectric power station in the valley of the river Santa. The Chimbote plant has two electric smelting furnaces plus a 200,000 ton per year blast furnace, two 30-ton arc furnaces, two 25-ton oxygen converters, a continuous caster, and rolling mills to make merchant bars and billets.

Plans to build a special steelmaking plant at Caplina

in the southern part of the country have been studied. The expected cost of its construction would be $24 million (78). A plant for producing tubes of large diameter with a capacity of 25,000 tons per year has also been proposed.

Iron and Steel Trade

The Chimbote plant supplies only 30 per cent of Peru's steel requirements. Sheet, plate, sections, tubes and tinplate are main imports, totalling 174,000 tons in 1967, with principal suppliers being Belgium-Luxembourg and Japan. Small amounts of steel are exported from Peru into other countries of Latin America.

URUGUAY

Energy and Mineral Resources

Raw material resources of Uruguay available for developing an iron and steel industry have been very little explored.

Iron and Steel Industry

Uruguay has the lowest per capita steel consumption among those Latin American countries that produce steel. Nervion Sil is the only steel producer, operating a 12-ton open-hearth furnace, a small electric furnace and a billet mill, making semi-finished steel (29). Cinoca S.A. has three small plants producing billets and welded tubes

(5,000 tons per year) and a small amount of ferroalloys. Some 25,000 tons of reinforcing steel can be rolled per year at the Industria Nacional Laminadora, S.A. plant (11). Several other companies produce galvanized sheets.

Total rolled steel output in Uruguay amounted to 26,000 tons in 1966 (80).

Iron and Steel Trade

Some 13,000 tons of steel were imported by Uruguay in 1967, mainly from Belgium-Luxembourg, the Federal Republic of Germany and the United Kingdom.

VENEZUELA

Energy and Mineral Resources

Venezuela has considerable iron ore reserves, amounting to 2,100 million tons of ore containing more than 50 per cent iron, including proved reserves of 1,600 million tons (1). The richest deposits are in El Pao (reserves of 250 million tons of ore containing 68 per cent iron) and Sierro Bolivar having 1,400 million tons and 63 per cent iron respectively (17). A new large deposit near Guri was discovered recently with total reserves estimated at 200 million tons of ore containing 48 per cent iron (65). Iron ore mining at the deposits of El Pao and Sierro Bolivar is carried out by two companies, Orinoco Mining (85 per cent of production) and Iron Mines (15 per cent of production)

with the participation of the United States Steel Corporation and Bethelhem Steel Corporation. Orinoco Mining is putting on-stream a highly-metallised briquet plant of 1 million tons capacity in Porto-Ordaz (66).

Venezuela is second in Latin America in the amount of iron ore produced. Ninety-seven per cent of iron ore mined is exported mainly to the Federal Republic of Germany, Japan, and the United States.

Proved reserves of coal are negligible, with total coal production only 34,000 tons in 1966 (1). Indigenous coals can be used for coke production providing they are mixed with imported coal. Venezuela is third in the world in crude petroleum production (in 1968 amounting to 15.8 million tons) and first in petroleum export. A 934 billion cubic meters reserve of natural gas exists in the country, with very mininal current production.

Iron and Steel Industry

Venezuela is first of the Latin American countries in its per capita steel usage, both in domestic production and apparent steel consumption. The domestic steel industry of Venezuela includes an integrated iron and steel works, two steelmaking and rolling plants and a sheet galvanising plant. Crude steel production in Venezuela is expected to reach 1.5 million tons by 1975 and over 2 million tons by 1980.

Venezuela's integrated works belongs to the state-owned Siderurgica del Orinoco, C.A. (SIDOR) with its plant located in Matangas. The plant's equipment includes: a million ton sintering plant, nine electric smelting furnaces with a total capacity of 650,000 tons of pig iron per year, four 250-ton open-hearth furnaces with a total capacity of 800,000 tons per year, a blooming, and billet rail, structural and section rolling mills, and a seamless tube mill with a capacity of 300,000 tons per year (11). Steelmaking capacities of SIDOR are to be increased to 1.2 million tons per year, with rolling capacity for flat-rolled products, and a strip galvanizing line. Siderurgica Venezolana (SEVENSA) is a privately owned plant with two electric furnaces, continuous casters, and rolling mills for merchant bars and wire rod. Total capacity of the plant is 120,000 tons per year.

Lamigal Company has been operating a facility making 24,000 tons of galvanised sheets annually since 1964. This plant was built with the participation of Japanese companies (29). Sidero-Galvanica S.A. operates a galvanised sheet plant of 20,000 tons per year capacity.

Iron and Steel Trade

Strip, plate and sheet predominate among the more than 300,000 tons of steel products imported annually by Venezuela (19). Imports come mainly from Belgium-Luxembourg, the Federal Republic of Germany, Japan and the United States.

THE COUNTRIES OF CENTRAL AMERICA

The mineral resources of the countries of Central America are insufficiently known. Deposits of iron ore in Honduras, Costa Rica and Salvador exist but are not mined. Minor reserves of chromite ore are known in Guatemala. Mining of ore was started at the time of World War II and totalled 28,000 tons in 1963. Coal resources (including brown coal) in Honduras are estimated at 5 million tons. In a number of countries charcoal production is possible (29). Electric power output in all countries of Central America totalled more than 2,500 million kilowatt-hours in 1965, half of which came from hydroelectric plants (29).

Nearly all the requirements for ferrous metals in these countries are met by imports, totalling about 300,000 tons in 1966, and at approximately equal levels in each nation (83). Billets, sections, sheets and plates, and tubes are the main items of imports. Principal suppliers are Belgium-Luxembourg, France, the United Kingdom and the United States. Small non-integrated works are presently proposed in all countries of Central America.

COSTA RICA

In Costa Rica a steel tubemaking plant with a capacity of 6,000 tons per year is being constructed by Industrias

Metallurgicas (INMENCA) with the participation of Mannesmann A.G. (the Federal Republic of Germany) (84). A galvanizing line is operated by Metales, Cia. S.A. producing in 1967, 11,000 tons. An increase in the country's capacity of galvanized sheets to 30,000 tons will result when a second line goes into operation (85).

EL SALVADOR

In El Salvador there is a small foundry working on scrap. A plant to produce galvanised sheets with a capacity of 1,000 tons per year, and a tubemaking plant are planned. A plant to produce bolts and nuts with a productivity of 600 tons per year may be constructed with the assistance of Japanese companies.

GUATEMALA

In Guatemala there is a sheet galvanizing plant with a capacity of 12,000 tons per year. It has also been built with the financial and technical assistance of Japanese firms (86). Aceros Suares has a small plant with a rolling mill capacity to produce 30,000 tons of merchant bars annually (87).

HONDURAS

There are no steel plants in Honduras. Altos Hornos de Mexico has studied the possibility of building a steel-

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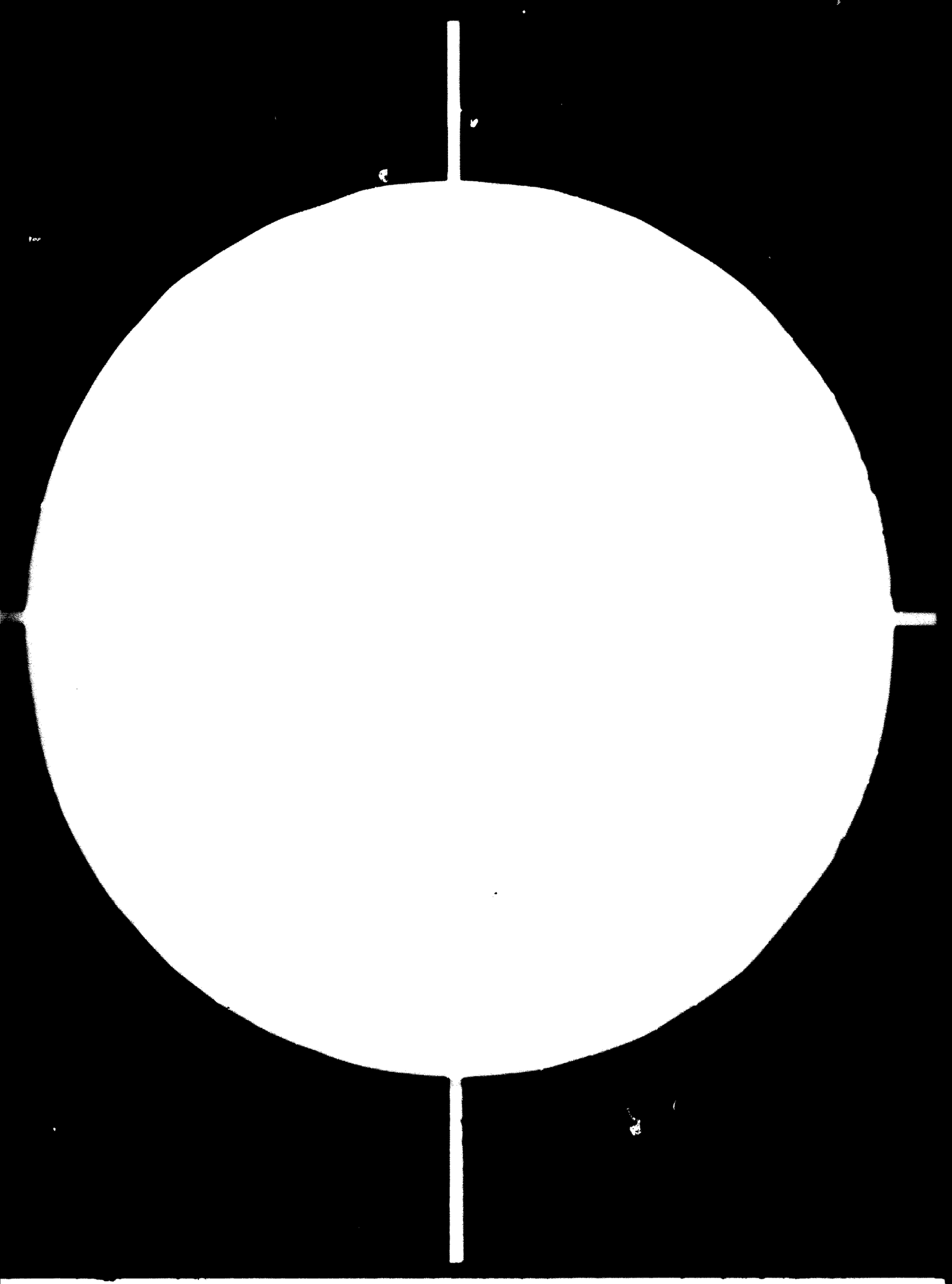

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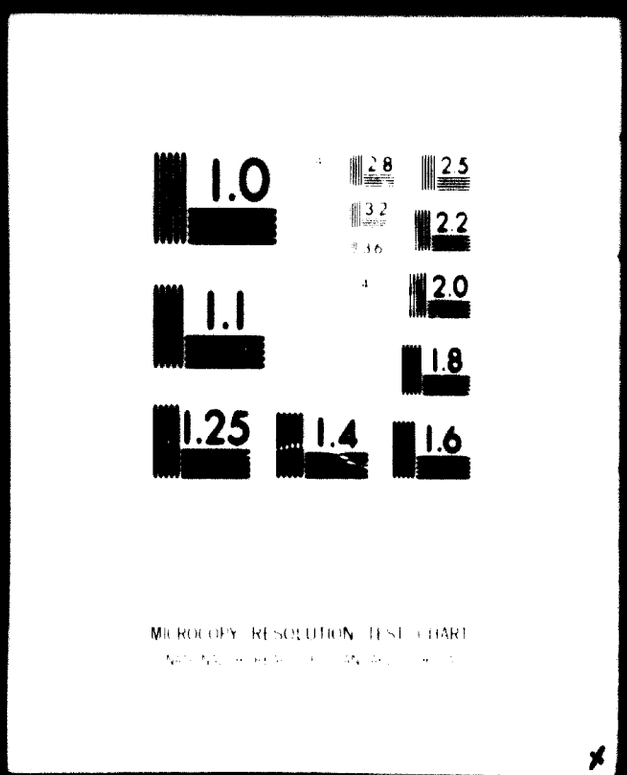
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making plant there with a capacity of 50,000 tons of steel per year (29).

NICARAGUA

In Nicaragua Cia. Aceros Nacionales was established in Managua in 1965 and plans to build a plant with capacity of 10,000 tons of tubes and sections per year (29).

PANAMA

In Panama Cia. Hierro Technica purchased the equipment (in Federal Republic of Germany) for a plant with a capacity of 6,000 tons of steel sheets per month. Production of this plant is designed for the automobile industry (88). Acero Panama S.A. established in 1961 operates a small electric furnace plant with a rolling mill having a capacity of 20,000 tons per year of reinforcing bars and wire rod.

CARIBBEAN COUNTRIES

CUBA

Cuba's economic activity is still primarily agricultural, with sugar as the chief crop. The country, however, has large mineral reserves, particularly lateritic nickel ores, as well as copper, pyrites and some chrome and manganese ores. Cuba's nickel production, estimated at 40,000 tons in 1969 makes it the world's fourth largest producer. Cuba's iron ore reserves occur mostly as by-product to nickel, sulfur (pyrites) and even copper. Investigations are under way to use the iron-rich (38 per cent iron in the case of Nicaro nickel processing residue) material for steelmaking.

Cuba has in operation a steelmaking plant with four open-hearths having a capacity of 100,000 tons per year to be increased by addition of a fifth open-hearth. Imported scrap is used, and the output is merchant bars and angles. Production in 1969 was 55,000 tons. The government plans to expand steel capacity substantially in the early 70s as basis for an overall heavy industry development. As noted, it is planned that Cuba's nickel-smelting plants will be the basis for a completely integrated iron and steel industry. Aimed-for production will probably be in the range of 250,000 tons annually in the first stage and 500,000 tons in the second stage.

Exact figures on Cuba's imports have not been available for some time. In 1955 and 1960 Cuba imported 269,000 and 216,000 tons, respectively, divided in 1955 as follows: merchant bars 89,000, wire and rod 53,000, plates and sheets 34,000, tinplate 18,000, balance miscellaneous. It is probable that by 1969 imports were at approximately the same level. Most of these were from the Soviet Union and other socialist countries.

JAMAICA

Jamaica is an island of 10,962 square kilometer area situated in the Caribbean Sea about 140 kilometers south of Cuba and 160 miles west of Haiti. Although not strictly a Latin American nation, its location is in the same general area. Jamaica has large reserves of bauxite and gypsum and the country accounts for nearly 25 per cent of world bauxite production.

In 1962 the Caribbean Steel Company, Ltd. was formed, with 50 per cent ownership by the Caribbean Cement Company Ltd. and the balance various Jamaican and outside interests. A steel plant with one 15-ton electric furnace, annual capacity 35,000 tons and an 18 inch and 12 inch bar mills with 80,000 tons annual capacity was built at Spanish Town at a cost of about $2.5 million. The plant uses scrap originating in Jamaica. Production in 1969 was under 30,000 tons.

REFERENCES

1. Mineralnie resursi kapitalisticheskih stran, The All-Union Geological Found, Moscow, 1968.
2. Continental Iron and Steel Trade Reports, 1968, March, II.
3. Gluckauf (in Russian), 1968, N. 15, p. 33.
4. Statistical Yearbook, 1968, 1967, 1966, U.N.

4a. Monthly Bulletin of Statistics, Dec. 69, U.N.

5. Statistics of World Trade in Steel, U.S., New York, 1955-1967.
6. Second Interregional Symposium on the Iron and Steel Industry, Moscow, 1968, Sept. 19, Oct. 9, 1968, Paper A-4.
7. Continental Iron and Steel Trade Reports, 1968, March 22.
8. "BIKI", 1968, No. 67, p. 2.
9. ECE Steel Committee, The World Iron Ore Market (in Russian), No. 332, Add. 9, 5 Sept, 1967.
10. Revista Latin0americana de Siderurgia, 1968, N. 94, p. 19.
11. Iron and Steel Works of the World, 1969, Fifth Edition.
12. Stahl und Eisen, 1967, No. 19, S. 1163-66.
13. Revista Latinoamericana de Siderurgia, 1967, No. 92, p. 49.
14. "BIKI", 1966, N. 114, p. 5.
15. RJ "Metallurgia", 1968, No. 12, 12B22.
16. Aussenwirtschaft, 1966, N. 51, S. 1297.
17. Mining Magazine, 1966, V. 115, No. 3, p. 228.
18. Continental Iron and Steel Trade Reports, Special Edition, 1967, August 25.
19. British Steel Corporation, Statistical Handbook, 1966, V. 1, II, 1965, V. I, II.
20. Tchernaja metallurgia kapitalisticheskih stran, Statisticheskii Sbornik, Metallurgisdat, Moscow, 1964.

21. Continental Iron and Steel Trade Reports, 1967, July 28.

22. Stahl und Eisen, 1966, No. 8, S. 1183.

23. "BIKI", 1968, No. 103, p. 5.

24. Skillings' Mining Review, 1967, V. 57, No. 52, pp.1-8.

25. Metal Bulletin, 1968. N. 5272, p. 16.

26. Metal Bulletin, 1966, N. 5086, p. 19.

27. Mining Journal, 1967, V. 269, N. 6885, p. 105.

28. "BIKI", 1966, N. 46, p. 7.

29. ECE Steel Committee, Add. 7, September 22, 1967, pp. 3-73.

30. Tsvetnaia metallurgia kapitalisticheskih stran sa 1958-1965 godi, Moscow, 1966, p. 210.

31. Metal Bulletin, 1966, N. 5143, pp. 18-19.

32. Blast Furnace and Steel Plant, 1966, V. 54, N. 8, P. 762.

33. Journal du Four Electrique, 1967, N. 2, p. 48.

34. "BIKI", 1967, No. 3, p. 5.

35. Blast Furnace and Steel Plant, 1967, V. 55, N. 3, p. 282.

36. Metal Bulletin, 1967, N. 5229, p. 12.

37. Metal Bulletin, 1967, N. 5223, p. 11.

38. Metal Bulletin, 1967, N. 5233, p. 15.

39. Mining Journal, 1967, V. 269, N. 6889, p. 332.

40. Blast Furnace and Steel Plant, 1967, V. 55, N. 7, p. 648.

41. Tchernie Metally, 1966, No. 23, p. 45.

42. Revista Latinoamericana de Siderurgia, 1967, N. 84, p. 35.

43. Revista Latinoamericana de Siderurgia, 1966, No. 80, p. 35.

44. Iron Age, 1967, V. 199, N. 11, pp. 74-76.

45. Journal of Metals, 1963, V. 15, No. 6, p. 441.

46. La Metallurgie,. 1966, V. 98, No. 1, p. 2.

47. Revista Latinoamericana de Siderurgia, 1967, No. 96, p. 37.

48. Metals U.K., 1967, V. 2, No. 10, p. 7.

49. Mining Magazine, 1967, V. 117, No. 4, p. 258.

50. Continental Iron and Steel Trade Reports, 1967, March 3, p. 14539.

51. Metal Bulletin, 1967, N. 5244, p. 17.

52. Metal Bulletin, 1968, N. 5276, p. 20.

53. "BIKI", 1967, Add. N. 5, pp. 32-33.

54. Iron and Steel Engineer, 1968, No. 1, pp. D-12.

55. Journal du Four Electrique, 1967, No. 7, p. 207.

56. Revista Latinoamericana de Siderurgia, 1966, No. 70, p. 19.

57. "BIKI", 1967, N. 41, p. 5.

58. Blast Furnace and Steel Plant, 1967, V. 55, No. 10, p. 970.

59. Blast Furnace and Steel Plant, 1966, V. 54, No. 8, p. 762.

60. Skillings' Mining Review, 1968, V. 57, N. 22, p. 14.

61. Continentaler Eisenhandel, 1968, N. 9, S. 27.

62. Metal Bulletin, 1968, N. 5303, p. 18.

63. Blast Furnace and Steel Plant, 1967, V. 55, No. 5, p. 440.

64. Mining Journal, 1967, N. 268, No. 6871, p. 321.

65. Metal Bulletin, 1968, N. 5279, p. 16.

66. Metal Bulletin, 1968, N. 5301, p. 18.

67. Skillings' Mining Review, 1966, V. 56, N. 14, p. 18.

68. Metal Bulletin, 1965, N. 5020, p. 18.

69. Mining Journal, 1967, V. 269, N. 6865, p. 279.

70. Metal Bulletin, 1966, No. 5102, p. 17.

71. Mines et Metallurgie, 1967, No. 8, p. 260.

72. "BIKI", 1968, N. 45, p. 5.

73. Mining Journal, 1967, V. 269, N. 6890, p. 180.

74. "BIKI", 1968, No. 66, p. 5.

75. Metal Bulletin, 1966, N. 5159, p. 14.

76. Stahl und Eisen, 1966, N. 1, S. 37.

77. Continental Iron and Steel Trade Reports, 1967, Dec. 14, p. 14924.

78. Mining Journal, 1967, V. 269, N. 6895, p. 269.

79. L'Usine Nouvelle, 1966, N. 15, p. 29.

80. Stahl und Eisen, 1968, No. 1, S. 44.

81. Tchernie Metally, 1966, N. 25, p. 69.

82. Metal Bulletin, 1967, N. 5242, p. 15.

83. Revista Latinoamericana de Siderurgia, 1968, No. 93, p. 18.

84. Metal Bulletin, 1966, No. 5122, p. 13.

85. Metal Bulletin, 1966, No. 5065, p. 14.

86. "BIKI", 1965, No. 22, p. 2.

87. Economica promishlennosti, Abstract Journal, 1967, N. 10, 10A45.

88. L'Usine Nouvelle, 1966, No. 40, p. 28.

89. Metal Bulletin, 1969, N. 5382, p. 30.

90. Metal Bulletin, 1969, N. 6376, p. 26.

CHAPTER 6

THE IRON AND STEEL INDUSTRY OF THE MIDDLE EAST COUNTRIES

The countries of the Middle East have only recently started domestic production of ferrous metals. Small non-integrated works, pre-dominantly for light structurals and bars and pipe mills have been commissioned only in the last few years.

Most countries of the region have considerable petroleum resources and the oil industry is the major factor in the economy of the area. Some general economic data of Middle East countries are given in Table 9 . Reserves of metallurgical raw materials have not been completely investigated in those countries.

Potential reserves of iron ore are estimated at 1,200 million tons of which 1,000 million tons are in Iran and Lebanon (1). Iron ore output in the area is insignificant, being at the level of 60,000 tons in 1967. Deposits of manganese and chrome ores are known in Iran and Jordon. Recent output of manganese ore was nearly 4,000 tons with chrome ore output some 150,000 tons annually, both from Iran. There is as yet no mining in Jordan.

Reserves of coal, including some coking coals, are known only in Iran where there are 300 million tons of potential

TABLE 9 SELECTED STEEL INDUSTRY DATA OF MIDDLE EAST COUNTRIES, 1967

	KNOWN (1) RESERVES Millions, metric tons				PRODUCTION Thousands, metric tons							Consumption of Crude Steel per capita (4)
	Iron Ore	Manganese Ore	Petroleum	Coal	Iron Ore	Manganese Ore	Petroleum	Coal	Electric Energy (2)	Iron Output	Steel Output (3)	
Bahrain	-	-	23	-	-	-	3550	-	-	14	-	-
Iran	560	1	7328	300	60	4	129800	300	-	1,100	-	29
Iraq	2	-	3758	-	-	-	59500	-	1207	178	-	39
Jordan	1	3	-	-	-	-	-	-	-	-	-	-
Kuwait	-	-	9501	-	-	-	115212	-	283	191	-	-
Lebanon	500	-	-	-	-	-	-	-	664	166	-	109
Saudi Arabia	55	-	10449	-	-	-	128928	-	268	121	-	33
Syria	100	-	206	-	-	-	-	-	658	130	-	38

(1) Countries with known reserves usually have considerably larger potential reserves.
(2) Millions of kilowatt-hours
(3) 1966 statistics
(4) Apparent consumption per capita in kilograms
(5) Symbol used - magnitude zero

reserves, with probable reserves of 65 million tons. Recent coal output in Iran has been about 300,000 tons per year. Reserves of natural gas are estimated at 6,200 billion cubic meters including those in Iran at 3,100 billion cubic meters and in Saudi Arabia 700 billion cubic meters.

Petroleum reserves of Middle East countries are estimated at about 36.8 billion tons which amounts to a very substantial portion of total world reserves. In 1967 petroleum output of this region amounted to some 510 million tons.

There are small non-integrated works making merchant bars and pipe in the area, specifically in Lebanon, Saudi Arabia, Kuwait, Iraq and Iran. In Iran a fully-integrated works with annual capacity of 500,000 tons of crude steel is planned with the technical assistance of the Soviet Union. Some of the other countries of the region have also announced plans for iron and steel facilities.

Although countries of the Middle East are smaller than developing countries of Africa in respect to population and land areas they import considerably more steel products. Annual tonnage of such imports by Middle East countries increased from 633,200 to 2.1 million tons from 1955 to 1967 (6, 7). Most steel imported is used in the petroleum, construction and agricultural industries. Heavy and light sections, steel pipe and fittings are the major

imported steel products (81).

The principal sources of finances for industrialization of Middle East countries are petroleum sales and royalties. It should be emphasized that unsettled conditions in the Near East have adversely affected projects for constructing new iron and steel plants. In addition, there are shortages of skilled workers and management, as well as scarcity of domestic steelmaking resources. Because of these detrimental factors as well as the likely continuing growth in demand for ferrous metals, it is probable that countries of the Middle East will continue to defend largely on imports of steel. Total imports will increase to 5 million tons by 1980.

BAHRAIN

Energy and Mineral Resources

No exploration for iron ores has been done. Estimated petroleum reserves are 23.2 million tons, with 1967 output at 3.55 million tons.

Iron and Steel Industry

Bahrain has no iron and steel industry at the present time.

Iron and Steel Trade

In 1967, ferrous metal imports were 14,200 tons consisting primarily of sections and steel tubes and fittings.

IRAN

Energy and Mineral Resources

Potential iron ore reserves of the country are estimated at 560 million tons with up to 61 per cent iron content. Output is presently only 60,000 tons (1966). Intensive exploration has been under way since 1965, with search for iron ore deposits preceding planned construction of an iron and steel works. There are approximately 15 million tons of high-grade iron ore in the Chogard deposit situated 10 kilometers to the north-east of the Bafk Oasis. In the same deposit some 50 million tons of nominally 60 per cent iron ores exist at a depth of several hundred meters. Other probable deposits exist, including 80 million tons of 63 per cent iron content in the Bafk-lead area. Large deposits are potentially available at 200 kilometers distance from Isfahan (10).

Iran has some reserves of manganese and chrome ores. Potential reserves of 30 per cent manganese ore are estimated at 0.5 million tons, with proved ores of 0.1 million tons. Potential reserves of chrome ore are estimated at 50 million tons, with chrome ore now being mined in Horasan and Kerman. In 1965, 3,600 tons of manganese ore

and 152,400 tons of chrome ore were produced (1).

Potential reserves of coal in Iran amount to approximately 300 million tons with proved reserves of 65 million tons. Coking coal exists in Hojedk Dar Tangal area to the north east of Kerman, where up to 20,000 tons are mined annually for local consumption. The coal is produced in small mines belonging to the state (1).

Probable natural gas reserves are estimated at 3,100 billion cubic meters, with 1965 output at 1.23 billion cubic meters. It is anticipated that natural gas production will increase to 5.5 billion cubic meters per year after the completion of the Transiranian gas pipeline. Iran is third in the countries of the Middle East with proved reserves of petroleum estimated at 7.3 billion tons. Power generating capacity of 791,000 kilowatts, with 1966 generated power of over 2 million kilowatt-hours (2).

Iron and Steel Industry

In 1967 Ahwaz Pipe Mills Company completed construction of the country's first pipe plant. The plant has a capacity of 450,000 tons of electric welded pipe in two size ranges made on four pipe mills. Cost of the works is estimated at $1,?00,000. The plant employs 220 workers and 45 engineering and management personnel. An agreement with the U.S. Torrarce Machine Company was concluded for training Iranian personnel over a five year period for

running the plant. It is anticipated that the 450,000 ton annual capacity will cover 80 per cent of demand for pipe for the construction of the Transiranian gas pipeline. Another works is now planned by the same company (5, 11).

Iran's first rolling mill was commissioned in 1967 by Iranian Rolling Mills Company in South Ahwaz. Built by Demag A.G. (Federal Republic of Germany) the mill started up with 65,000 tons of light section capacity per year using imported billets (5). A rod mill of 85,000 tons annual capacity has been added for a total annual capacity of 150,000 tons (5). Cost of constructing both mills is estimated at $17 million. Capital was furnished by both private and government Iranian sources, plus Demag A.G. and Engelhardt Industries (United States). It is planned to raise capacity to 400,000 tons per year, with two electric arc furnaces using Hyl sponge iron

A Soviet-Iranian agreement was concluded in 1966 to construct an iron and steel works of 600,000 tons annual capacity of 1971. The plant is located at 40 kilometers west of Isfahan, on the Sajanderoot River. The plant is designed for step-by-step increases in annual capacity to 4 million tons. Initial products will be heavy and light sections, rails and merchant bars. The plant is to be operated by the National Iranian Steel Corporation and is being furnished by the Soviet Union. The site for the works was determined by the availability of water power and transportation to connect the works with major centers of ferrous

metal consumption, viz. Teheran and Ahwaz. A dam for providing the plant with water is to be constructed on the Sajanderoot River. Iron ore will be delivered from the Chogard deposit, whose reserves are estimated to last 25 years. Since 1967, underground development of a coal mine in Hojedk Dar Tangal has been underway. A railway connecting Isfahan with Kashan-Iesd (near Ardekan) is also being built. The railway will link the iron and steel works with Togalgard village located near coal mines of four Bavk and Sarand fields. The Iranian government has allocated $40 million for constructing the 800 kilometers of railway (12, 13).

Iron and Steel Trade

In 1967 Iran imported 1,100,400 tons of iron and steel products, consisting mostly of sections and steel tubes and fittings. It is anticipated that total iron and steel demand of the country will increase to 4 million tons by the mid 1970s, with continuing needs for high level of imports.

IRAQ

Energy and Mineral Reserves

Iron ore reserves have not been adequately explored. Proved reserves in known deposits are estimated as low as 2 million tons. In 1967, proved oil reserves were

estimated at 3.7 billion tons, with oil output at 59.5 million tons (3, 4). In 1966, 1,207 million kilowatt-hours of electric power was produced.

Iron and Steel Industry

An electric-weld pipe plant of 10,000 tons annual capacity went into production in 1966. Iraq's government has also arranged with the Soviet Union for construction of a steel plant with annual capacity of up to 100,000 tons of sections and 9,000 tons of iron pipe and castings.

Iron and Steel Trade

Iraq's steel imports in 1967 were 177,500 tons, primarily of sections and steel tubes and fittings.

ISRAEL

Energy and Mineral Resources

No important deposits of raw materials for the iron and steel industry are known in Israel. Proved petroleum reserves are 4.2 million tons, with output in 1965 at 203,000 tons. Installed generating capacity was 720,000 kilowatts, with power production in 1964 at 3,644 million kilowatt-hours.

Iron and Steel Industry

Little progress in Israel's industrialization program has been made with the iron and steel industry, because the supply of raw materials is inadequate. In particular, Israel has virtually no iron ores or coal and only limited hydro power resources. The country presently has a small steelmaking plant and two steel-using plants.

Israeli Steel Mills Ltd., founded in 1959, operates two 50-ton open-hearth furnaces with annual capacity of 90,000 tons, and two rolling mills with annual capacity of up to 100,000 tons of merchant bars and light sections. Middle East Tube Company, Ltd., produces various types of steel tubes, including electric welded and seamless. Output was 45,000 tons in 1963. Pecker Plada Ltd. processes steel sheets and plates into formed sections, containers, hoops and so on.

Iron and Steel Imports

About half the requirements of Israel domestic market are supplied by imports. Plates and sheets of various kinds, especially uncoated sheets, are the main import item. Principal suppliers are Belgium, the Federal Republic of Germany, France, the United Kingdom, and the United States.

JORDAN

Energy and Mineral Resources

The only known reserves of iron ore contain 500,000 tons of 60 per cent iron and are located in the Ajlun area. Potential manganese ore reserves of 3 million tons exist with proved reserves of 1 million tons at average manganese content of 50 per cent (1).

Iron and Steel Industry

Jordan Iron and Steel Industry Company, Ltd., (in cooperation with Italian companies) in the mid 1960s started up a bar mill with an annual capacity of 50,000 tons of reinforcing bars.

Iron and Steel Trade

Billets for this mill are imported, as is the additional small amounts of finished steel used in Jordan.

KUWAIT

Energy and Mineral Resources

There is no information about any iron ore reserves in the country. In 1967, proved oil reserves amounted to 9.6 billion tons, with production that year of 115 million tons. In 1966, 983 million kilowatt-hours of power was generated (2, 3).

Iron and Steel Industry

Kuwait Metal Pipe Industries, operates a plant in Sheba with an annual capacity of 15,000 tons of helically-welded pipe. Technical and financial assistance was furnished by Japanese companies. Annual capacity increases to 30,000 tons are planned, including butt-welded and galvanized pipe (5). There is a possibility that the Indian Heavy Engineering Company will supply a semi-integrated works, with arc furnaces and a rolling mill of annual capacity up to 50,000 tons (5, 17).

Iron and Steel Trade

In 1967 Kuwait's ferrous metal imports amounted to 190,600 tons consisting primarily of sections and steel tubes and fittings.

LEBANON

Energy and Mineral Resources

Potential iron ore reserves of the country are estimated at 500 million tons of up to 50 per cent iron content. Coal fields are known in Vitoli and Besharre areas. Only a lignite deposit near Tarablus is presently being worked. Power capacity in the country in 1966 was 374,000 kilowatts, with electric power of 765 billion kilowatt-hours.

Iron and Steel Industry

There are three ferrous metal plants rolling sections and one making pipe in Lebanon. Lebanon Steel Mill Company has a plant in Tripoli of 100,000 tons annual capacity making steel in a 7-ton electric arc furnace and with three section mills. Societe National des Tubes operates a tube welding and galvanising line in Beirut. A reinforcing bar mill of 120,000 tons annual capacity is operated at the Byblos-Amchit works of Consolidated Steel Lebanon Company. Tubes du Levant Company operates a similar works in Beirut.

Iron and Steel Trade

In 1967 Lebanon imported 166,000 tons of steel, consisting primarily of billets, sections and sheet and strip.

SAUDI ARABIA

Energy and Mineral Resources

Potential iron ore reserves of the country are estimated at 55 million tons of 50 per cent iron content. A deposit in Wadi Fatima with potential iron ore reserves of 30 million tons of ore containing 45.6 per cent iron is best known. In 1967, oil reserves were estimated at 10.4 billion tons, with oil output of 128.9 million tons. Natural gas reserves are estimated at 700 billion cubic meters, with production in 1967 of 227 million cubic

meters (14). Power capacity in the same year was 94,000 kilowatts, with 269 million kilowatt-hours generated.

Iron and Steel Industry

In 1967, an eleven-stand section mill with annual capacity of 15,000 tons (one-shift operation) was commissioned at works constructed by the state-owned General Petroleum and Mineral Organization (Petromin). Equipment was supplied by the Loewy Robertson Engineering Firm (United Kingdom) (7).

In 1966, the Saudi Arabian government concluded a contract with several Japanese companies for financing and delivering equipment for the construction of a 50,000 ton capacity plant to produce helical-welded pipes. There is no further information about this contract.

Iron and Steel Trade

In 1967, ferrous metal imports amounted to 120,700 tons, consisting mostly of sections and steel tubes and fittings.

SYRIA

Energy and Mineral Resources

Potential iron ore reserves of the country are estimated at 100 million tons of 32 per cent iron content.

Oil and natural gas reserves are estimated at 205 million tons and 14,200 million cubic meters respectively (1, 3). Power generation in 1966 totalled 658 million kilowatt-hours.

Iron and Steel Industry

Syria has no iron and steel industry at the present time. In recent years possible construction of a 75,000 ton reinforcing bar plant and a rail mill has been discussed. No action on these projects has been taken (6).

Iron and Steel Trade

In 1967, ferrous metals imports by Syria totalled 130,000 tons consisting primarily of sections and steel tubes and fittings.

REFERENCES

1. Mineralnie resursi kapitalisticheskih stran, Moscow, 1968.
2. Statistical Yearbook, 1967.
3. "BIKI", 1969, No. 27, p. 4.
4. Glukauf, 1968, No. 15, p. 33.
5. Iron and Steel Works of the World, 1965, 1969.
6. Tekkokai, 1967, No. 2, p. 65.
7. Steel Times, 1967, V. 195, No. 518, p. 551.
8. Statistics of World Trade in Steel, United Nations, 1967, 1968.

9. Stahl und Eisen, 1969, No. 9, S. 505.

10. Mineral Trade Notes, 1967, V. 64, No. 12, p. 22.

11. Metal Bulletin, 1967, No. 5257, p. 18.

12. Moniteur official du commerce international, 1964, No. 311, p. 385.

13. Orien, 2, 5, 1966, p. 3.

14. Mining Journal, 1966, V. 266, No. 6826, p. 504.

15. Japan Metal Bulletin, 1966, No. 2030, p. 3.

16. Japan Metal Bulletin, 1966, No. 1952, p. 2.

17. Metal Bulletin, 1968, No. 5264, p. 11.

CHAPTER 7

IMPORTS, EXPORTS AND CONSUMPTION OF IRON AND STEEL IN DEVELOPING COUNTRIES THROUGHOUT THE WORLD

Until the post World War II years, most countries in the world now classed as developing depended on imports for the majority of iron and steel products used by them. In recent years, however, these developing countries, insofar as they are able, are building domestic iron and steel industries. For all developing countries combined, imports in 1955 equalled 68 per cent of their consumption. In the early 1970s the import share of developing country steel consumption will decrease to less than 40 per cent, and by 1980 to as little as 30 per cent. At the same time (by 1980) the developing countries' proportion of total world steel production will increase to 5.6 per cent from the 1.6 per cent it was in 1955. Statistics regarding production and consumption of steel on a regional basis are given in Table 10 on the following page.

AFRICA

A domestic iron and steel industry (except for iron ore production) is almost non-existent in most developing countries of Africa. Only two fully-integrated iron and steel works have been built, one each in the United Arab

TABLE 10 REGIONAL STATISTICS OF STEEL PRODUCTION(1) AND TRADE IN DEVELOPING COUNTRIES IN SELECTED YEARS
Thousand, Metric Tons

	TOTAL	AFRICA	ASIA	LATIN AMERICA	MIDDLE EAST
1955					
Production	4,287	No data	1,757	2,530	No data
Imports	9,023	1,626	2,689	3,918	790
Exports	No data	-	No data	No data	No data
Apparent consumption	13,310	1,626	4,446.	6,448	790
1960					
Production	8,736	151(2)	3,757	4,828	100
Import	9,982	1,642	3,490	3,595	1,255
Export	212	-	65(4)	147(3)	No data
Apparent consumption	18,506	1,793	7,182	8,276	1,355
1965					
Production	15,473	209(2)	6,955	8,291	95
Import	11,754	1,988	4,350	3,722	1,704
Export	579	-	113(4)	466(3)	No data
Apparent consumption	26,648	2,197	11,182	11,547	1,799
1967					
Production	17,315	220(2)	7,390	9,687	100
Import	12,343	1,907	4,775	2,980	2,681
Export	363	-	363(4)	No data	No data
Apparent consumption	29,295	2,127	11,802	12,667	2,781

(1) In terms of crude steel
(2) Algeria and the United Arab Republic
(3) Brazil and Chile
(4) India

Republic and in Tunisia. These have a combined annual capacity of about 400,000 tons of steel. Some 40 small-capacity plants also exist, mostly producing small sections, reinforcing bars and galvanized sheets.

As can be seen from Table 10, in 1967 African developing countries produced only 10 per cent (220,000 metric tons) of the steel they consumed. Of the 220,000 tons produced, the United Arab Republic accounted for 90 per cent. For the year 1969, the total steel produced in African developing countries was 370,000 tons, with the United Arab Republic's share having dropped to 46 per cent. While total tonnages of domestic iron and steel production are increasing, imports by African developing countries will continue to supply the major part of their needs for many years.

Since imports of ferrous metals are of such importance to developing African countries, it is of interest to examine the product mix of imports. These are shown in Table 11 on the following page for the United Arab Republic and in Table 12, same page, for other developing countries of Africa.

More than half the imports to African countries other than the United Arab Republic were sections, pipes and fittings. In these developing African countries steel products are used mostly for building a small amount of manufacturing, packing for agricultural products, as well as in the oil-gas industry and agriculture for irrigation

TABLE 11 PRODUCT PERCENTAGES OF STEEL IMPORTS BY THE UNITED ARAB REPUBLIC IN SELECTED YEARS

	1955	1960	1965	1967
Ingots and billets	0.5%	2.7%	0.1%	18.8%
Railway materials	13.5	7.6	10.3	3.0
Sections	46.0	27.5	24.1	29.3
Wire rods	0.8	0.6	0.1	13.4
Strips	3.2	4.9	14.1	8.4
Plates	6.5	12.6	14.8	6.4
Sheets	8.2	6.4	13.5	5.4
Pipes and fittings	13.3	28.8	7.9	9.1
Wire	3.8	3.8	3.7	1.4
Tin plate	3.5	4.1	10.7	5.0
Axles, wheels and bandages	0.7	1.0	0.7	0.8

TABLE 12 PRODUCT PERCENTAGES OF STEEL IMPORTS BY DEVELOPING COUNTRIES OF AFRICA, OTHER THAN THE UNITED ARAB REPUBLIC IN SELECTED YEARS

	1955	1960	1965	1967
Ingots and billets	2.1%	1.9%	1.4%	2.3%
Railway materials	10.9	7.1	3.5	6.7
Sections	38.7	34.3	30.4	26.6
Wire rods	2.2	2.2	5.3	3.6
Strips	1.5	1.5	2.5	1.3
Plates	4.8	4.5	4.6	6.7
Sheets	25.2	14.7	16.5	16.4
Pipes and fittings	7.9	26.5	28.0	27.6
Wire	2.9	4.0	2.8	3.1
Tin plate	3.1	2.6	5.0	4.9
Axles, wheels and bandages	0.7	0.7	1.0	0.8

and watering purposes. In recent years there has been a drastic increase in the proportion of pipes and fittings, due to increased activity in developing oil and natural gas industry and in developing oil and natural gas fields (7). The proportion of pipe and fittings in total imports of ferrous metals to the countries of this region tripled between 1955 and 1967, going from 7.9 to 27.6 per cent. In 1967 pipe and fittings accounted for about 70 per cent of Libya's imports, and about 30 per cent of Algeria's and Nigeria's in the same year.

It has been estimated that the developing countries of Africa will be using 10.5 million tons of steel in the 1972-1975 period (11), and some 12 million tons by 1980 (12). Of this the United Arab Republic should be producing about 1 million (or more) tons. Other comparatively firm plans for increasing steel production in African countries include reconstruction and enlargment of existing iron and steelworks, especially the fully-integrated works in Algeria and Morocco. The initial planned annual capacity of the iron and steel works at Annaba (Algeria) is 400,000 tons of crude steel and that of the Nador plant (Morocco) 180,000 tons. Less certain as to completion dates are eight integrated works of possible total capacity of 2.5 million tons planned for Congo (Kinshasa), Ivory Coast, Liberia, Mauritania, Nigeria, Uganda and Zambia.

In summary, the developing countries of Africa will

have to import 8 million tons of steel in addition to their probable domestic production of 4 million if the projected total consumption of 12 million tons in 1980 is to be attained.

ASIA

Total consumption of ferrous metals in Asia developing countries is almost equal to that of the Latin American countries but Asian countries still have a much smaller domestic production. In Asian countries as is true throughout most of the world, the domestic share of apparent steel consumption is steadily increasing. This remains primarily due to the increased production of India which country still makes 90 per cent of Asian steel (outside of Japan and People's Republic of China). Steel imports supplied 60 per cent of steel used in Asian developing countries in 1955, but by 1967 this proportion had dropped to 40 per cent (Table 13 on the following page).

It was only after World War II that a domestic iron and steel industry began in some of the developing countries of Asia (other than in India). These steel plants are still very small and make mostly small merchant bar. For the countries other than India, 80 per cent of steel used is still being imported.

Because India produces (as of 1967) nearly 90 per

TABLE 13 STEEL PRODUCTION[1] AND TRADE IN DEVELOPING COUNTRIES OF ASIA IN SELECTED YEARS
Thousand, Metric Tons

	TOTAL	INDIA	OTHER COUNTRIES
1955			
Production	1,757	1,732	25
Import	2,689	1,129	1,560
Export	No data	No data	No data
Apparent consumption	4,446	2,861	1,585
1960			
Production	3,757	3,339	408
Import	3,490	1,518	1,972
Export	65	65	No data
Apparent consumption	7,182	4,792	2,390
1965			
Production	6,955	6,413	542
Import	4,340	1,113	3,227
Export	113	113	No data
Apparent consumption	11,182	7,413	3,769
1967			
Production	7,390	6,630	760
Import	4,775	802	3,973
Export	363	363	No data
Apparent consumption	11,802	7,069	4,733

(1) In terms of crude steel

cent of steel made in Asia's developing countries (India's share of apparent consumption is smaller at 60 per cent), the statistics for the region are strongly influenced by India's steelmaking performance. India's six integrated plants have a capacity of over 9 million tons (see page 114, more than twice the apparent consumption of all the other countries of the region. Even with this large domestic capacity, India still imports some steel products primarily sheets and plates. In the period 1955 to 1967 the share of sheets in the total import of ferrous metals into India more than doubled from 13.0 to 26.8 per cent, as can been seen from Table 14, below.

TABLE 14 PRODUCT PERCENTAGES OF STEEL IMPORTS BY INDIA IN SELECTED YEARS

	1955	1960	1965	1967
Ingots and billets	5.3%	5.2%	3.6%	4.3%
Railway materials	12.5	16.4	0.1	-
Sections	21.7	13.5	19.0	16.8
Wire rods	1.9	2.1	6.4	8.2
Strips	5.2	3.6	5.5	7.4
Plates	16.5	9.3	19.9	11.5
Sheets	13.0	26.0	29.4	26.8
Pipes and fittings	11.8	6.3	4.8	4.7
Wire	5.7	9.3	4.7	3.0
Tin plate	6.0	7.6	4.4	14.4
Axles, wheels, tyres	0.4	0.7	212	2.8

As can be seen from Table 14 above, the proportion of sheets, strip and plate in imports increased for all developing countries of Asia in the period from 1955 to 1967. This increase occurred due to growth in construction,

shipbuilding, light industry and canned food production. In the same period, imports of semi-finished steel jumped by as much as 2.5 times. The growth of semi-finished steel imports into developing countries of Asia was necessary to supply the non-integrated steel plants that were constructed in recent years. These plants have either rolling mills (mainly for the production of sections) or else facilities for the production of tin plate and galvanised sheet.

TABLE 15 PRODUCT PERCENTAGE OF STEEL IMPORTS BY DEVELOPING COUNTRIES OF ASIA, OTHER THAN INDIA, IN SELECTED YEARS

	1955	1960	1965	1967
Ingots and billets	7.4%	10.4%	12.0%	18.5%
Railway materials	5.6	4.0	4.1	2.2
Strips	2.9	3.7	2.8	4.0
Sections	25.6	19.3	30.0	16.3
Plates	6.9	7.9	6.3	8.7
Sheets	24.2	25.5	24.0	27.1
Pipes and fittings	10.2	8.3	7.1	6.3
Wire	6.4	7.4	6.0	4.4
Tin plate	9.8	11.2	5.3	8.8
Axles, wheels and tyres	0.3	0.6	0.4	0.3

Country by country share by percentage of imports during the 1955 to 1967 period is shown in Table 16 on the following page. The most striking change has been the decrease of India's share from nearly one-half to one-sixth. Philippines, Pakistan and Thailand have increased their share to well over half the total imports in 1967.

As with other developing countries of the world total demand for ferrous metals in the Asian area can be expected to increase markedly. Projected absolute growth should be greatest in India which has been predicted as high as 20 million tons by 1975 (India's 1967's actual production was 6.6 billion tons). For the area as a whole, total steel demand by 1975 could be 25 million tons, and by 1980 30 million tons annually.

TABLE 16 COUNTRY-BY-COUNTRY PERCENTAGES OF STEEL IMPORTS BY DEVELOPING COUNTRIES OF ASIA IN SELECTED YEARS

	1955	1960	1965	1967
Burma	2.4%	2.8%	2.7%	1.6%
Ceylon	1.9	2.8	1.9	2.3
Hong Kong	5.6	6.7	10.7	6.8
India	42.0	43.5	25.2	16.5
Indonesia	11.3	9.0	7.3	4.1
Malaysia	9.5	4.4	6.1	6.8
Pakistan	11.4	13.7	19.9	17.5
Philippines	9.6	10.5	15.5	22.3
Thailand	5.9	6.2	10.3	14.7
Others	0.4	0.4	0.4	7.4

Porjects already underway to satisfy this iron and steel demand are India's Bokaro works adding 1.7 million tons by 1971, all of sheets now in short supply, also India's Bhilai's increase of possibly 1 million tons of heavy products (India will shortly be exporting rails). With similar large works in Pakistan and the Philippines adding some 3 million tons in the early 70s, there is

substantial iron and steel activity in the region (altogether some 30 plants constructing or planned).

LATIN AMERICA

In 1967 the steelmaking capacity of the countries of Latin America was more than 12 million tons per year with major capacities in Brazil at 4.6, Mexico at 3.2 and Argentina at 1.9 million tons, respectively (7). In the post World War II years many countries of Latin America have been markedly increasing both their steel consumption and their domestic production. Ten countries now produce some crude steel, and it can be expected that more will do so within the next decade. Some statistics showing growth of steel usage in the major consumers are given in Table 17 on the following page.

Steel imports by Latin American countries have remained at about 3 million tons for many years, while total domestic production of steel has been rapidly increasing. As a result the proportion of imports of semi-finished and steel tubes has declined as shown in Table 18 on page 221, while that of flat-rolled products has increased. The steel sheet share of imports has doubled since 1955, from 12.5 to 27.7 per cent in 1967. This increase is due to the greater industrialization of Latin American countries especially by the increasing importance of such industries as automobile, machine-building, and some others. Argentina

TABLE 17 STEEL PRODUCTION(1) AND TRADE IN MAJOR STEEL PRODUCING COUNTRIES OF LATIN AMERICA IN SELECTED YEARS
Thousand, Metric Tons

	ARGENTINA	BRAZIL	CHILE	MEXICO	VENEZUELA
1955					
Production	218	1,162	312	761	No data
Import	1,726	291	64	301	625
Export	No data	No data	No data	No data	No data
Apparent consumption	1,944	1,453	376	1,062	625
1960					
Production	277	2,282	451	1,539	47
Import	1,315	390	85	263	476
Export	No data	23	124	No data	-
Apparent consumption	1,592	2,649	412	1,802	523
1965					
Production	1,368	3,017	476	2,455	625
Import	1,179	179	134	276	571
Export	No data	453	13	No data	No data
Apparent consumption	2,547	2,743	597	2,731	1,196
1967					
Production	1,326	3,665	631	3,023	690
Import	704	337	38	191	497
Export	No data	No data	No data	No data	No data
Apparent consumption	2,030	4,002	669	3,214	1,187

(1) In terms of crude steel

and Brazil, as well as Chile and Mexico all have greatly increased their domestic heavy industry (8).

TABLE 18 PRODUCT PERCENTAGES OF STEEL IMPORTS BY LATIN AMERICAN COUNTRIES IN SELECTED YEARS

	1955	1960	1965	1967
Ingots and billets	24.0%	18.1%	25.3%	14.2%
Railway materials	8.8	10.6	4.9	4.5
Sections	17.3	16.3	16.9	15.4
Wire rods	0.2	0.5	2.3	1.7
Strips	1.2	3.4	1.4	2.0
Plates	6.8	8.0	5.4	8.6
Sheets	12.5	15.7	22.5	27.7
Pipes and fittings	17.0	13.1	9.1	10.1
Wire	2.7	3.3	2.7	3.5
Tin plate	8.4	10.3	8.6	10.9
Axles, wheels, tyres	1.1	0.7	0.9	1.4

Latin American countries are rebuilding and enlarging existing iron and steel plants, and constructing new ones. Two integrated plants, 500,000 annual tons in Argentina, and in Mexico a plant of 250,000 annual tons are now being finished. In the next several years, some 40 plants both integrated and non-integrated are to be constructed, including eight integrated iron and steel works with total capacity of 5,000,000 tons of steel in Brazil, Mexico, Colombia and Uruguay. Demand for iron and steel in the countries of Latin America will increase to 25.8 million tons in 1975 and 38.5 million tons in 1980 according to estimates of the Economic Commission for Latin America (9).

The total domestic production of iron and steel in

Latin America in 1980 will probably not exceed 30 million tons. Even this would be more than double the 1970 total of 13 million tons. Thus, if the demand reaches the 38.5 million tons projected by the Economic Commission for Latin America, substantial tonnages of steel will have to be imported each year throughout the 1970s.

THE MIDDLE EAST

Although the United Arab Republic is politically a part of the Middle East, for the purposes of this review it has been considered a part of Africa. Therefore, the following analysis of the iron and steel industry in the region excludes the United Arab Republic figures.

Domestic production of steel in this area started only in post-World War II period, so that imports still supply nearly all ferrous metals consumed. In 1967, over 2 million tons of steel was imported with less than 0.1 million tons produced in the region (Israel) 50,000 tons, and some in Lebanon). The great importance of the petroleum industry to the area influences imports, which are about 25 per cent pipe and fittings (Table 19 on the following page). Some two-thirds of entire imports go to Iran, Iraq, and Saudi Arabia (Table 20, following page).

TABLE 19 PRODUCT PERCENTAGES OF STEEL IMPORTS BY COUNTRIES OF THE MIDDLE EAST IN SELECTED YEARS

	1955	1960	1965	1967
Ingots and billets	- %	- %	1.1%	4.5%
Railway materials	21.0	5.4	0.6	1.4
Sections	40.6	58.4	45.6	42.6
Wire rods	0.4	0.3	0.5	0.6
Strips	0.2	2.1	1.6	2.1
Plates	5.7	3.7	4.0	6.5
Sheets	9.7	8.3	11.7	12.1
Pipes and fittings	15.6	18.3	30.4	25.2
Wire	2.5	1.5	1.8	4.0
Tin plate	3.8	1.9	2.6	1.9
Axles, wheels tyres	0.5	0.1	0.1	0.0

TABLE 20 COUNTRY-BY-COUNTRY PERCENTAGES OF STEEL IMPORTS INTO THE MIDDLE EAST IN SELECTED YEARS

	1955	1960	1965	1967
Iran	41.4%	42.4%	41.1%	52.1%
Iraq	12.8	20.6	12.2	8.3
Kuwait	3.3	9.5	9.2	8.9
Lebanon	20.0	11.2	13.4	7.8
Saudi Arabia	9.3	5.0	18.1	5.7
Syria	10.8	9.2	5.0	6.1
Others	2.4	2.3	1.0	11.1

No substantial variations in the types of steel imports by the countires of the Middle East are expected. Steel consumption will continue to grow, as will domestic production (6). The largest iron and steel works currently under construction is the integrated works at Isfahan, Iran, the initial capacity of which will be 500,000 tons of crude steel per year. In several other countries of the area, steel plants are also under construction, mostly for finishing steel although some semi-integrated plants are planned.

In summary, during the decade of the 70s steel consumption in Middle East countries is expected to increase to 4 million tons, with imports furnishing 3 million tons and domestic production likely to be approximately 1 million tons.

REFERENCES

1. Anderson, Factors Affecting Steel Demand and Its Product Pattern in Developing Countries, Report C-1-2, Second Interregional Symposium UNIDO on the Iron and Steel Industry, Moscow, September 19 -October 9, 1968.

2. Statistic of World Trade in Steel, United Nations, New York 1956-1968.

3. Statistical Yearbook, United Nations, 1956-1967.

4. Annual Statistical Reports, American Iron and Steel Institute, 1956-1967.

5. Statistical Handbook, British Steel Corporation, 1956-1966.

6. Trudi Instituta Chermetinformascia, Moscow, 1968.

7. EEK, Committee on Iron and Steel Industry, UNO, Steel/Working Paper, N. 337, Add. 7, September, 1967. World Steel Trade and Demand for Steel in Developing Countries, Chapter VI. Supplies of Steel in Developing Countries, pp. 14, 24.

8. Gomes, Economic Conditions Affecting the Growth of Latin-American Steel Production. Report C-1-5 Second Interregional Symposium UNIDO on the Iron and Steel Industry.

9. Suarez. Present Status and Future Prospects of the Iron and Steel Industry in the Latin-American Countries. Second Interregional Symposium UNIDO on the Iron and Steel Industry, Moscow, 19 September 0 9 October, 1968.

10. EEK, Committee on the Iron and Steel Industry, UNO, Steel/Working Paper, N. 337, Add. 7, September 22, 1967.

11. Draht, 1967, N. 4, pp. 238-41.

12. Present Status and Future of the Iron and Steel Industry in African Countries. Second Interregional Symposium UNIDO on the Iron and Steel Industry, Mowcow, 19 September - 9 October, 1968.

SUMMARY

1. Industrialization is one of the major problems confronting developing nations. Essential to industrialization is access to adequate supplies of iron and steel, which most developing countries hope to make in their own borders. The initiative in creating an iron and steel industry generally comes from governments of these countries, while financing and construction of iron and steel plants must generally be furnished by developed countries.

2. Great difficulties exist in creating and operating an iron and steel industry, primarily because of the large capital and human resources required. Most developing countries lack sources of capital, especially foreign funds. These countries also have limited domestic markets for ferrous metals, as well as limited supply of skilled workers and managers, both of which tend to make domestically produced iron and steel products more costly than those that can be imported.

3. Iron and steel enterprises are now in operation or under construction in some 45 (out of a total of more than 92) developing countries of Africa, Asia, Latin America and Middle East. In more than 30 of the 45 countries the iron and steel plants consist only of rolling mills using imported billets, or of pipe and/or galvanizing plants, both

using imported flat-rolled products. In Burma, Ghana, Guatemala, Iran, Iraq, Israel, Kuwait, Lebanon, Saudi Arabia, Singapore, Thailand, Uganda, Uruguay, Philippines, Ethiopia and some other countries there are steelmaking plants with arc furnaces using domestic or imported scrap and with mills rolling light sections or wire rods. A small group, primarily, Argentina, Brazil, Chile, India, Mexico, Peru, the United Arab Republic, Venezuela and some others have a relatively high level of industrial development. Some 30 fully-integrated works constructed mainly during the last decade are in operation in the eight named countries. These works furnish 80 per cent of the eight countries' consumption of ferrous metals.

4. The 45 or more developing countries with no iron and steel enterprises of any kind do not have, at present, the necessary economic strength for creating a domestic industry. Many of these are countries of Africa and Asia. These countries without any steel industry are also lagging behind in industrial development, and will likely be dependent on ferrous metal imports for the next decade at least.

5. In the 1960-67 period, average growth rates of steel production in developing countries exceeded their steel consumption growth rates. When all planned projects for constructing new iron and steel works and enlarging existing plants are completed in the next few years, the average production and consumption will be still further in balance.

Nevertheless, it should be noted that in each region there is one country accounting for most of production and growth of iron and steelmaking (in Latin America there are two countries accounting for more than 50 per cent of total production). Amongst African developing nations the United Arab Republic produces 90 per cent of domestic steel made as does India in Asia. In the Middle East there is for all practical purposes no domestic steel industry (Israel produces more than 90 per cent of the area's production with its 50,000 annual tons).

Thus, the significant conclusion is that with the few exceptions noted, creation of an effective domestic iron and steel industry in most developing countries of the world is still to be attained.

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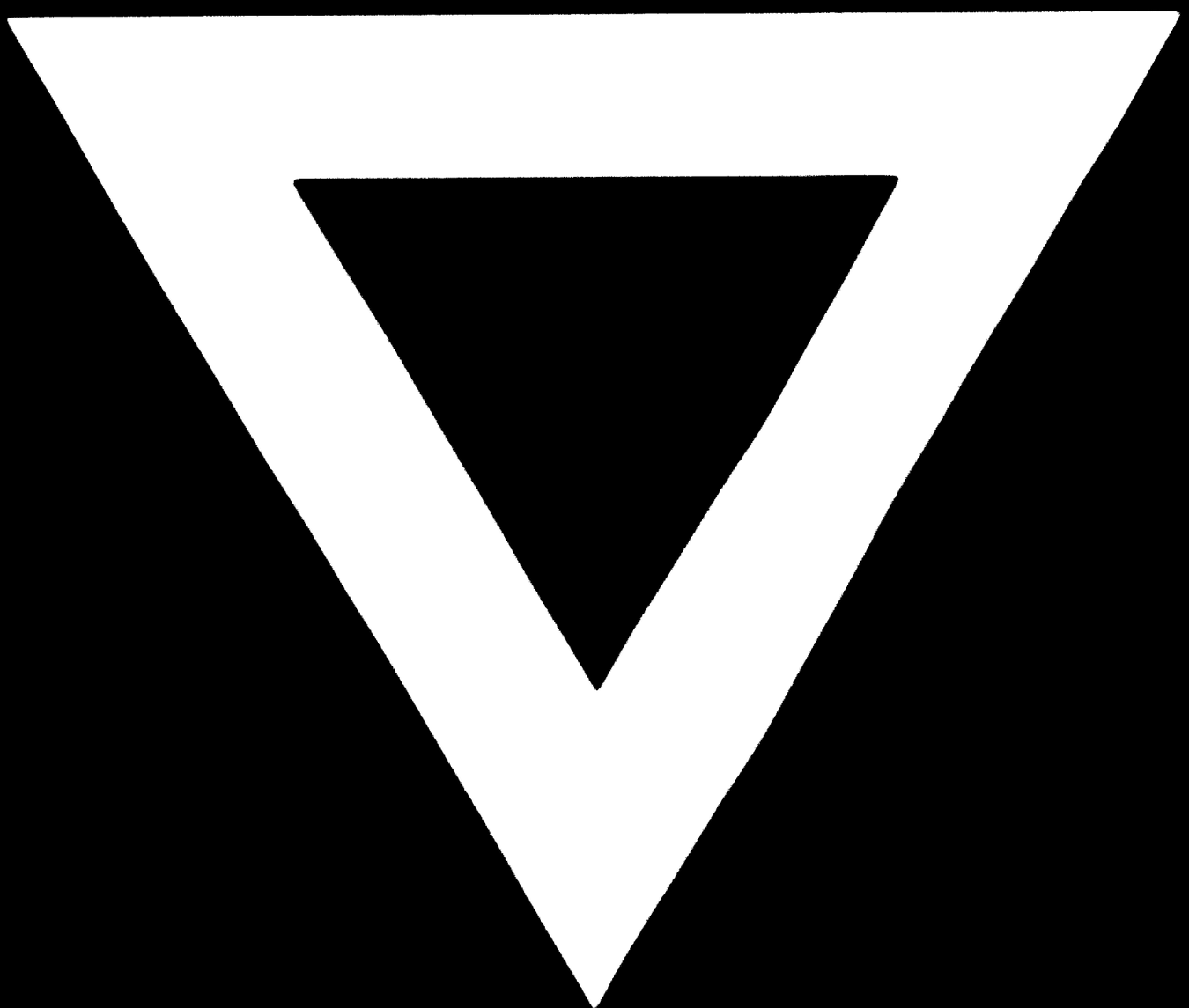

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