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TECHNICAL DEVELOPMENT OF THE USSR IRON AND STEEL INDUSTRY AND CO-OPERATION BETWEEN THE SOVIET UNION AND DEVELOPING COUNTRIES[1]

by

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1/ The views and opinions expressed in this paper are those of the author and do not necessarily reflect the views of the secretariat of UNIDO.

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SUMMARY

In 1972, the Soviet Union produced 92.3 million tons of molten iron, 126 million tons of steel, and 87.4 million tons of rolled products. In 1973 it is expected that 130 million tons of steel will be produced and in 1975 146 million tons.

The Soviet iron and steel industry is characterized by its high level of concentration and specialization. The main trends in the development of the iron and steel industry of the USSR during the next years are substantial improvements in quality and diversification in the product mix.

In the paper some aspects of the technical progress of the iron and steel industry of the USSR, mainly connected with the design and construction of new metallurgical units, shops, and works, are reviewed.

In the Soviet Union the iron and steel works are designed and constructed with a view to maximum introduction of up-to-date technology, units, and shops of high capacity, the use of continuous and high-speed processes, and the application of systems for automation of technological processes and management of production. In the USSR the intensification of the processes of steel production is closely connected with the use of oxygen and natural gas.

At present, in the USSR and in other countries (with the assistance of the USSR) blast furnaces with useful volumes of 1033, 1386, 1719, 2000, 2300, 2700, 3000, and 3200 m^3 are in operation. At the Krivoy Rog Works, blast furnace No. 9 with a useful volume of 5000 m^3 is under construction.

The oxygen converters in operation and under construction in the Soviet Union and in USSR-aided countries have capacities ranging from 0.5 to 8 - 10 million tons per year, depending on the scale of production. Accordingly, the capacity of individual BOF's ranges from 50 - 400 tons.

The facilities for production of electric steel constructed in the Soviet Union and in USSR-aided countries have capacities ranging from 50,000 tons to 3 million tons per year. Normally, the capacities of individual furnaces range from 25 to 200 tons. They are provided with removable roofs, electromagnetic stirrers, and arrangements for injection of oxygen from the top.

Continuous casting has been widely applied industrially for the production of the following types of steel: carbon-killed; aluminium-killed; rimming steel for production of sheets for the car industry and for the electric industry; low-alloy and high-alloy steels.

In the USSR, a great range of rolling mills of different types are being designed, manufactured, and operated for the production of all kinds of finished products from carbon and alloy steels.

Considerable progress has been achieved in increasing the dimensional accuracy of rolled products and in improving their service quality and mechanical properties. These successes in rolling of steel in the Soviet Union have been achieved thanks to a number of factors, of which mention should be made of the specialization of the rolling mills in iron and steel plants which has taken place on a national scale and the installation of up-to-date high-productivity equipment.

The USSR has widely developed international connexions with other countries. Based on design work in Soviet organizations and with the technical and economic co-operation with the USSR, iron and steel plants have been or are being constructed in a number of countries.

The Soviet Union has assisted or is assisting a number of developing countries in creating their own iron and steel industry. Loans for the development of the iron and steel industry have been given to India, Iran, Turkey, Republic of Sri Lanka, Arab Republic of Egypt, Algeria, etc. Design documentation is being prepared for the iron and steel plant in Pakistan (Karachi).

The total capacity of iron and steel plants constructed, being constructed, and planned for construction with the assistance of the USSR in the developing countries at 1 January 1973 is as follows:

	Total capacity (million tons) according to agreements	Total capacity plants (million tons/year) already in operation
Pig iron	13.6	4.9
Steel	16.0	3.5
Rolled products	12.3	2.2
Iron ore	11.2	4.9
Coke	7.3	3.6

Technical assistance by the USSR to other countries in the creation of their own iron and steel industry is provided with a view to maximum utilization of local resources and technical capabilities for manufacture of equipment, steel constructions, and supply of building materials.

The loans provided by the USSR to developing countries are repaid mainly by supply of traditional export commodities and with the production of the newly developed national industry.

The level of economic development of a country is determined above all by its situation with regard to basic industries. The iron and steel industry is a branch of basic industry, and plays an important role in the establishment of the material and technological foundations of an industrially developed society.

In a contemporary economically developed society, the products of the iron and steel industry are the fundamental constructional materials for the creation of means of production.

The share of iron and steel in the total consumption of constructional materials by basic branches of the mechanical engineering industry in the USSR is more than 96%. Great importance is therefore attached to the development of the iron and steel industry.

In 1972, the Soviet Union produced 92.3 million tons of pig iron, 126 million tons of steel, and 87.4 million tons of finished rolled products. It is expected that more than 130 million tons of steel will be produced in the USSR in 1973, and 146 million tons in 1975. In recent years, the trend has been for increases in Soviet iron and steel production to be achieved without any increase in the number of workers employed in the industry.

The general features of the development of the Soviet iron and steel industry are described in the papers by Professor L.M. Efimov (TsNIIChermet), "Recent achievements in the iron and steel industry of the Soviet Union and the availability to developing countries of Soviet experience in metallurgy" (ID/WG.146/47) and "The use of oxygen in steel production" (ID/WG.146/74), and the paper by Z.I. Nekrasov, member of the Academy of Sciences of the USSR, on "Progress in blast-furnace production in the USSR" (ID/WG.146/73).

The present paper considers only a few points concerning the technical development of the iron and steel industry of the USSR, in particular those connected with the design and construction of new metallurgical units, shops, plants, and works.

The Soviet iron and steel industry has a high degree of concentration and specialization of production. In the USSR, the average amount of steel produced in a year in an integrated works is more than 4 million tons. The Magnitogorsk Metallurgical Combine produces approximately 15 million tons a year, while the Krivoy Rog Works produces nearly 11 million tons and the Ilyich Works at Zhdanov more than 7 million tons a year and other examples could be given.

In future, the volume of iron and steel production will considerably increase in a number of works. Large capital investments are being made in construction and in the expansion of large works now in operation: Krivoy Rog, Novolipetsk, Cherepovets, West Siberia, Karaganda, Nizhniy Tagil, Azovstal, etc.

Designing experience and economic calculations show that the optimum capacity for a new integrated works making flat-rolled products under USSR conditions should be around 10 million tons of steel a year, and for a two-section plant the figure should be more than 20 million tons.

In the USSR, steelworks are designed and constructed with a view to maximum utilization of up-to-date technology, high unit capacity of plants and shops, and the utilisation of continuous processes and systems for the automation of technological processes and the organization of production.

The process of specialization and concentration in the iron and steel industry is closely linked with the increase in unit capacity and the size of metallurgical plants, i.e. the useful volume of blast furnaces and the capacity of oxygen converters, electric steel furnaces and rolling and tube mills, and also with the introduction of the principles of production-line, continuous, accelerated, and intensified operation.

In comparison with small- and medium-sized plants and shops, large specialized plants and shops achieve a higher level of productivity of labour, lower production costs, and lower unit capital investment.

In the USSR, the intensification of steel production processes is connected with the use of oxygen and natural gas and the achievement of a maximum level of continuous operation.

The most important trend in the development of the iron and steel industry in the USSR in coming years will be towards a significant improvement in quality and enlargement of the range of production, which will ensure savings in metal, electric power, and other expenditures in the steel-user branches of industry.

In designing and building iron and steel industry facilities, the following most important trends in technical and technological developments are taken into account.

The primary means of preparing iron ore for smelting is thorough enrichment of the ore and agglomeration. In the USSR, sinters with various degrees of basicity are produced, including high-basicity sinter.

In addition to the production of sinter, that of pellets is spreading as a result of the rapid growth in the production of fine-particle concentrates of highly enriched iron ore. In future, the production of pellets will considerably exceed the total production of sinter. In our country, a metallized pellet factory with an annual production capacity of 600,000 tons for electric steel production is being built.

One of the main trends in the development of by-product coking is an increase in the capacity of coke ovens from 40 m^3 to 50 m^3. In order to use the heat of the hot coke for the production of steam, improve the quality of metallurgical coke, and protect the environment, dry coke-quenching facilities are commonly being introduced in by-product coking plants.

At present, blast furnaces with volumes of 1033, 1386, 1719, 2000, 2300, 2700, 3000, and 3200 m^3 are being prepared in the USSR and in other countries, where they have been built with assistance from the USSR. At the Krivoy Rog Works, blast furnace No. 9, with a volume of 5000 m^3, is being built (starting-up planned for 1974). The annual capacity of a blast furnace of this type is 4 - 5 million tons of iron.

The high-capacity blast furnaces built in the USSR are highly mechanized and automated. Many of them achieve high levels of technical and economic efficiency.

Soviet blast furnaces have long intervals between overhauling: first-degree overhaulings (change of hearth and shaft lining) take place every fifteen to twenty years, and second-degree overhaulings (replacement of shaft lining) every eight to ten years.

The blast furnaces with volumes of 2000 and 2700 m^3 have two tapping holes and two casting bays each.

The blast furnace with a volume of 3200 m^3 has four tapping holes, which are opened alternately to tap iron continuously. The circular casting bay of the furnace is on one level, without steps. The casting bay and the space directly adjoining the furnace are served by cranes running on circular tracks with load capacities of 20 - 25 tons, which have cantilever arms with load capacities of 3.2 tons and electric stackers. In addition, machines are installed in the casting bay for mechanized work. The design of the furnace and the casting bay completely eliminates manual hearth work. The hot-blast stoves of the furnace ensure a constant blast temperature of 1200°C. The furnace has skip loading of the burden and a double inclined hoist. The enlarged skip hopper charges the sinter, pellets, and coke directly from the bunkers into the skip, with intermediate screening of the fines.

Where prepared iron ore, closely sized strong coke, a 35% oxygen-enriched blast heated to 1200°C and the injection of natural gas are used, the annual production capacity of a blast furnace with a useful volume of 3200 m^3 is approximately 2.5 million tons.

The blast furnace with a useful volume of 5000 m^3 presents better technological parameters and solutions than the furnace with a useful volume of 3200 m^3.

The furnace will be equipped with a conveyer belt system for feeding the charge into the throat, charging apparatus of a new design, a casting bay with an improved layout, stoves with self-contained combustion chambers, and equipment for the processing of slag directly at the blast furnace, making slag heaps unnecessary. The iron will be tapped into a mixer-type ladle with a capacity of approximately 400 tons. Furnace operation with injection of natural gas into the hearth, using a blast enriched to 35 or 40 per cent with oxygen and heated to 1400°C, is planned. As a result, operation using a prepared charge is possible with a consumption of approximately 360 - 380 kg of coke per ton of iron.

The design and equipment of the furnace [illegible] provide for [illegible] with a gas pressure of 2.5 at. beneath the bell. The energy of the increased pressure may be utilized by installing a gas turbine. All blast furnaces designed in the USSR may operate both with water or evaporative cooling.

In the last few years, steelmaking has been developed in the Soviet Union by building oxygen-converter and electric-furnace shops. Oxygen-converter shops are used for the mass production of carbon and low-alloy steels.

The oxygen-converter shops built in the Soviet Union, and in other countries with its assistance, have annual capacities of from 0.5 million tons to 8 - 10 million tons, depending on the scales of production required. They are equipped accordingly with converters having capacities of 50 to 400 tons. In order to achieve the most economical solution in each plant, three converters which are as large as possible are usually installed in each shop. In the future, it is possible that converters with capacities of 500 tons will be installed.

Up to 30% scrap is used in the converter charge.

When new industrial complexes are built, continuous casting is generally used. However, any type of casting can be used in oxygen-converter plants, depending on demand.

High-capacity equipment is installed in oxygen-converter shops to provide continuous operation at a high level of productivity. In newly designed shops, the converters have a volume of 0.9 - 1 m^3 per ton of charge and are equipped with suspended drive. The gas exhaust systems of converters operate without burning of the carbon monoxide. The physical heat of the gas is used after being cleaned in Venturi tubes. An oxygen blast of around 7 m^3 per minute per ton of steel is provided for. To charge the converters, ladle cars with capacities corresponding to those of the converters and scrap pans large enough to enable all the scrap to be charged in one or two loads are used.

Oxygen converters are equipped with automatic process control and regulation systems. In addition to computers for process control of the process using a static system, it is planned to develop a dynamic control system, making it possible to carry out virtually all heats at the prescribed steel temperature and with the proper carbon content.

At the present time, a number of high-capacity oxygen-converter shops with converters having capacities of around 150 tons are operating in the Soviet Union. At the Karaganda Metallurgical Combine, a shop is in operation which has converters with a capacity of 300 tons and economical installations for converter gas exhaust without burning in the smoke-stack. At the West Siberia and Novolipetsk works, oxygen converter shops are being built which have converters with a capacity of 350 tons. The annual capacity of each shop is 8 million tons of steel. Both plants are being equipped with continuous steel casting units. At the Azovstal Works, it is planned to build a high-capacity oxygen-converter shop with converters having capacities of 350 - 400 tons and continuous casting units.

Electric steelmaking shops are being built for the production of high-quality alloy steel, and also for the conversion of surplus scrap into ordinary carbon steel.

The electric steelmaking shops built in the Soviet Union and with its assistance in other countries have capacities of from 50,000 to 3 million tons a year, depending on the scale of production and grades of steel required. They are usually equipped with electric arc furnaces which have a capacity of 25 to 200 tons, removable roofs, electro-magnetic stirrers, and oxygen lances in the roof. Electric furnaces are equipped to evacuate gases directly from the hearth and scrub them using Venturi tubes. In shops which have been designed, provision is made for the installation of electric furnaces with transformers having a high unit capacity of 500 - 800 kVA/ton. In future, it is planned to build electric furnaces with capacities of 300 - 400 tons.

Electric furnaces are intended to operate using scrap and substituting metallised pellets for part of the scrap. Shops are planned in such a way as to provide for an independent supply of charge and removal of products for each furnace. The steel is as a rule cast in continuous casting units. A number of process operations are automated. For new shops, computerised control of melting and shop operation is being developed.

In many works, the production of high-quality steel in electric furnaces with a capacity of 100 tons has been adopted. At the Krasny Oktyabr Works, an electric furnace with a capacity of 200 tons is in operation. In a number of electric steel shops, continuous casting units are used.

In order [illegible] the [illegible] demand of [illegible] branches of industry for high-quality metal, steel is [illegible] in [illegible], vacuum-arc, vacuum-induction, electron-beam, and plasma furnaces. The electro-slag melting process developed in the USSR, which makes it possible, with a relatively small capital investment, to produce high-quality metal free of non-metallic impurities, is especially widespread. The facilities are equipped with programme control systems.

In the USSR, the continuous casting of killed carbon steel, steel killed with aluminium, rimming steel for automobile body-work sheet and tinplate, electrical steel, low-alloy steel, and high-alloy steel has been widely developed.

Continuous casting units produce billets with cross-sections of from 82 x 82 mm to 350 x 350 mm and hollow billets with diameters of from 190 mm to 360 mm. The slab casters produce slabs with dimensions of 150 - 250 mm x 500 - 1850 mm.

The continuous casting units are designed to cast steel from ladles with capacities of up to 400 tons, and in future there will be ladle capacities of up to 500 tons. In new shops, mainly curved-mould type continuous casting units are being built.

Vertical continuous casting units will be used for the casting of hollow tube billets and ingots made of special alloys and high-alloy steels intended for electro-slag, vacuum, and other types of melting.

In the USSR, the method of continuous casting of steel with no interruption between melts (sequence casting) has been developed and introduced on a large scale. New means of casting have been adopted, including casting through extended nozzles reaching beneath the surface of the metal in the mould, the application of synthetic slags to the surface of the metal in the mould, and the utilisation of a protective gas atmosphere.

In the USSR, automation of the process of continuous casting has been developed and introduced, including automation of the maintenance of a given metal level in the tundish and in the mould, of the cutting of ingots into uniform lengths, the transport and delivery of billets from the continuous casting units, and the control of technological parameters such as the temperature of the molten metal and the cooling water, the flowrate and pressure of the sources of energy, etc. Out-of-furnace steel treatment has been introduced, including degassing of the molten steel, finishing of the steel in the ladle with argon, and treatment of steel with synthetic and furnace slags in the ladle at the time of tapping, using original steel-treatment technologies developed in the Soviet Union.

In the Soviet Union, a large number of rolling mills of various types for the production of all kinds of rolled products from carbon and alloy steels are being designed, manufactured, and operated. The production of economical types of rolled product is being rapidly developed. This applies above all to rolled sheet and plate metal, cold-rolled sheet and plate with various coatings, cold-rolled dynamo steel, transformer steel with specially low power loss, special-purpose bent and fancy sections, high-precision sections, rounds with variable cross-sections for machine building and rolled high-alloy steels with special properties, wide-flange girders, etc.

Considerable progress was achieved in increasing the precision of dimensions of rolled products, improving their surface quality and mechanical properties, etc. These successes in rolling in the Soviet Union have been achieved thanks to a number of factors, of which mention should be made of the specialization of rolling mills in iron and steel works which has taken place on a national scale and the installation in rolling shops of up-to-date high-productivity equipment which is for the most part manufactured in domestic enterprises.

The nation-wide specialization of rolling mills, under which each mill is used for the production of a relatively narrow range of types of rolled products, has helped to increase the productivity of mills and raise the quality of the rolled products and also the level of mechanization and automation of production.

For the production of rolled products with improved properties which better meet the rising requirements of consumers, great attention is being paid in planning the production of rolled sections and sheet and plate whose cross-sections, dimensions, and physical and mechanical qualities produce the most economical effect when they are used.

One way of economizing metal is by decreasing the weight of rolled product per unit of length by making the elements of the cross-section of rolled sections thinner and decreasing the thickness of rolled sheet and plate without impairing their qualities.

Low-alloy steels and steels which have been hardened by heat treatment after rolling are increasingly being used to produce this type of rolled product.

For the purpose of economizing metal, repetitive section rolled products - in particular the rolled products with variable cross-sections used in machine building with minimum waste, and also bent sections - are increasingly being produced.

For the same purpose, it is intended to develop further, on a large scale the production of rolled products, primarily sheet, with more economical anti-corrosion plating or coatings, in particular electrolytic tinplate, lacquered chrome plate, and plastic-coated, aluminium-plated, zinc-plated and bi-metallic sheet, etc.

One feature of the rolled steel production of the Soviet Union is the high degree of utilization of plants, especially rolling mills, which achieve record productivity.

For example, more than 5.5 million tons of ingots are rolled annually on blooming mills and universal slab mills; 1.3 million tons of rails and beams are rolled on rail mills; 800,000 - 1 million tons of finished rolled products are produced on continuous light-section and rod mills; 1 million tons of plate are turned out by 2-stand plate mills; 4 million tons of strip are produced by continuous hot-rolling wide-strip mills, etc. The capacity of the existing continuous wide-strip mill model 2000 at the Novolipetsk steel works is 6 million tons of strip a year, and the model 2000 mill being built at the Cherepovets Works will have a capacity of more than 6 million tons.

In addition to the high-capacity specialized rolling mills, low-capacity and medium-capacity mills are being designed and manufactured in the USSR to produce a wide range of types of rolled product.

In order to improve the mechanical properties of the finished rolled products, hardening heat treatments are now being used in the Soviet Union on many types of rolled product, including railway rails, wheels, reinforcing steel, sections, plate, wire rod, etc.

In the Soviet Union, automation is used in many rolling mills and units involved with the finishing of rolled products, as well as where control of technological parameters, such as the thickness of strip produced by hot-rolling and cold-rolling wide-strip mills, is required.

All the mills designed and manufactured in the Soviet Union provide high reliability under conditions of intensive-operation processing and can quickly be put to maximum designed capacity with full mechanization and an accepted level of mill automation.

The continuous billet mills with alternating horizontal and vertical stands which are manufactured are designed for rolling conversion billets and round tube billets of various sizes from blooms with cross-sections of up to 400 x 400 mm.

The mills are fitted out with flying shears to cut billets with cross-sections of up to 150 x 150 mm and automated systems of waste-free billet cutting. The maximum rolling speed of the mills is 7 m per second.

The mills for producing railway rails and large structural sections make a wide range of sections, are fully mechanised, make large use of automation of the rolling and finishing processes, and also use equipment for continuous heat treatment of rails.

At the present time, a mill for the production of wide-flange beams in sizes Nos. 20 - 100, with an annual capacity of 1.5 million tons, is being built at the Nishniy Tagil Metallurgical Combine.

Automated continuous mills with capacities of [illegible],000 - [illegible] million tons are being designed and manufactured for the production of medium-section and light-section rolled products; the medium-section mills are of the single-strand type, and operate at speeds up to [illegible] m per second, while the light-section mills are of the two-strand type and operate at rolling speeds of up to 20 m per second. Furnaces with walking hearths are being built to heat the billets before rolling. At the Krivoy Rog and Cherepovets Works, reinforcing steel is heat-hardened in continuous light-section mills, using the process heat.

At present, continuous mills for the production of wire rod with groups of finishing stands and maximum rolling speeds of up to 60 m per second are being designed. The mills are designed to operate using billets with cross-sections of more than 100 mm.

Continuous and semi-continuous combination mills for the production of light-section rolled products and wire rod from alloy and high-alloy steels with an annual capacity of 100,000 - 130,000 tons are being designed and manufactured.

Mills for the production of deformed-bar repetitive rounds are being manufactured and are successfully operating. These mills, which have a relatively low capacity but are fully mechanized, produce repetitive sections which are close in contour to the finished products.

Equipment for shops producing a wide range of bent sections is being designed and manufactured.

The wide-strip mills being designed have facilities for the automation of the rolling process and metal cooling and this, together with the greater reliability of the stands and the installation of hydraulic roller-bending systems, ensures the production at high rolling speeds of rolled products with a high degree of size precision, where the initial weight of the metal is high. It is planned to carry out finishing operations for hot-rolled steel, including quality control and grading, by a continuous-operation method, using equipment which is an integral part of the rolling mill.

Wide strip hot-rolling mills produce coils weighing up to 4[illegible] tons at speeds of 20 m/second, and more. The product varies, depending on the type and design of the mill, from [illegible] to 16 mm in thickness and from 500 to 2000 mm in width.

High-capacity furnaces with walking beams, which have a higher level of technical and economic efficiency than pusher-type furnaces, are being built for reheating slabs before rolling.

For cold rolling shops, five-stand and six-stand automated mills producing strip with a minimum thickness of 0.15 mm at rolling speeds of up to 40 m/second are being manufactured.

The installation in shops of pickling units using hydrochloric acid and ideal emulsion systems with cold rolling mills ensures high-quality surfaces of sheet product.

For annealing, single-base top hat furnaces with weights of charge of up to 160 tons are being installed. The furnace stands are fitted with circulation fans with cooling gas envelopes, making it possible to shorten the time required to cool the coils after annealing and to increase furnace productivity.

For cutting the cold-rolled coils, high-productivity transverse and longitudinal cutting units with strip processing speeds of up to 6 m/second and automatic grading of the sheet by thickness (in the case of transverse cutting units) are being installed.

The mills and finishing units in cold-rolling and hot-rolling shops are being fitted with up-to-date electric drive and automated systems using thyristor transducers and no-contact equipment which ensure a high-accuracy and high-speed systems control.

In the Soviet Union, the production of tubes, and in particular heat-hardened tubes with anti-corrosion coatings, large-diameter high-pressure gas pipeline tube, high-strength boring and drive tube, thin-walled seamless, electric-welded tubes, and special-purpose tube for the chemical, boiler and ball-bearing industries is rapidly expanding owing to the priority development of the most advanced means of production and the introduction of continuous and production line systems.

The tube rolling and tube welding mills and the cold-rolling and hot-rolling mills for the production of high-precision tubes manufactured by Soviet industry have been proven in many years of practical operation.

Their technological parameters, operating conditions, durability, and kinematic characteristics are selected on the basis of comprehensive theoretical and experimental research, and these mills have record productivity. For example, the 30 - 102 tube-rolling units with continuous mills at the Pervoural'sk New Tube Works and the Nikopol Southern Tube Works are unequalled anywhere in the world as far as technical features and technical economic characteristics are concerned. Technologies have been introduced for the production of high-strength straight-and spiral-welded tube with diameters of 1020 mm and 1420 mm for gas mains, spiral-welded thin-walled tube with diameters of 150 - 350 mm, high-strength tube of oil pipeline grade with new types of cutting and joining, and boiler tube with guaranteed strengths for high-capacity energy facilities. Efficient methods of warm-rolling of tube on cold-rolling mills, using low-deformability steels, have been developed and introduced on an industrial scale in the Soviet Union. Tube production is being automated to a large degree at all stages of production.

The production of electric-welded gas pipeline tube with diameters of 1220 mm, 1420 mm, and 1620 mm has considerably increased as a result of the introduction of its production at the Volzhsk Tube Works and construction of a shop at the Khartsysk Tube Works.

Achievements in the field of design, construction, and operation of metallurgical shops and works in general make it possible for the Soviet Union to have extensive international relations with other countries.

The Soviet Union has increased its sales of licences for various metallurgical processes and plants to many countries throughout the world, including Japan, France, the Federal Republic of Germany, and Italy. On the basis of designs prepared by Soviet engineers, metallurgical enterprises are being set up with technical and economic co-operation with the USSR in many countries.

The Soviet Union is involved in scientific, technical, and economic co-operation in the development of the iron and steel industry with the following socialist countries: the People's Republic of Bulgaria, the German Democratic Republic, the Hungarian People's Republic, the Democratic People's Republic of Korea, the Republic of Cuba, the Polish People's Republic, the Socialist Republic of Romania, and the Czechoslovak Socialist Republic.

The Soviet Union is providing technical co-operation in the construction of metallurgical installations in Finland and France.

The Soviet Union is assisting some developing countries to establish their own iron and steel industries.

Loans for the development of iron and steel industries have been made to India, the Republic of Sri Lanka, the Arab Republic of Egypt, Algeria, and other countries. The national iron and steel industries of two of our neighbours, Iran and Turkey, are being successfully established and developed with assistance from the USSR. Design documentation for a metal works in Pakistan (Karachi) is being prepared.

The share of the USSR's total economic and technical assistance to the developing countries accounted for by the iron and steel industry is approximately 32 per cent. The share of total USSR assistance to the development of iron and steel industries in foreign countries accounted for by such assistance to developing countries is around 50%.

There are agreements with developing countries for the construction of 19 iron and steel industry installations. Of these, nine have started operation.

The total capacity of iron and steel plants built, being built or to be built with assistance from the USSR in developing countries, as at 1 January 1973, was as shown by the following figures:

	Total capacity under agreements (millions of tons/year)	Of that total, capacity accounted for by plants already in operation (millions of tons/year)
Iron	13.6	4.9
Steel	16.0	3.5
Rolled products	12.3	2.2
Iron ore	11.2	4.9
Coke	7.3	3.6

The iron and steel enterprises which have been built (or are being built) in developing countries with assistance from the USSR in most cases produce (or will produce) a very considerable, if not by far the largest, share of national iron and steel production.

In many developing countries, production forces are inadequately developed. In most developing countries, the iron and steel industry is absent, and iron and steel consumption is low. In addition, the countries of Asia, Africa, and Latin America have substantial raw-materials resources to provide a basis for the establishment of their own metallurgical supply bases. The developing countries account for approximately 80% of total reserves of iron ore and around 45% of total production, but only 5% of the total steel production of all capitalist countries.

Such developing countries as Brazil and India have especially substantial reserves of iron ore. There are large reserves of ore in Algeria, Venezuela, Peru, Chile, and other countries.

The amounts and geographical location of metallurgical raw materials and fuel show that the developing countries have a reliable source of raw materials on which to base the establishment of their own metallurgical industries. However, the developing countries do not have machine-building industries capable of producing all types of modern metallurgical equipment, and they have too few (or no) skilled metallurgical engineers, design and operating personnel, technicians, and workers.

Under these conditions, rapid establishment of the developing countries' own metallurgical industries can take place on the basis of foreign assistance.

The economic and technical assistance provided by the Soviet Union to the developing countries for the development of iron and steel industries takes the following forms:

- Supply of complete sets of equipment and necessary materials for plants being constructed abroad;
- Carrying out by Soviet organizations of design and scientific research work connected with the construction of plants in these countries;
- Assignment of Soviet experts to developing countries to provide technical assistance in the construction of installations, mounting of equipment, starting up and operation of installations and mastery of the manufacturing of metallurgical products;
- Organisation and carrying out of instruction in industrial training of citizens of these countries in the course of construction of installations, both in the countries and in metallurgical enterprises in the USSR;
- Training of national cadres in Soviet educational institutions.

The Soviet Union not only helps to build plants, but also often provides the basic materials for them.

The first agreement concerning the provision of economic assistance by the Soviet Union in the development of an iron and steel industry was concluded with India in 1955.

For the past 18 years, the Soviet Union has been providing assistance, and is continuing to do so, to the developing countries in establishing enterprises for the extraction and preparation of iron ore and fluxes and the production of agglomerates, coke, iron, steel, and rolled products.

In order to determine the technological possibilities and economic advisability of building metallurgical enterprises, Soviet design organisations prepare technical and economic feasibility studies.

A characteristic of the economic and technical co-operation of the USSR with the developing countries is that the Soviet Union gives them assistance in establishing and strengthening the State sector of their economies. This is important for accelerating their economic development and strengthening their economic position.

The economic co-operation of the USSR with developing countries in the establishment of those countries' own metallurgical supply bases is founded on equality and respect for national sovereignty.

The metallurgical enterprises constructed with assistance from the USSR are in the full ownership of the State in whose territory they are located.

The technical assistance of the Soviet Union to foreign countries in establishing iron and steel industries contemplate maximum use of local resources and the technical potential for manufacturing equipment and metal structures and supplying building materials.

This type of co-operation makes it possible to utilize the country's local resources, creates stable employment for the population, brings about the accumulation of industrial experience in the country with relation to the construction of up-to-date enterprises, and trains the country's own national builders, mechanics, and operating personnel.

The provision of loans to the developing countries for the development of iron and steel industries and other economic branches is one of the most important forms taken by the USSR's economic co-operation with these countries.

The loans made by the Soviet Union are long-term and favourable, in that the annual interest rate is low and the period for utilization and repayment of a loan is long.

Since the loans made by the USSR are repaid over a long period of time, countries can repay them out of profits from the sale of the products manufactured by the enterprises established with assistance from the Soviet Union.

The loans made by the Soviet Union are in the main repaid by means of supplies of traditional exports produced by small-scale domestic industry. All this makes it easier for the developing countries to settle loans, promotes the development of the national economy, and creates a stable market for goods. For example, India delivers to the USSR, in addition to its traditional goods (tea, jute, pepper, etc.), products from the enterprises established under Soviet co-operation with India, i.e. rolled products and cast iron from the Bhilai Works, surgical instruments from the Madras Works, and optical lenses from the Works in Durgapur. India has refunded to us more than half the loans, including repayment in full of the loan made for construction of the first phase of the Bhilai Works. Egypt is also using the products of enterprises established with Soviet assistance to settle accounts with us. Examples of these products are steel plate from the Helwan Iron and Steel Works and stamped automobile and tractor parts.

Thus, the establishment in developing countries of those countries' own metallurgical supply bases makes it possible to solve a large group of economic problems, such as the following:

- Reduction of countries' expenditure of foreign exchange by reducing or eliminating iron and steel imports;
- Enhancement of a country's export potential by making iron and steel exports possible;
- Creation of a basis for the development of metal-consuming economic branches, and through this creation of more jobs in industry for the population.

The data concerning individual objects of co-operation are indicative of the scale and direction of the Soviet Union's technical assistance for the establishment in developing countries of those countries' own metallurgical supply bases, and of the importance of the USSR's assistance in strengthening the economies.

In India, the first phase of the Bhilai Works, with an annual capacity of 1 million tons of steel, was constructed with assistance from the USSR in 1957 - 1961.

The excellent design features and the equipment installed in the works made it possible to fulfil the design capacity of the first phase of the works in the first year after completion of its construction. Subsequently, the capacity of the works was increased to 2.5 million tons of steel a year with assistance from the USSR. The works accounts for approximately 30% of the steel produced in the country and approximately 65% of the rails produced.

At the present time, the Soviet Union is providing economic and technical assistance in the construction of the following iron and steel industry installations in India:

- The Bhilai Works: expansion of capacity from 2.5 million tons to 4 million tons of steel a year;
- A works in Bokaro producing flat-rolled products with an initial capacity of 1.7 million tons of steel a year and provision for subsequent expansion to 4 million tons of steel (and the further possibility of expansion to 5 million tons or more of steel a year);
- An iron-ore mine at Rajhara-Pahar, with a capacity of 4 million tons a year;
- A limestone quarry at Nandini, with a yield of 2.1 million tons a year;
- An iron-ore mine at Dalli, with a yield of 2.5 million tons a year (when fully developed, 5 million tons a year).

Design work is being done in connexion with the further expansion of the Bhilai Works from an annual capacity of 2.5 million tons to 4 million tons of steel through the construction of a new complex of shops, including an oxygen converter shop and a plate mill shop. When these shops have started operating, India will almost completely meet the demand for flat-rolled steel out of its own production.

The works at Bokaro is now being built. In 1972, the first basic production units - a coke-oven battery, a sintering plant, and a blast furnace with a useful capacity of 2000 m^3 with a complex of ancillary shops and power plants - started operating. The oxygen converter shop, slabbing mill model 1250, continuous wide strip mill model 2000, cold-rolling shop, and other installations are now under construction.

The existing capacity of the works in Bhilai and Bokaro, together with the capacity which can be created with assistance from the USSR, will enable India to produce, even in the very near future, around 7 to 8 million tons of steel a year, in other words, more than is produced at the present time by all the metal works in India put together.

Rational general plant layout and composition of shops and equipment make it possible to expand the works in Bhilai and Bokaro considerably by building new metallurgical shops and plants. The report of the first meeting of the Indo-Soviet Inter-Governmental Committee on Economic, Scientific and Technical Co-operation signed in February 1973 provides for co-operation by the Soviet Union in the further expansion of the Indian works at Bhilai and Bokaro to an annual capacity of 17 million tons, or two and a half times the country's steel production in 1971 - 1972.

An electric steelmaking shop with furnaces having a capacity of 25 tons and continuous casting facilities for the production of billets with cross-sections of 80 x 80 mm and 100 x 100 mm have been built in Arkanam, with technical assistance from the USSR.

In view of this, India is undertaking to exceed the present steel production levels by a considerable amount in the very near future, thereby taking another big step towards ensuring its economic independence, and developing its own steel-using sectors, i.e. heavy machine building, the electrical industry, railway coach building, etc.

From 1955, when the first agreement on the construction of the Bhilai Works was concluded, to the present, serious qualitative changes have taken place in the co-operation between the Soviet Union and India in the field of iron and steel.

The first phase of the Bhilai Works was completely designed by Soviet organizations, and approximately 87% of the equipment was supplied from the Soviet Union. When the factory was expanded to a capacity of 2.5 million tons of steel a year, the share of the equipment supplied from the USSR decreased to 80%, and when blast furnace No. 6 complex was built, the proportion declined to 34%.

In the construction of the first phase of the works in Bokaro, supplies of equipment from the USSR should amount to 3[illegible]%, while those of refractory materials should be 9% and those of pipe 30%. The remainder will be supplied by Indian enterprises.

These figures show that Indian domestic industry is gathering experience in the production of complex metallurgical equipment for the development of the country's own metallurgical supply base.

Under the existing agreement, the Soviet Union is providing assistance to India in setting up a state institute for the design of metallurgical enterprises by sending Soviet specialist designers to India and teaching Indian specialists in Soviet design organizations.

. Indian design organizations are now carrying out design work for the works in Bokaro and for the expansion of the Bhilai works to an annual capacity of 4 million tons of steel.

Around 1000 engineering and technical cadres have been trained in the Soviet Union for the operation of the Bhilai works. Around 6600 skilled workers and technicians have been trained in Indian educational institutions set up with assistance from the Soviet Union.

The data given concerning co-operation between the Soviet Union and India in the field of iron and steel show that, with assistance from the USSR, India is not only establishing a strong modern metallurgical supply base, but is also realising the conditions for the development of metallurgy through its own efforts on the basis of the following:

- Metallurgical equipment produced in India;
- Works and shop designs developed by its own efforts;
- Its own experience in the building and operation of metallurgical enterprises.

In Iran, the first phase of the Isfahan Works, with an annual capacity of 550,000 tons of steel, for the production of rolled sections using local iron ore, coal, and natural gas has been constructed with technical and economic assistance from the USSR. In 1971, a complex of shops, including a sintering plant, a by-product coke-oven battery, and a blast furnace with a useful volume of 1033 m^3 was started up, and in 1972, two oxygen converters and three continuous steel casting units started operating. In March 1973, a rolling mill 650, with an annual capacity of 600,000 tons, intended for the production of a wide range of structural shapes, started operating. All the products are manufactured directly from billets from the continuous casting units. The placing of the mill stands is such that the finished product can be rolled in two strands, with simultaneous production of commercial billets. The placing of the mill stands in series on one axis ensures a minimum processing cycle for light-weight sections and guarantees the best temperature conditions for their production. A light-section and wire rod mill is now being completed.

At the present time, design work is being carried out for the second phase of the works, with an increase in its capacity to 1.9 million tons of steel a year, for the production of a wide range of rolled sections. As part of the second phase, a blast furnace with a useful volume of 2000 m^3 is being built; the capacity of the existing oxygen converters is being enlarged to 100 tons, and a new converter with a capacity of 100 tons, a continuous casting unit, a medium-section mill model 500, a light-section mill model 300, and other installations are being built.

Iran now imports around 500,000 tons of section metal a year, and demand for it will increase. The metal works in Isfahan will by and large meet the requirements of the country in respect of such types of rolled products as girders, channel bars, rounds, and wire rod and will enable the country to achieve considerable savings by reducing imports.

It is planned eventually to construct at this works a group of sheet and plate shops comprising hot- and cold-rolling sheet and plate mills, coating and plating shops, an oxygen converter shop, a blast furnace, and other facilities, increasing the annual capacity of the works to 4 million tons of steel.

While the steel works is being built, the Soviet Union is assisting Iran in setting up ore-mining enterprises, coal mines, coal-enrichment plants, and a machine building plant. Thus, the establishment of the iron and steel works has marked the beginning of the development of Iran's ore-mining industry and domestic machine building, which are foundations for the country's developing industrialization.

The construction of a steel works in Iran is a clear example of successful economic co-operation between countries with different social systems.

In Turkey, an iron and steel works has been built at Iskenderun with technical and economic assistance from the USSR. The works has an annual capacity of 1 million tons of steel (first phase), and provision has been made for expanding it to 2 million tons. The iron-ore supplies of the works come from local deposits.

As part of the works, it is planned to build a by-product coking plant, crushing and grading and sintering plants, a blast-furnace shop with furnaces having useful capacities of 1386 m^3 each, a converter shop with two converters having capacities of 130 tons each and continuous casting units, and a rolling mill with continuous billet, light-section, and wire rod mills.

In the Arab Republic of Egypt, a large metallurgical and machine-building complex will be built with assistance from the USSR at Helwan. A sintering plant, a by-product coking plant, hot and cold rolling plate and sheet shops, and other installations have been started up. A blast-furnace shop with furnaces having useful capacities of 1033 m^3, an oxygen converter shop with 80 ton converters and a continuous-casting unit, and other facilities are being built. The annual capacity of the part of the plant which can be expanded is 1.2 million tons of steel; the possibility of further expansion is provided for.

An iron-ore mine is being established in the oasis at Bahariya.

In the People's Democratic Republic of Algeria, a converter shop with continuous-casting units has been set up with assistance from the Soviet Union at the works in Annaba. This works is being erected with assistance from a number of capitalist countries as well (France, Italy, the Federal Republic of Germany, and Austria). The converter shop, which started up in May 1972, has two converters with capacities of 50 tons each and three continuous steel casting units for the production of slabs. The annual capacity of the shop which has been built is 410,000 tons.

It is planned to expand [illegible] with assistance from the Soviet Union to an annual capacity of around 2 million tons of steel by building a new blast furnace, re-organizing the converter shop (increasing the capacity of the existing converters from [illegible] tons to 35 tons and building still another converter with continuous steel casting unit) and installing new rolling mills. In addition, it is planned to build a new sintering plant and a new by-product coking shop as part of the works.

Local iron ore is used at the works.

An increase in the annual capacity of the works to 2 million tons of steel with an expansion of its range of rolled products will make it possible not only considerably to improve the supply of the country with metal and raise the technical and economic efficiency of the works' operation but also substantially to increase Algeria's export potential in respect of this type of product.

The basic technological equipment for the blast furnace and rolling shops will be supplied from the USSR and paid for out of the loan made by the Soviet Union; the building will be carried out by Soviet organizations with a large degree of participation by Algerian State firms.

A rolling mill built with technical and economic assistance from the USSR to produce 60,000 tons of rolled sections a year started operating in the Republic of Sri Lanka in 1967. Design documentation is being prepared for an expansion of the mill and increase in its capacity, with construction of an electric steelmaking shop, which will make it possible largely to meet the country's requirements in respect of rolled sections.

Agreement has been reached concerning assistance by the Soviet Union in the construction of a metal works in Pakistan (Karachi).

In addition to bilateral economic and technical co-operation with the developing countries, the Soviet Union gives these countries technical assistance under the auspices of the United Nations by organizing group and individual in-plant training for engineers and technicians and providing consultancy services regarding the development of domestic metallurgical industries.

The courses which have been established in the USSR at the Zaporozhstal Works are intended to assist engineers and technicians to up-grade their skills by studying and mastering the most recent achievements in Soviet industry and applying theoretical knowledge to practical in-plant work. Between 1965 and 1972 inclusive, 288 specialists from 36 developing countries of Asia, Latin America, and Europe, including 45 from the Arab Republic of Egypt, 26 from India, 10 from Iran, 12 from Brazil, and 14 from Bolivia, underwent training in the courses.

Metallurgists from India were also individually trained in the USSR.

The pupils master up-to-date methods in the technologies of all iron and steel processes, the operation of the most modern equipment, and management of the organisation of production and maintenance.

Specialists are trained at the Zaporozhstal Works, and also visit enterprises which extract, enrich, and sinter iron ore and produce pellets, ferro-alloys, coke, refractory materials, rolled sections, converter steel, and billets made in continuous-casting units.

In conclusion, it should be mentioned that the Soviet Union's technical and economic relations with foreign countries in the field of the iron and steel industry, based on mutual benefit, are from year to year growing and becoming stronger, in full accordance with the guidelines of the twenty-fourth session of the Communist Party of the Soviet Union on the five-year plan for development of the economy of the USSR for 1971 - 1975, which states that "The development of strong external economic and scientific and technical relations with the developing countries of Asia, Africa, and Latin America should be maintained under conditions of mutual benefit and in the interests of strengthening these countries' economic independence".

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