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Nº 86

ECONOMIC INTELLIGENCE REPORT

THE FERROUS METALLURGICAL INDUSTRY OF THE USSR

CIA/RR 88

28 January 1957

CENTRAL INTELLIGENCE AGENCY

OFFICE OF RESEARCH AND REPORTS

SECRET

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S-E-C-R-E-T

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(ORR Project 23.604)

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Office of Research and Reports

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THE FERROUS METALLURGICAL INDUSTRY OF THE USSR*

Summary

The ferrous metallurgical industry of the USSR is the second largest in the world. In 1955 the Soviet industry produced 45.3 million metric tons** of crude steel, 17 percent of total world production and equal to 43 percent of US production. Of total production of crude steel in the Sino-Soviet Bloc in 1955, 62.5 million tons, the USSR produced 72.5 percent. The ferrous metallurgical industries of the European Satellites and Communist China are dependent on the USSR for supplies of raw materials and equipment. In 1955 the USSR provided about 51 percent of the iron ore required by the European Satellites and most of the more complex equipment for the ferrous metallurgical industries of the Satellites and Communist China.

The production capacity of the Soviet ferrous metallurgical industry has increased steadily during the postwar period, and Plan goals have been fulfilled consistently. Production of crude steel increased from 12.3 million tons in 1945 to 45.3 million tons in 1955, and during the period of the Fifth Five Year Plan (1951-55), production of crude steel increased at an average annual rate of 3.6 million tons.

Steel is produced in every economic region*** of the USSR, but the location of the major Soviet iron and steel complexes is determined by the availability of the three bulk raw materials -- iron ore, coking coal, and limestone. More than 75 percent of the Soviet ferrous metallurgical industry is concentrated in the Ukraine (Region III) and the Urals (Region VIII). These areas are distant from the principal industrial centers of the European USSR, and in 1955 the average haul of ferrous metals to the consuming industries was 1,055 kilometers, an increase of 9 percent above the average haul in 1940.

* The estimates and conclusions contained in this report represent the best judgment of ORR as of 1 August 1956.

** Tonnages throughout this report are given in metric tons.

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The Soviet steel industry is supported by indigenous sources of raw materials which, in general, are adequate both for the present requirements of the industry and for long-term growth. Soviet resources of iron ore, coking coal, limestone, and most alloying materials are among the largest in the world. Supplies of nickel, molybdenum, and cobalt apparently are adequate for normal peacetime consumption, but they might become critically short in a wartime economy -- particularly cobalt. Domestic reserves of tungsten are relatively small, but they are adequately supplemented by imports from Communist China.

Since 1950 the USSR has been a net exporter of all ferrous metallurgical raw materials and products except tungsten and molybdenum. In 1955, Soviet exports of manganese amounted to 17 percent of domestic production; of iron ore, 12 percent; of chromite, 12 percent; of nickel, 11 percent; of pig iron, 2.5 percent; and of finished steel, 2 percent.

Although a greater part of Soviet exports of ferrous metallurgical materials and products have gone to other countries of the Sino-Soviet Bloc, substantial amounts have gone into Free World markets. In 1955, Soviet exports to non-Bloc countries included 537,000 tons of manganese, 88,000 tons of chromite, 120,000 tons of scrap iron, 665,000 tons of pig iron, and 326,000 tons of finished steel. Soviet plans call for increasing exports of ferrous metallurgical commodities to the Free World, particularly to the underdeveloped nations. The USSR has undertaken to supply to India, for example, 1 million tons of finished steel over the 3-year period ending in 1958.

The pattern of consumption of iron and steel in the USSR is not revealed by the Soviet government, undoubtedly because the pattern would provide information on the production of military equipment. It is apparent, however, that in terms of gross national product (GNP) the relative consumption of steel in the USSR is greater than in the US. In 1955 the Soviet GNP was equal to 36 percent of the US GNP. Soviet consumption of steel, however, was equal to 46 percent of US consumption. A general indication of the pattern of steel consumption in the USSR is implicit in the fact that in 1955 the Soviet economy channeled 56 percent of total production of steel into heavy industry. In the US, only 31 percent of total production was consumed by heavy industry in 1955.

In the ferrous metallurgical industry of the USSR, technology is equal, generally, to that of Western nations, including the US. The application of Soviet technology, however, has varied among different sectors of the industry. Advanced technology has been applied to the preparation of raw materials, to blast furnace and open hearth furnace processes, and to the military applications of high-temperature alloys, but the application of new technology to rolling mills and finishing lines has begun only recently.

Because the manufacture and construction of metallurgical equipment in the USSR has not kept pace with the demand, there has been considerable selectivity in the allocation of modern equipment among the plants in the industry. The highest priority has been accorded to investment in technological improvements and new equipment, in the preparation of raw materials, and in the ironmaking and steelmaking departments of major plants such as the Magnitogorsk and Kuznetsk combines. These facilities are as efficient and productive as the best units in the US, and they serve as models for other Soviet steel plants.

The data available on capital investment in the ferrous metallurgical industry of the USSR are scant. It is known, however, that the Fourth Five Year Plan (1946-50) called for an investment of 27 billion rubles, and it is estimated that about 23 billion rubles actually were invested. Total investment in the industry during the Fifth Five Year Plan probably was about 41 billion rubles, and the Sixth Five Year Plan (1956-60) calls for an investment of about 80 billion rubles -- 13 percent of the planned capital investment in all Soviet industry and 20 percent of the planned investment in heavy industry.

Until 1949, prices of finished steel products in the Soviet ferrous metallurgical industry were considerably below actual cost, and the industry was heavily subsidized. In 1949, major increases in steel prices eliminated the need for subsidization of the industry as a whole, although some plants continue to operate at planned losses. Since that time the price trend has been downward, indicative of a policy of relating prices to costs of production.

About 645,000 persons were employed in the Soviet ferrous metallurgical industry in 1955. Of this total, about 411,000 were employed in iron and steel works, about 71,000 in iron ore mining, between 40,000 and 70,000 in various levels of administrative work, and the remainder in other segments of the industry. In the Soviet iron and steel industry, labor productivity is considerably lower than it is in the US industry. In 1955, US annual production per worker was 163 tons of crude steel, and annual Soviet production per worker was only 88 tons. The level of labor productivity depends to a considerable extent on the levels of technology that have been introduced in the various segments of the industry. In those plants that employ the latest technological developments, for example, labor productivity is much higher than the industry average and is closely comparable with that in the US industry.

Prospects for the long-term development of the ferrous metallurgical industry of the USSR appear to be excellent. Soviet reserves of the major raw materials for the industry are adequate, and those few alloying materials of which there are not large indigenous reserves can be imported from Communist China. The quality of the finished product is satisfactory. The production of the industry meets domestic requirements and provides exports for competition in world markets.

To insure continued expansion of the industry, however, the USSR must make large capital investments in the development of raw materials, in the modernization of existing plants, and in the manufacture and construction of new equipment and new plant facilities. The provisions of the Sixth Five Year Plan indicate the clear intent of the Soviet government to make the necessary investment. The Plan calls for an increase in production of crude steel from 45.3 million tons in 1955 to 68.3 million tons in 1960, an average annual rate of increase of 4.6 million tons. These planned increases are commensurate with objectives in other sectors of Soviet heavy industry and appear to be designed to support the planned peacetime growth of the national economy.

The Soviet production goals for crude steel and finished steel probably will be reached, but it is likely that some specific aspects of the Plan are beyond the capability of the USSR. Although capital investment in the industry certainly will increase substantially, it probably will fall short of the goal. As a consequence, the goals for the replacement of obsolete equipment and for increased labor productivity will not be reached. The directives of the Sixth Five Year Plan, however, appear to provide for excess capacity to assure the fulfillment of production goals even though all of the component objectives are not met.

I. Introduction.

A. Scope.

This report surveys the ferrous metallurgical industry of the USSR and its contribution to the Soviet economy and to that of the Sino-Soviet Bloc. To provide a basis for an assessment of the capabilities of the industry, the report is not limited to operations under the Ministry of Ferrous Metallurgy. Production of some commodities discussed in the report is under the control of other ministries. To present a broad view of the resources base as well as of significant economic and technological aspects of the industry itself, the report covers the major raw materials used in making iron and steel and the reserves and production of the principal alloying metals consumed by the industry.

The important units of the Soviet ferrous metallurgical industry are shown in the accompanying chart, Figure 1.* Among these the basic unit is the steel plant. The most economical form of the steel plant is the integrated plant, combining at one location the production of coke, pig iron, and crude and finished steel. This report, however, follows the general practice of using the term steel plant to denote any facility which produces steel, whether or not the facility is an integrated plant.

B. Significance.

The ferrous metallurgical industry of the USSR is the second largest in the world. In 1955, Soviet production of crude steel amounted to 17 percent of world production, and on 1 January 1956 crude steel capacity in the USSR was equal to about 41 percent of US capacity. The relation of production of crude steel in the USSR to that in other areas of the world is shown in the accompanying chart, Figure 2.* 1/**

Soviet production of crude steel in 1955 was equal to the combined production of West Germany, the UK, Belgium, and Sweden. Total Sino-Soviet Bloc production, 72.5 percent of which was produced in the USSR, was equal to 34 percent of total NATO production. 2/ Estimated production of crude steel in the Sino-Soviet Bloc in 1955 is shown in Table 1.***

* Following p. 6.

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*** Table 1 follows on p. 6.

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Table 1

Estimated Production of Crude Steel in the Sino-Soviet Bloc a/
1955

Country	Production (Million Metric Tons)	Percent of Total
USSR	45.3	72.5
Czechoslovakia	4.5	7.2
Poland	4.4	7.0
East Germany	2.7	4.3
Hungary	1.6	2.6
Rumania	0.8	1.3
Bulgaria	0.1	0.2
Communist China	2.9	4.6
North Korea	0.2	0.3
Total	62.5	100.0

a. 3/

The maintenance and enlargement of the heavy industrial and defense base in the USSR is vitally dependent on the metallurgical industry. During the Fifth Five Year Plan (1951-55) a continually growing demand for steel in the consuming sectors of heavy industry, construction, transportation, and defense resulted in a crude steel growth pattern of about 3.6 million tons annually. The directives of the Sixth Five Year Plan (1956-60) require an average annual growth rate of 4.6 million tons of crude steel. 4/

C. History and Development.

1. Early Five Year Plans and World War II (1928-45).

At the beginning of the First Five Year Plan (1928-32), the Soviet ferrous metallurgical industry, because of the disastrous effects of the revolution, had just attained the 1913 production level of 4.3

FIGURE 1

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USSR
THE FERROUS METALLURGICAL INDUSTRY FROM RAW MATERIALS TO FINISHED PRODUCTS

(Simplified Schematic)

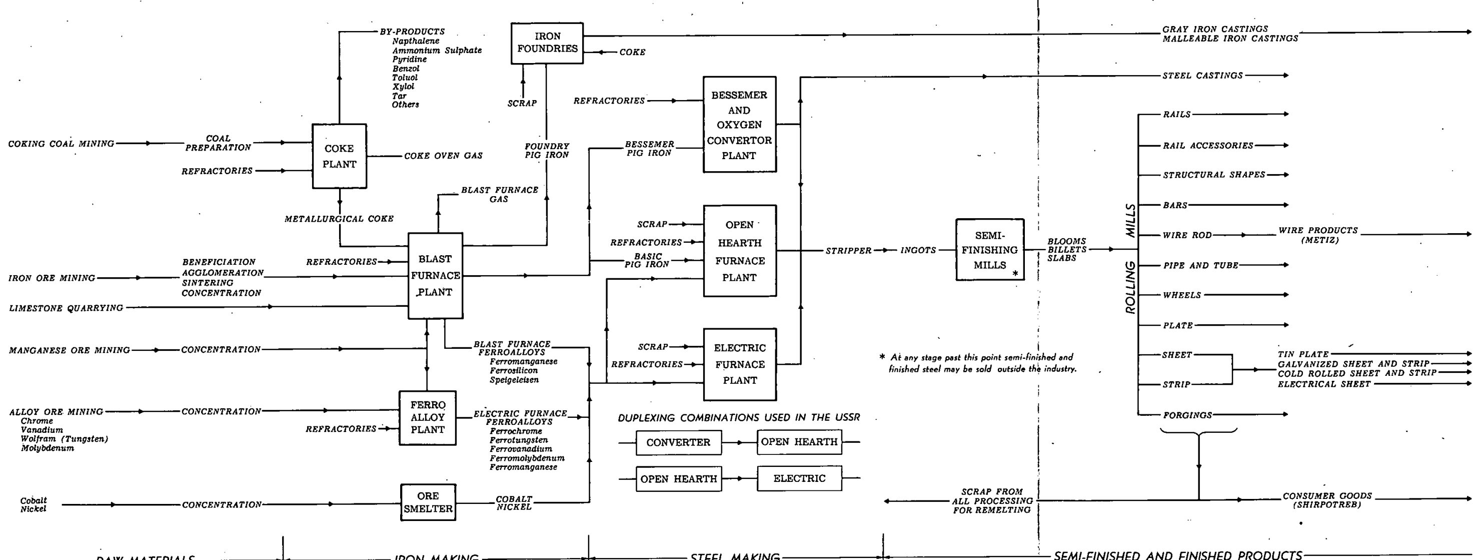

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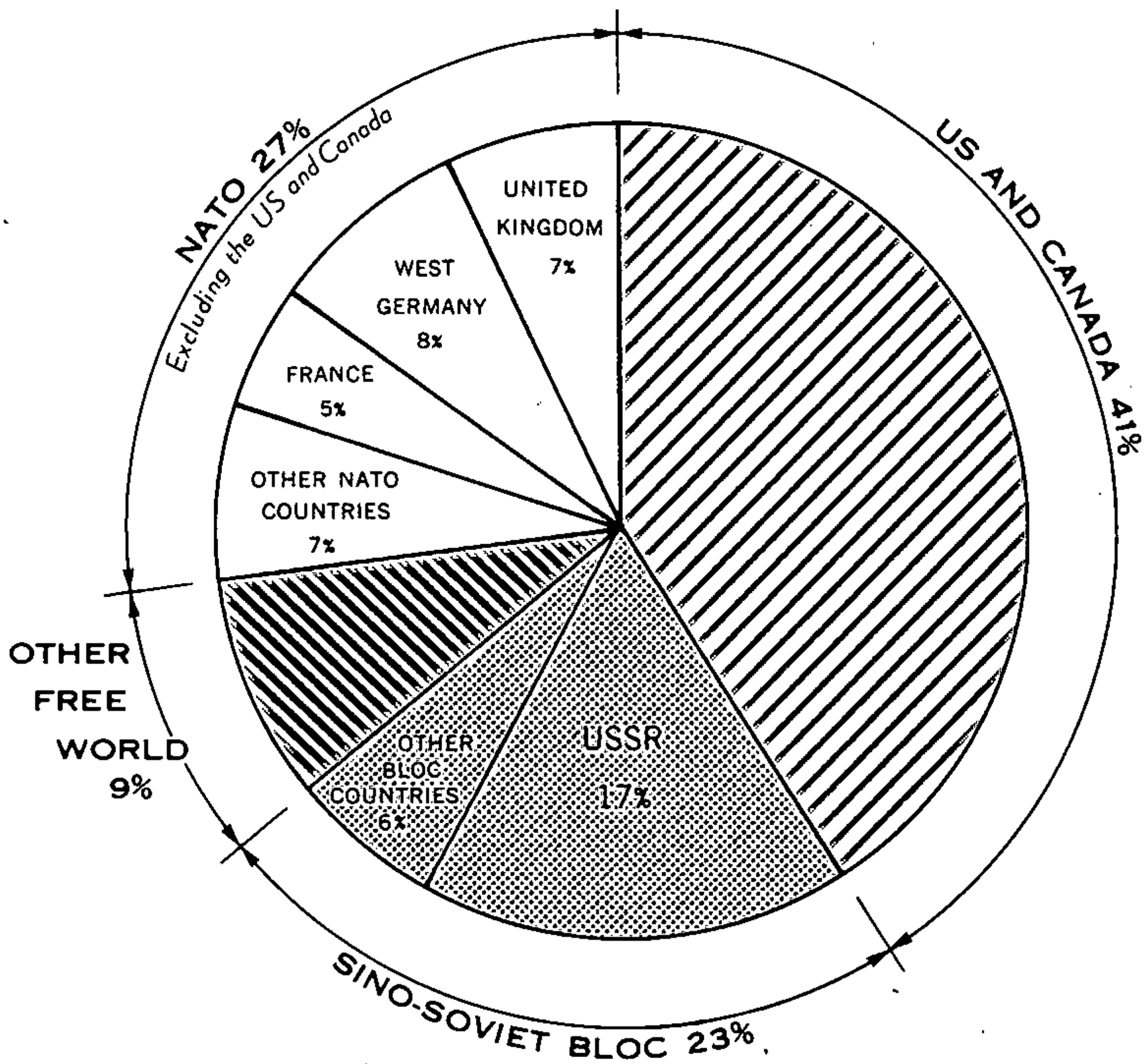
FIGURE 50X1

COMPARISON OF WORLD PRODUCTION OF CRUDE STEEL, 1955

WORLD TOTAL
268 MILLION METRIC TONS



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million tons of crude steel. The ambitious First Five Year Plan goal of 10.3 million tons of crude steel was fulfilled by only 57 percent (5.9 million tons), a failure caused largely by Soviet operational and technical incompetence. 5/

In spite of this early failure the groundwork had been laid -- with much US equipment and technical assistance -- for the progress made during the Second Five Year Plan (1933-37). Completion of the initial stages of the Magnitogorsk, Kuznetsk, and other combines during this period enabled production of crude steel in 1937 to reach 17.7 million tons, a 4-percent overfulfillment of the 17-million-ton goal. 6/

The Third Five Year Plan (1938-42) started auspiciously with a forecast for a 1942 production of crude steel of 28 million tons. The effects of the purges, however, were so disruptive that by the end of 1940, on the eve of German invasion, the production of crude steel had risen only 3 percent above the 1937 level. 7/

At the onset of the German advance in June 1941 a tremendous effort was made to evacuate essential equipment. By 1942 the USSR had lost, primarily in the Ukraine, 75 percent of its coking coal capacity, more than 60 percent of its iron ore, 68 percent of its pig iron, and 65 percent of its steel capacity. Production of crude steel dropped from 18.3 million tons in 1940 to 6.5 million tons in 1942. By drastic restrictions in the allocation of steel, by a considerable effort to construct steel plants in the Urals, and by importing 2.5 million tons of finished steel and thousands of tons of war material from the US, the USSR managed to maintain a supply of steel sufficient to conduct the war. 8/

2. <u>Fourth Five Year Plan (1946-50)</u>.

The principal task of the Soviet ferrous metallurgical industry during the Fourth Five Year Plan (1946-50) was to complete restoration of wartime damage and achieve a considerable increase above 1940 production levels. Goals for 1950 called for the production of 25.4 million tons of crude steel, 17.8 million tons of finished steel, 19.5 million tons of pig iron, 40 million tons of commercial-grade iron ore, and 30 million tons of coke. In February 1946, Stalin stated that by about 1960 the USSR should have a capacity for the annual production of 50 million tons of pig iron and 60 million tons of crude steel. 9/

By 1948, reconstruction had advanced to a point where production of crude steel exceeded the 1940 level, and in 1949 production of pig iron reached the 1940 level. Most of the plants in the Ukraine were rebuilt with as much modernization introduced as the pressing demand for immediate production would permit. Seizure of metallurgical equipment as reparations, particularly in East Germany and Manchuria, aided the task of reconstruction. The steel industries of the Ukraine and of the badly damaged Leningrad area were completely restored by the end of the Plan period. 10/

Goals for crude and finished steel were exceeded by the end of the Plan period. Production of 27.3 million tons of crude steel, an overfulfillment of 1.9 million tons, was largely the result of utilization of abundant war scrap. The underfulfillment of production goals for both commercial-grade iron ore and pig iron was slight. The failure in construction of new plants was more pronounced, however, for of the six new plants planned, only the Kazakh and Uzbek works produced any steel by 1950. 11/

3. Fifth Five Year Plan (1951-55).

To insure an advance of 70 percent in the growth of industrial production during the Fifth Five Year Plan (1951-55) the goals for pig iron and crude steel were set at 34 million and 44.3 million tons, respectively. Stalin's 1960 goal of 50 million tons of pig iron and 60 million tons of crude steel was restated. 12/

The Plan directed that, because of the relatively low investment required, expansion of existing steel plants was to be the most important source of increased production. Emphasis on expansion of plants already in operation was a change from the policy of constructing new facilities -- a policy stressed in all previous Five Year Plans. Although the new policy was not an abandonment of the theory of "regional self-sufficiency," the Plan statement was tacit admission of the high costs and extensive delays encountered in the construction of new plants. The Plan included the completion of plants started during the Fourth Five Year Plan at Novo-Troitsk, Sumgait, Rustavi, and Cherepovets. 13/

During the Fifth Five Year Plan, great emphasis was to be placed on improving efficiency of operation. Increased operating efficiency at existing plants was to provide about one-third of the planned increases in production. The automatization of equipment and the production of alloy and special steels from electric furnaces was to increase. Many types of finished steel new in the USSR -- such as wide-flanged beams, Z-beams, and railroad car channels -- were to be added. Sharp increases were scheduled for plate, light sections, wire, and stainless steel sheet. 14/

By the end of the Fifth Five Year Plan, many achievements and a few notable failures had been recorded by the Soviet ferrous metallurgical industry. The production plans for crude steel and finished steel were overfulfilled by 1 million and 1.3 million tons, respectively, but production of several types of finished steel -- light sections, wire rod, cold rolled sheet, and metal articles -- were under Plan. The production of plate in 1955 was 88 percent greater than in 1950; small sections were 100 percent greater; wire, 2.1 times more; electrical sheet, 2.3 times; stainless steel, 2.9 times; and stainless steel sheet, 2.8 times greater than in 1950. Production of pig iron fell short of Plan goals by 2 percent, but the supply of scrap apparently was adequate to overcome this deficiency and also to provide for an overfulfillment of the plans for crude steel. 15/

Planned goals for investment and capital construction, for labor productivity, and for increasing blast furnace efficiency were not met. Blast furnace efficiency, scheduled for a 30-percent increase, registered only a 22-percent increase. The most startling failures probably were the 26-million-ton underfulfillment in opening new iron ore mining capacity and the failure to construct rolling mills of 4.8 million tons of capacity (estimated to be a shortfall of 25 to 35 percent). 16/

During the period of the Fifth Five Year Plan, construction continued at the new Novo-Troitsk, Cherepovets, Rustavi, Temir-Tau, Begovat, and Sumgait iron and steel works and at the Baglai and Moscow coke plants. The new No. 1 blast furnace of the Cherepovets plant, completed in 1955, is shown in Figure 3.* Major construction projects,

* Following p. 10.

adding new units of capacity at existing plants, were under way at the Magnitogorsk, Chelyabinsk Bakal, Azovstal', Krivoy Rog, Dneprodzerzhinsk, Voroshilovsk, Zaporozh'ye, and Novo-Lipetsk metallurgical plants.

D. Sixth Five Year Plan (1956-60).

The ambitious directives of the Sixth Five Year Plan (1956-60) announced in January 1956 called for a 23-million-ton (51-percent) increase in production of crude steel to a level of 68.3 million tons by 1960 (the Fifth Five Year Plan increase in production of crude steel was 18 million tons, 66 percent). Although the expansion of the US steel industry by 1960 will be influenced by diverse economic and political factors, estimates indicate a probable increase of 20 million tons (17 percent) -- from 116 million tons to 136 million tons. By 1 January 1961, therefore, Soviet steel capacity will equal 52 percent of US capacity, compared with 41 percent on 1 January 1956.*

The Soviet Plan directives also call for a 1960 production of 114.3 million tons of commercial-grade iron ore, 64.6 million tons of coke, 53 million tons of pig iron, and 52.7 million tons of finished steel, increases of 59, 48, 59, and 52 percent, respectively.** 17/

Soviet blast furnace productivity will be greatly improved by the construction of 58 new sinter lines (39 were built between 1950 and 1955). The production goal of 73 million tons of sinter will provide the industry with a sinter-to-pig-iron ratio of 1.38 to 1 in 1960 and will result in significant increases in the production of existing blast furnaces. Another factor which will contribute to higher blast furnace production is the trend to larger furnaces. The Sixth Five Year Plan calls for the completion of a 2,000-cubic-meter furnace with a 32.2-foot hearth diameter (the largest furnace in the US at present is 1,810 cubic meters with a hearth diameter of 30.3 feet). Many large open hearth and electric furnace units are also comtemplated. 18/

* The Soviet steel industry is assumed to be operating at capacity. Estimated crude steel capacity as of 1 January 1956, for example, is obtained by totaling production in 1955 and in 1956 and dividing by 2.
** The production increases specified by the Plan directives were applied to estimated 1955 production to obtain Sixth Five Year Plan goals. In the case of finished steel, 1955 production was underestimated, and only a 49-percent increase now will be required to achieve the original goal.

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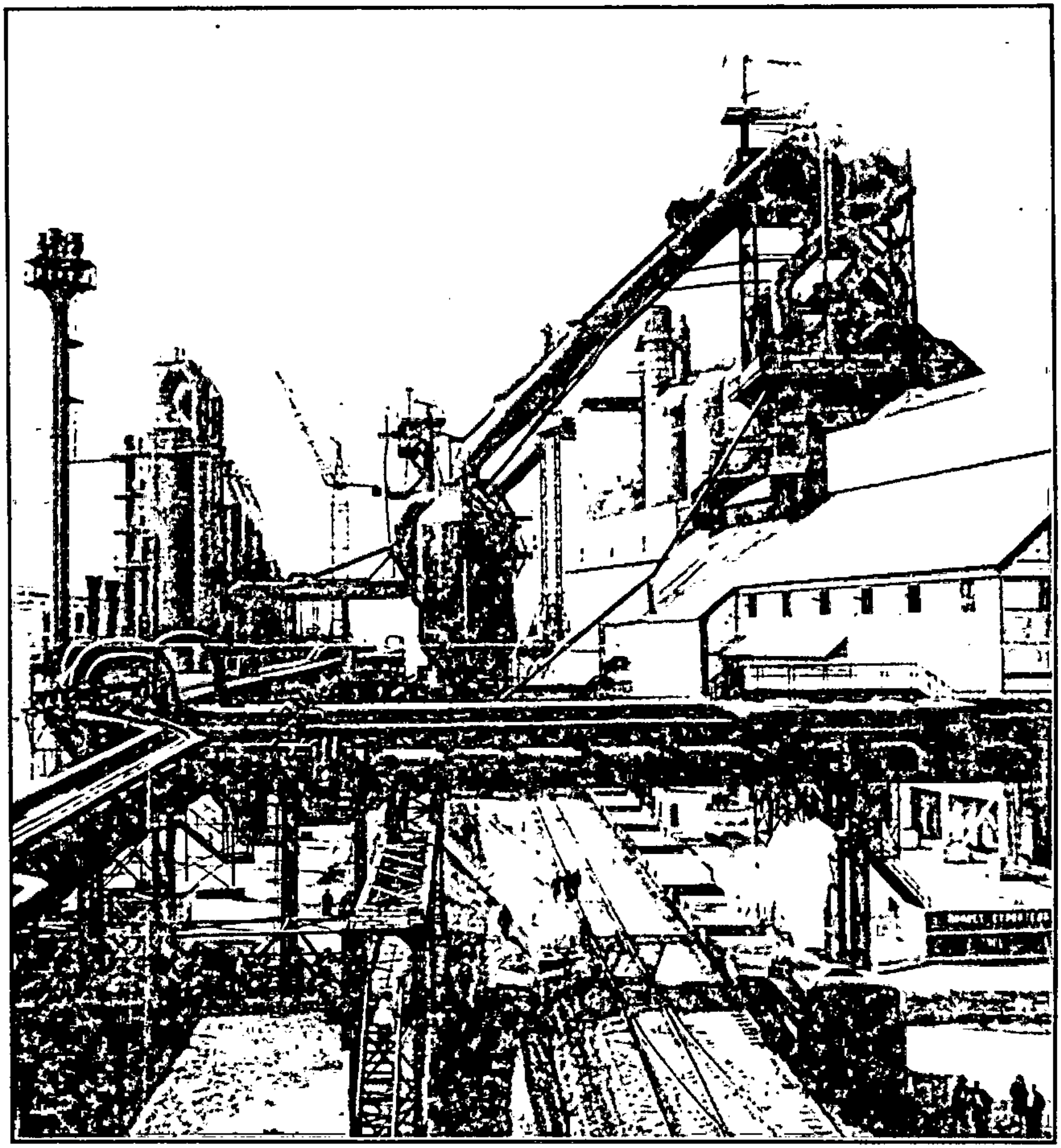

Figure 3. No. 1 Blast Furnace of the Cherepovets Metallurgical Plant, 1955.

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Another noteworthy goal is the planned erection at steel plants of 18 oxygen stations (2 were built during the Fifth Five Year Plan period) with capacities ranging from 10,000 to 30,000 cubic meters per hour. As a result, about 40 percent of the production of crude steel, including all converter steel, will be smelted with oxygen-enriched blast. Soviet metallurgical capabilities will continue to improve during the Sixth Five Year Plan period with the expansion of continuous casting in plants at Gor'kiy, Sverdlovsk, Stalino, Voroshilovsk, Taganrog, Kramatorsk, and other sites; vacuum melting and casting; and the erection of more electrolytic tin lines, which will effect an economy in the use of tin. 19/

The commissioning of a number of new continuous hot and cold sheet and strip mills will permit a significant increase in the highly deficient flat-rolled product category; sheet is to increase 85 percent, including a 2.2-fold increase in production of thin sheet and a four-fold increase in production of cold rolled sheet. During the next several Five Year Plan periods the USSR hopes to bring the production of flat-rolled products up to 40 or 45 percent of the total production of finished steel, as is the case in the US. Because flat-rolled products are predominantly used in consumer applications, the rise in production of sheet and strip steel indicates a contemplated increase in the production of consumer durable goods. 20/

To obtain the production increases called for by the Sixth Five Year Plan, the Plan directives specify the amount of construction of new capacity to be undertaken and the minimum increase in production to be achieved through the more efficient organization of production and use of existing capacity. These directives as they apply to iron ore, pig iron, and crude and finished steel provide for increases in capacity substantially greater than the added production called for by the Plan. Increases in capacity and production in the ferrous metallurgical industry of the USSR called for by the Sixth Five Year Plan are shown in Table 2.*

A major part of the apparent excess capacity probably is designated for the retirement or replacement of obsolete facilities. This assumption is substantiated by Soviet journals stressing the uneconomic aspects of maintaining high-cost, obsolete units in operation and referring to the inability of the Ministry of Ferrous Metallurgy

* Table 2 follows on p. 12.

Table 2

Increases in Capacity and Production
in the Ferrous Metallurgical Industry of the USSR
Called For by the Sixth Five Year Plan (1956-60) a/

Million Metric Tons

Source of Increase	Commercial-Grade Iron Ore	Pig Iron	Crude Steel	Finished Steel
Capacity				
From increased efficiency	N.A.	6.9	10.8	7.0
From new construction	68.5 b/	16.8	15.8	16.3
Total	N.A.	23.7	26.6	23.3
Production	42.4	19.7	23.0	17.4
Apparent excess capacity	N.A.	4.0	3.6	5.9

a. 21/
b. This is the approximate amount of commercial-grade ore that would be mined from the 91 million tons of raw ore mining capacity to be developed during the Sixth Five Year Plan period. Because 1.23 tons of raw ore were required to produce 1 ton of commercial-grade ore in 1955 and it is expected that 1.44 tons will be required in 1960, the 68.5 million tons of commercial-grade ore would require 91 million tons of raw ore mining capacity.

to effect their replacement. The underfulfillment of the Fifth Five Year Plan in the creation of new iron ore mining and rolling mill capacity by 26 million and 4.8 million tons, respectively, concurrently with the overfulfillment of production goals strongly suggests serious shortcomings in retirement and modernization programs. 22/

Another factor bearing on the apparent excess capacity is the probability that an attempt is being made to create some reserve capacity to enable the industry to meet goals and to operate with greater flexibility. In the iron ore mining industry the creation of reserve capacity by 1960 is not possible, according to the Soviet Minister of Ferrous Metallurgy, in spite of huge planned increases in capacity. This situation undoubtedly is a reflection of the shortcomings encountered during the Fifth Five Year Plan period in opening new capacity. 23/

The planning of an apparent excess capacity affords the industry several important opportunities. If planned increases in efficiency materialize and if construction schedules are met, the industry will be in position to meet production goals and at the same time to replace obsolete units and create some reserve capacity. Underfulfillment of plans for expanding capacity, although it would prevent the successful achievement of retirement and reserve aims, would not bar the possibility of meeting production goals. A shortfall of nearly 15 percent in the planned expansion of crude steel capacity could occur without endangering the production goal. In view of past failures to meet construction goals, this margin may be more apparent than real. Continued deferment of the installation of modern facilities must eventually be paid for in high costs and low labor productivity.

Investment for capital construction in the industry during the Sixth Five Year Plan period will be almost twice that expended on Soviet ferrous metallurgy during the Fifth Five Year Plan period. The considerable quantity of increased production planned to be obtained by improved utilization of existing facilities -- 35 percent for pig iron and 47 percent for crude steel -- materially reduces the investment that would be required if the expansion were to be accomplished wholly by the construction of new facilities. Fulfillment of the Plan, however, will require record outlays. The added production from increased efficiency will be obtained through mechanization and automation and by the provision of oxygen plants, high-capacity turboblowers, more power facilities, and other ancillary improvements. In addition, 16.8 million tons of pig iron and 15.8 million tons of crude steel capacity must be constructed, some in sparsely populated areas requiring housing and utility and transportation facilities as well as production units. New mines must be opened, and heavy investment must be made in beneficiation plants. 24/

The greatest investment will take place in Siberia and Kazakhstan, where in the course of the next 10 or 15 years production facilities are to be established capable of producing 15 million to 20 million tons of pig iron annually. The creation of a new metallurgical base in the eastern USSR will bring about a realignment of producing units and their raw material supplies. The Urals-Kuznetsk complex, based on the exchange of Kuznetsk coking coals and Magnitogorsk iron ore, will be supplanted by the Southern Urals - Karaganda - Kuznetsk complex. In addition, three new complexes -- the Northern Urals - Pechora, the Kuznetsk-Yeniseysk, and the Aldan-Amur -- will be created. 25/

The old Urals-Kuznetsk complex has been modified to include recent developments in Kazakhstan and is now termed the Southern Urals - Karaganda - Kuznetsk complex. The tremendous reserves of iron ore located at Kustanay, coupled with the now proved feasibility of coking Karaganda coals, more than adequately compensates for the declining quality of the ore mined at Magnitogorsk and lessens the dependence of the Southern Urals coke plants on long-haul Kuznetsk coals. The fully integrated Karaganda works now under construction at Temir-Tau, near Karaganda, will be the second largest plant in the USSR when completed. The first 2 blast furnaces are to provide 1.35 million tons of pig iron annually by 1960 and will operate on Karaganda coal and local Atasuskiy iron ores. The Magnitogorsk, Chelyabinsk Bakal, and Kuznetsk combines -- currently the key steel producers in the complex -- are undertaking major expansion programs that will be largely finished by 1960, as will be the smaller but important Novo-Troitsk plant. Further development of the Karaganda works and the initiation of construction of a major integrated steel plant near the Kustanay deposits will continue during the 1961-65 period, maintaining and increasing the importance of the Southern Urals - Karaganda - Kuznetsk complex in the national economy. 26/

The formation of a Northern Urals - Pechora complex is predicated on the further development of Pechora Basin coking coals and the completion of a rail line from the northern Urals to the Pechora area. Both tasks probably will be completed late in the Sixth Five Year Plan period, making the Northern Urals - Pechora complex a real economic asset in freeing the northern Urals, which is deficient in coking coals, from dependence on long-haul Kuznetsk coal. 27/

The development of ferrous metallurgy in the area of Siberia which lies between the Kuznetsk Basin (Kuzbas) and Lake Baykal will give rise to a new combination of plants and raw materials termed the Kuznetsk-Yeniseysk complex. Within the framework of this complex, three major integrated steel plants will be started during the Sixth Five Year Plan period. The first of these, on which planning is most advanced, is the West Siberian plant, to be located in the Altay district. Production from what will be the world's largest blast furnace is scheduled to begin in 1959-60. The plant's raw material base will be similar to that of the present Kuznetsk combine and will include the currently developing iron ore deposits of the Abakan-Minusinsk region and probably those at Korshunovsk in the Angara-Ilimsk district. Although some construction may start during the 1956-60 period on the other two steel plants to be located in East Siberia, one in Krasnoyarskiy Kray and one in Irkutskaya Oblast, the greatest development of these facilities will occur during the 1960's, concurrently with full exploitation of the Angara-Ilimsk (Korshunovsk) and Lower Angara iron ore deposits. 28/

Farther to the east, in the Transbaykal area, the discovery of large deposits of iron ore near Aldan and of coking coal near Chul'man, both in the southern Yakutskaya ASSR, presage the establishment of an Aldan-Amur metallurgical complex. With another iron ore deposit along the Argun' River in Chitinskaya Oblast and with the prospective development of cheap hydroelectric power near the confluence of the Zeya and Amur Rivers, the Transbaykal area is rich in the resources necessary to support a steel industry. The opening of the Aldan-Amur complex probably will permit the long-delayed integration of the steel plant at Komsomol'sk and could eliminate the apparent dependence of East Siberia and the Soviet Far East on pig iron from Manchuria. 29/

The abundance of reserves of raw materials; the experience gained by the USSR during preceding Five Year Plans in expanding ferrous metallurgy; and the margins of safety built into the Sixth Five Year Plan in respect to total production of iron ore, pig iron, and crude and finished steel (see Table 2*) seem to assure the fulfillment of the production goals of the metallurgical industry. The Ministry of Ferrous Metallurgy has consistently failed in the past, however, to complete modernization and new construction programs as scheduled. These failures have been ascribed by the Ministry to its lack of control of the production of metallurgical equipment and the construction of new projects, which are administered

* P. 12, above.

by the Ministry of Heavy Machine Building and the Ministry of the Construction of Metallurgical and Chemical Industry Enterprises, respectively. The magnitude of the current construction program and the commitments of the USSR to provide capital equipment for the European Satellites, Communist China, and India make it probable that the new construction and modernization goals of the Sixth Five Year Plan will not be met on schedule. 30/

The Sixth Five Year Plan provides for a 51-percent increase in production of crude steel; the expected increase in the US during the same period is only 17 percent. In terms of tonnage, however, Soviet expansion will exceed that of the US by only 3.1 million tons for the 5-year period. During and after the XX Party Congress, Bulganin, Khrushchev, and other speakers emphasized the Soviet intention to exceed the US production of steel and other items on a per capita basis during the next several Five Year Plans. Considering the 1955 populations of the US and the USSR (165 million and 200 million, respectively) the Soviet steel industry would require a production of 127 million tons, 2.8 times its present production, to equal the US 1955 per capita production. If the Soviet intentions are serious, therefore, the rate of growth of the Soviet steel industry in absolute tonnage must be materially increased, principally in the expensive sector of new construction.

II. Organization.

A. Council of Ministers.

Administrative organization in the USSR is divided into three major levels: the Council of Ministers, the various ministries, and their main administrations, and the individual enterprises. The Council, which includes the various ministers in charge of major sectors of the Soviet government, exercises over-all supervision of, leadership of, and coordination among the several branches of the economy. In the Council the iron and steel industry is represented by Deputy Chairman Ivan F. Tevosyan, formerly Minister of Ferrous Metallurgy, and by Aleksandr G. Sheremet'yev, the present Minister. 31/

B. Ministry of Ferrous Metallurgy.

Before 1939 the Soviet iron and steel industry was controlled by the Commissariat for Heavy Industry. In that year the Presidium of the Supreme Soviet of the USSR established the All-Union Peoples Commissariat for Ferrous Metallurgy. 32/ In 1948 the Ministry of Ferrous Metallurgy and the Ministry of Nonferrous Metallurgy (both changed from Commissariats in 1946) were merged to form the Ministry of the Metallurgical Industry, which was divided into the Ministries of Ferrous and Nonferrous Metallurgy in December 1950. In March 1953 the two ministries were recombined, but in February 1954 they once more became individual ministries. In addition, the Supreme Soviet in 1954 created the Republic Ministry of Ferrous Metallurgy of the Ukrainian SSR. Although the Ukrainian Ministry presently controls about 40 percent of the iron and steel industry of the USSR, it is still subordinate to the union-republic Ministry in Moscow for important policy decisions. 33/

Tevosyan has remained the dominant personality throughout all ministerial shifts. When Tevosyan became a Deputy Minister of the Council of Ministers in 1953, he was succeeded by Anatoliy N. Kuz'min who held the post until his death in November 1954. Kuz'min was succeeded by Sheremet'yev. The Ukrainian Ministry is directed by Sergei I. Tishchenko. 34/

The Ministry of Ferrous Metallurgy controls the production of all iron and manganese ores, high-temperature coke, ferroalloys, and pig iron, but only about 85 percent of the production of crude and finished steel. The remaining 15 percent of the steel is produced in plants of the Ministries of Heavy Machine Building, Transport Machine Building, Petroleum

Industry, Shipbuilding, and Defense and in those of various republic ministries of local industry. The mining of nickel, cobalt, and several other ores used extensively in steelmaking is under the direction of the Ministry of Nonferrous Metallurgy. 35/

The Ministry of Ferrous Metallurgy receives major assistance in the field of research and development from the Academy of Sciences and its various affiliates and from many metallurgical institutes. Ivan P. Bardin, a Vice President of the Academy of Sciences and Director of the Central Scientific Research Institute of Ferrous Metallurgy, whose pronouncements often reveal the principal problems confronting the development of metallurgy in the USSR, is regarded as the outstanding spokesman for the industry outside the Ministry. 36/

C. Main Administrations.

The subordinate administrative apparatus of the Ministry of Ferrous Metallurgy consists primarily of two types of main administrations: production-territorial units, which control producing enterprises in particular districts or enterprises producing certain types of goods; and auxiliary and administrative units which supervise certain functional operations such as transport, personnel, and finance, and as such serve in a staff capacity to the production-territorial administrations. For counsel and advice on broad matters of policy the Minister has recourse to the Collegium, which is composed of 6 to 12 of the most able people in the Ministry. The technical council of the Ministry studies the applicability of new scientific and technical innovations. The administrative structure of the Ministry of Ferrous Metallurgy is shown in the accompanying chart, Figure 4.* 37/

D. Enterprises.

At the base of the administrative pyramid of the Soviet ferrous metallurgical industry are the various producing units, or enterprises. Each enterprise is a legal entity "operating on the basis of economic accountability" (khozraschet) with limited administrative control in the hands of the director. The enterprise has its own working capital and fixed assets and can make contracts, sue, and be sued. The primary objective of the enterprise is to operate in conformity with the state plan and to fulfill the prescribed production goals as efficiently and economically as possible. 38/

* Following p. 18.

FIGURE 4

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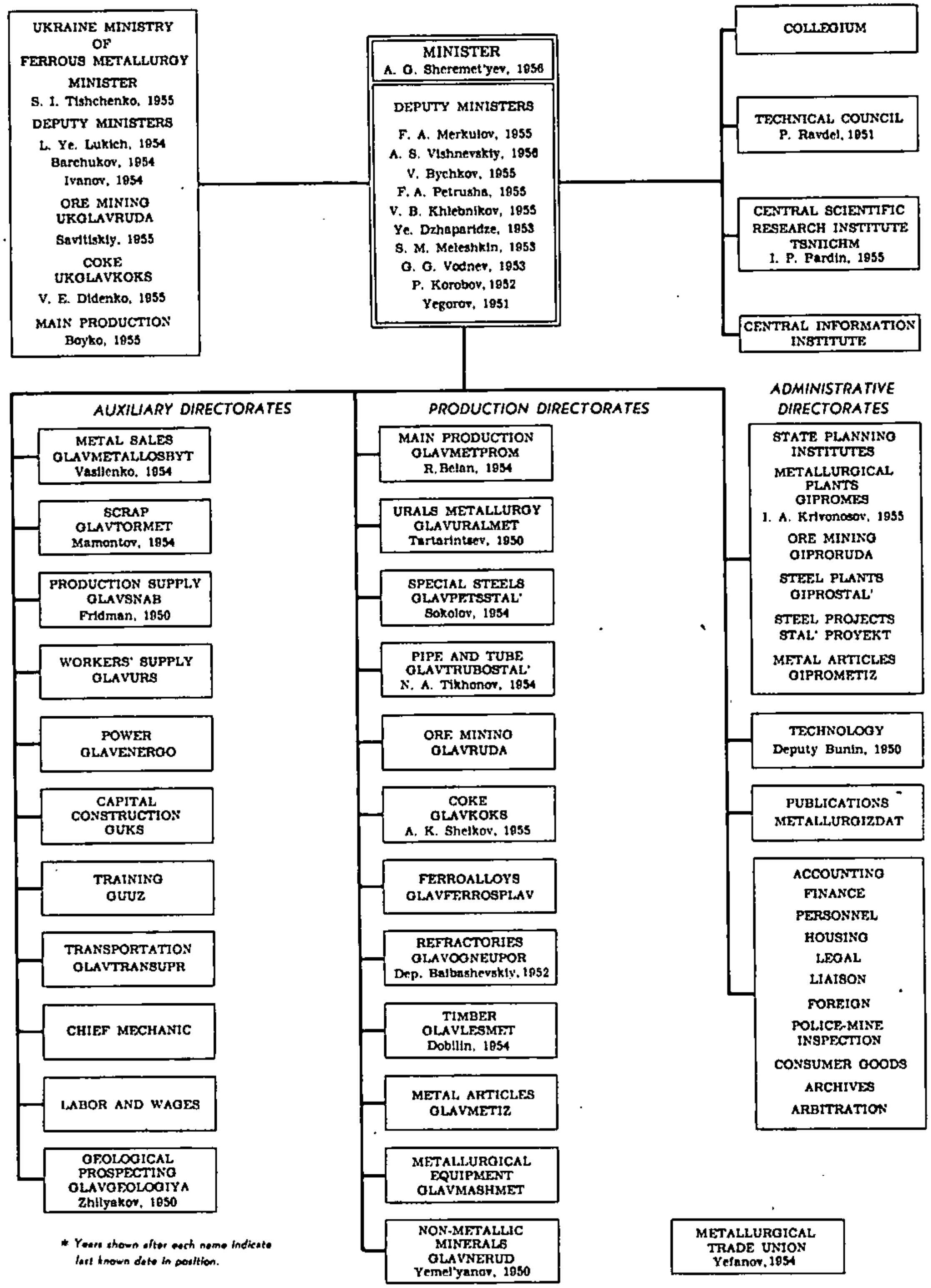
USSR
ADMINISTRATIVE STRUCTURE OF THE MINISTRY OF FERROUS METALLURGY, 1955 *



* Years shown after each name indicate last known date in position.

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III. Planning and Control.

A. Plan Formulation.

Planning for the ferrous metallurgical industry of the USSR is developed for several time periods. At least in theory, there are at all times monthly, quarterly, annual, or Five Year Plans. Five Year Plans are prepared in the form of general directives; annual plans, which serve as the operational program of the enterprise, are drawn up in great detail. 39/

Formulation of the annual plan begins at the enterprise level. The proposed plan, sent by the enterprise through its main administration to the Ministry of Ferrous Metallurgy, includes a production plan, a labor plan, a plan of the cost of production, a capital investment plan, a plan showing consumption norms of raw materials and equipment, and a plan for the introduction of new technological features. 40/

The Ministry of Ferrous Metallurgy consolidates and prepares the annual plan and then forwards it to the Council of Ministers by 15 August of each year, at the same time sending a copy to the State Economic Commission (Gosekonomkomissiya). Gosekonomkomissiya must approve the plan by 1 October. Financial aspects of the annual plan are gone over by the Ministry of Finance, which must give its approval by 10 October. 41/

Either the Council of Ministers or Gosekonomkomissiya may alter the goals sent up in the Ministry's annual plan, as happened during the formulation of the 1955 and 1956 plans. The magnitude of the 1955 upward adjustment is unknown. In spite of the greater production ordered, however, the steel industry succeeded in overfulfilling the annual plan by 570,000 tons of crude steel and 200,000 tons of finished steel. Over the Ministry's strong objections the government also raised goals in the 1956 annual plan for crude and finished steel by 1.3 million and 1.7 million tons, respectively. 42/

These changes in the annual plan were made in the summer of 1955, when the State Planning Commission (Gosplan) was formulating the Sixth Five Year Plan goals and Gosekonomkomissiya was examining the Ministry's 1956 annual plan. The Ministry's relatively moderate 6-percent increase of 2.6 million tons of crude steel (3.9 million tons less the known increase of 1.3 million tons),* proposed and forwarded to the Council of Ministers before 15 August, would have met the 1960 goal of 60 million tons of crude steel set by Stalin in 1946. In July 1955, Premier Bulganin specifically reemphasized the 60-million-ton goal. Sometime during the third quarter of 1955 the government and Gosplan decided to place additional emphasis on ferrous metallurgy, as subsequently revealed by the directives of the Sixth Five Year Plan. The result of this decision was to request the Ministry of Ferrous Metallurgy to raise the 1956 goal for crude steel from about 2.6 million to 3.9 million tons, an increase of 50 percent. 43/

B. Tekhpromfinplan.

After returning through the administrative hierarchy from the Council of Ministers, the approved plan with its basic directives is received at the enterprise. In accordance with the directives, each enterprise draws up in detail a Technical-Industrial-Financial Plan (Tekhnicheskiy-Promyshlennyy-Finansovyy Plan -- Tekhpromfinplan) which must then be approved by the chief directorate of the enterprise by the first of the new plan year.** 45/

The basic elements of the Tekhpromfinplan are (1) the production plan showing the type of product and its value; (2) the plant utilization plan outlining the operation of equipment and various monetary funds; (3) the plan for labor and wages showing the expected increase in labor productivity; (4) the plan for the supply of materials, fuel, energy, replaceable equipment, and instruments; (5) the cost plan, including charges for amortization, administration, and marketing; and (6) the financial plan stating the proposed income and expenditures of funds. Daily, weekly, monthly, and quarterly operating plans are set up based on the goals of the annual Tekhpromfinplan. 46/

* This figure is predicated on an 8.5-percent annual increase in production of crude steel required to meet the 1960 goal of 68.3 million tons.

** In actual practice the method of planning does not operate without difficulty. For example, in 1953 the important Serp i Molot Plant in Moscow did not receive approval for its Tekhpromfinplan until November, 10 months late. 44/

C. Control.

In fulfilling the directives of the Tekhpromfinplan the enterprise is under the supervision of its own chief directorate and the Ministry of Ferrous Metallurgy. In addition the State Bank (Gosbank), through its local branches, exercises financial control by holding the settlement account of the enterprise where all of the monetary transactions of the enterprise are recorded in detail. Because the enterprise is forced to operate with minimum working capital, inadequate for coping with emergencies, Gosbank has an additional element of control in its power to grant short-term credit. 47/

IV. Production of Iron and Steel.

A. Steel Plant.

In this report, as in general usage, the term steel plant denotes a facility that makes or rolls steel. Because of the savings that may be made by combining in one plant conversion of raw materials into coke, pig iron, crude steel, and finished steel products, the most economical unit is the integrated plant. An important reason for the striking contrast in efficiency* between the average Soviet plants and the average plant in the US is the relatively low proportion of the total production of Soviet steel that is made in integrated units. In 1955, only 60 percent of Soviet steel came from integrated plants, compared with 92 percent in the US. The degree of integration in the USSR, however, will rise considerably during the next 10 years as a result of the large number of integrated plants currently under construction or planned. 48/

Although Magnitogorsk is one of the three largest steel plants in the world,** the Soviet steel industry is composed to a considerable extent of small and relatively uneconomical plants. No determination can be made of the precise optimum for steel plant capacity under all conditions, but 1 million tons is the approximate minimum required to derive the maximum benefit from highly productive blast furnaces, open hearth furnaces, and blooming and rolling mills. In the USSR, 11 plants, each with a capacity of 1 million tons or more, account for 50 percent of the production of crude steel; in the US, 82 percent of total annual production is produced in 46 plants of this size. All of the new integrated plants in the USSR are planned for capacities in excess of 1 million tons. The further development of the oxygen converter and of continuous casting processes, however, may substantially reduce the minimum capacity now required to achieve optimum economy with conventional modern equipment. 49/

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* See IX, A, p. 109.
** With a 1955 production of crude steel of 5.8 million tons, Magnitogorsk would rank second, just ahead of the Sparrow's Point Plant of the Bethlehem Steel Company (5.6 million metric tons in 1955) and behind the Gary Works of the US Steel Corporation (6.5 million metric tons in 1955). All three mills are scheduled for further expansion.

B. Distribution of Facilities.

Markets as well as raw materials exert a strong influence in determining the location of iron and steel plants. Because 4 tons of raw materials are required to produce 1 ton of finished steel, however, gathering costs are the controlling factor, and they dictate a location as close as possible to sources of iron ore and coking coal, the major bulk materials. Thus the Ukraine, possessing abundant reserves of both iron ore and coking coal, accounts for one-half of the pig iron and one-third of the steel produced in the USSR. The Urals area, rich in iron ore but depending on the Kuznetsk Basin for coking coal, accounts for an additional one-third of the pig iron and steel. The remaining production is widely distributed, the principal producers being the Kuznetsk metallurgical combine in West Siberia (Region IX), which accounts for 6 percent of the crude steel, and the plants of the Central Region (Region VII), which are based largely on scrap generated by the manufacturing industries of the region and produce 6.1 percent of total Soviet crude steel. 50/

The regional distribution of production of coke, pig iron, crude steel, and finished steel in the USSR, by economic region, in 1955 is shown in Table 3.*

The Kuznetsk combine in Stalinsk provides an example of the heavy transportation costs resulting from a plant location remote from major consuming industries. The only integrated plant east of the Urals, Stalinsk was constructed on the theory that savings in transportation would be achieved by crosshauling coal from the Kuznetsk Basin (Kuzbas) and iron ore from Magnitogorsk. Much of the finished steel produced at Stalinsk, however, is shipped west, some as far as Leningrad, because the vast territory to the east is at such a low stage of industrialization that it cannot consume the production of the plant. 51/

* Table 3 follows on p. 25.

Table 3

Distribution of Production of Coke,
Pig Iron, Crude Steel, and Finished Steel in the USSR
by Economic Region a/
1955

Percent of Total

Economic Region	Coke	Pig Iron	Crude Steel	Finished Steel
I (Northwest)	0.1	0.3	2.3	2.0
II (West)	0	0	0.3	0.4
III (South)	52.8	49.8	37.4	38.6
IV (Southeast)	0	0	2.2	2.0
V (Transcaucasus)	1.3	1.3	2.1	1.6
VI (Volga)	0	0	3.7	3.4
VII (Central)	2.4	7.1	6.1	5.4
VIII (Urals)	27.6	35.1	36.0	34.4
IX (West Siberia)	10.7	6.4	7.3	7.0
X (Kazakhstan and Central Asia)	0	0	1.0	1.1
XI (East Siberia)	0.3	0	0.9	0.8
XII (Far East)	0.1	0	0.7	0.7
Unallocated	4.7	0	Negligible	2.6
Total	100.0	100.0	100.0	100.0

a. 52/. For the distribution of production of coke, pig iron, and crude and finished steel in the USSR by Soviet republic in 1955, see Appendix A, Table 38, p. 147, below.

C. Pig Iron and Scrap.

1. Pig Iron.

The USSR is the world's second largest producer of pig iron. Soviet production in 1955 was 33.3 million tons, equal to 47 percent of that of the US, and on 1 January 1956 Soviet production capacity was equal to 45 percent of that of the US. To meet the 1960 Plan goal, an average annual growth rate of 3.9 million tons will be required, a rate which is substantially greater than the rate of 2.8 million tons achieved during the Fifth Five Year Plan period. Estimated production of pig iron in the USSR in 1913, 1928, 1930-40, and 1945-60 is shown in Table 4. 53/

Table 4

Estimated Production of Pig Iron in the USSR a/
1913, 1928, 1930-40, and 1945-60

Million Metric Tons

Year	Production	Year	Production
1913	4.2	1946	9.9
1928	3.3	1947	11.2
1930	5.0	1948	13.7
1931	4.9	1949	16.4
1932	6.2	1950	19.2
1933	7.1	1951	21.9
1934	10.4	1952	25.1
1935	12.5	1953	27.4
1936	14.4	1954	30.0
1937	14.5	1955	33.3 b/
1938	14.7	1956	36.6
1939	14.5	1957	40.2
1940	14.9	1958	44.1
1945	8.8	1959	48.4
		1960 (Plan)	53.0

a. 54/. Production figures include blast furnace ferroalloys.

b. [redacted] Of the 33.3 million tons of pig iron produced in 1955, between 98 and 99 percent was produced at coke-operated furnaces, and the remainder in charcoal blast furnaces.

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50X1

In the USSR, pig iron is classified as basic (open hearth), converter, foundry, or natural alloy pig or as a type of blast furnace ferroalloy. Production of pig iron in the USSR, by type, in 1955 is shown in Table 5.

Table 5

Production of Pig Iron in the USSR, by Type a/
1955

Million Metric Tons

Type	Quantity
Basic (open hearth)	25.990
Foundry	4.570
Converter	1.840
Natural alloy	0.165
Spiegeleisen	0.425
Ferromanganese	0.165
Ferrosilicon	0.145
Total	33.300

a. 55/

The principal type of natural alloy pig iron is a chrome-nickel pig (0.5 to 1.4 percent chrome and 0.7 to 1.4 percent nickel) smelted from Yelizavetinskiy ores. In 1955, production of a natural alloy chrome-nickel pig iron from Khalilovo ores began in the new blast furnace at Novo-Troitsk in the southern Urals. Blast furnace ferroalloys consist of ferromanganese (70 to 75 percent manganese), ferrosilicon (9 to 13 percent silicon), and spiegeleisen (10 to 25 percent manganese). Although several blast furnaces in the Ukraine are operating exclusively on these products, the usual practice in the USSR is to produce ferroalloys just before a furnace is taken out of operation for relining. 56/

During 1955, Soviet blast furnaces required 62 million to 63 million tons of iron ore (averaging 54 percent iron) and 31 million to 32 million tons of coke. Supplies of limestone for use as a fluxing agent are available in many localities, but requirements are much higher in the Ukraine because of the high-sulfur Donets coke and the siliceous Krivoy Rog ores. Low-grade manganese ores are often added to Soviet blast furnaces to aid in the elimination of sulfur and to obtain basic pig iron with an average 2-percent manganese content. About 5 percent of the metallic burden of Soviet furnaces consists of scrap, mill scale, and open hearth slag. 57/

A study of operating achievements of Soviet and US blast furnaces suggests that the production rates of some large, modern Soviet furnaces are superior to the best US furnaces of comparable size. The blast furnaces at Magnitogorsk produce about 2,000 tons of pig iron daily, which is about 10 percent more than the best US furnace produces. The outstanding performance of the Magnitogorsk furnaces is a result of the high degree of raw material preparation combined with the application of advanced technological features. The cost of the product, however, may be higher than the US cost. The blast furnace division of the Magnitogorsk metallurgical combine is shown in Figure 5.* Average furnace productivity rates in the Soviet blast furnace industry, which are substantially below the Magnitogorsk rate, probably compare favorably with the average US rate. 58/

An approximate measure of the increased productivity achieved by Soviet furnacemen is afforded by the blast furnace coefficient, or index of utilization. An index of 0.80 signifies that 0.80 cubic meters of blast furnace volume were utilized for the production of 1 ton of pig iron in 24 hours. An index of utilization for blast furnaces in the USSR in 1940, 1945, and 1950-56 is shown in Table 6.**

Planned gains in Soviet production of pig iron from increased operating efficiency were not met in 1953, 1954, and 1955 -- presumably as a result of the delays encountered in the construction of new raw

* Following p. 28.
** Table 6 follows on p. 29.

50X1

Figure 5. Blast Furnaces of the Magnitogorsk Metallurgical Combine, 1955.

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Table 6

Index of Utilization for Blast Furnaces in the USSR a/
1940, 1945, and 1950-56

Cubic Meters per Ton of Pig Iron per 24 Hours

Year	Index	Year	Index
1940	1.19	1952	0.88
1945	1.15	1953	0.86
1950	0.98	1954	0.83
1951	0.93	1955	0.80
		1956 (Plan)	0.76

a. 59/. There are other indexes of utilization. In the US, productivity is measured by the tons of pig iron per square foot of hearth per 24 hours, which makes comparison with Soviet furnaces difficult.

material preparation plants required to prepare a furnace charge of higher quality. 60/

The use of pig iron as a source of ferrous metallics is relatively more important in the USSR than in nations which industrialized earlier and have supplies of scrap in the form of obsolete structures and machines. The ratio of production of pig iron to production of crude steel has always been higher in the USSR (0.82 in 1940 and 0.72 in 1953) than in the US (0.68 in 1940 and 0.66 in 1953) or in the UK (0.63 in 1940 and 0.64 in 1953). The ratio in the USSR reached a low of 0.70 in 1950 because of the availability of war-created scrap and a consequent emphasis on the construction of scrap-operated plants in the 1946-50 period. During 1952 and 1953 the Soviet supply of ferrous metallics became so restricted that it was necessary to construct a large number of new blast furnace installations. By 1955 the ratio had risen to 0.74, and according to the Sixth Five Year Plan it will rise to 0.78 in 1960. 61/

2. Scrap.

Soviet practice in the use of scrap as against pig iron in steelmaking furnaces varies from the exclusive use of pig iron to an all-scrap charge, depending on the relative cost and availability of the two materials. In the absence of suitable sources of coking coal and iron ore for the production of pig iron, an adequate scrap supply can serve as a raw material base for the establishment of a metallurgical industry, as is the case in the areas around Leningrad, Moscow, Stalingrad, Gor'kiy, and Komsomol'sk in the Soviet Far East.

Until 1940 the practice in the USSR was to use 40 percent or less scrap in the steelmaking charge. The enormous supply of war scrap available between 1945 and 1950 led to investment in steel plants largely dependent on scrap. Beginning in 1951, when war scrap supplies approached exhaustion, this policy produced a serious shortage of ferrous metallics. 62/

Scrap drives of all sorts, including house-to-house collections, augmented the tonnage flowing to the steel mills. Reports of interruption in steelmaking operations and decreased production in some plants indicate that the supply of scrap was in a critical state. The construction of new blast furnace capacity, designed to alleviate the critical shortage of scrap, fell behind schedule, and, as a result, the demand for scrap remained high. 63/

Intense scrap collection efforts, however, enabled the ferrous metallurgical industry to meet planned production goals for crude steel in 1955, even though the supply of ferrous metallics remained tight.

D. Crude Steel.

The USSR is the second largest producer of crude steel in the world. In 1955, Soviet production was 45.3 million tons, equal to 43 percent of US production, and capacity on 1 January 1956 was equal to about 41 percent of US capacity. To meet the 1960 Plan goal, an average annual growth rate of 4.6 million tons will be required, a rate substantially greater than the rate of 3.6 million tons achieved during the Fifth Five Year Plan. Estimated production of crude steel in the USSR in 1913, 1928, 1930-39, and 1945-60 is shown in Table 7.* 64/

* Table 7 follows on p. 31.

Table 7

Estimated Production of Crude Steel in the USSR a/
1913, 1928, 1930-39, and 1945-60

Million Metric Tons

Year	Production	Year	Production
1913	4.3	1946	13.3
1928	4.3	1947	14.5
1930	5.8	1948	18.6
1931	5.6	1949	23.3
1932	5.9	1950	27.3
1933	6.9	1951	31.4
1934	9.7	1952	34.5
1935	12.6	1953	38.1
1936	16.4	1954	41.4
1937	17.7	1955	45.3
1938	18.1	1956	49.2
1939	17.6	1957	53.3
1940	18.3	1958	57.9
1945	12.3	1959	62.8
		1960 (Plan)	68.3

a. 65/. Crude steel is steel for ingots and castings.

The Soviet steel industry has about 158 plants producing crude steel. In 1955 these plants had 532 open hearth furnaces (the US had 924), 206 electric furnaces (the US had 259), and 48 Bessemer converters (the US had 33). [redacted] 50X1
50X1

Production of crude steel in the USSR and the US, by process, in 1955 is shown in Table 8.*

* Table 8 follows on p. 32.

Table 8

Production of Crude Steel in the USSR and the US, by Process a/
1955

Process	USSR (Million Metric Tons)	USSR (Percent of Total)	US (Percent of Total)
Open hearth	40.3	89	88
Electric b/	3.2	7	8
Bessemer b/	1.8	4	4
Total	45.3	100	100

a. 67/
b. Crude steel produced by a duplex process, either a combination of a Bessemer converter and an open hearth furnace or of open hearth and electric furnaces, is shown as open hearth steel.

Virtually all open hearth steel is produced in basic* furnaces similar to the 150-ton Sumgait units shown in Figure 6.** Several acid open hearth furnaces are in operation at Uralmash and at other machine building plants. Production of converter steel is limited to Bessemer converters (acid refractory lining), but a Thomas converter (basic refractory lining) may be in a stage of reconstruction at Kerch'. There are two duplex processes currently in use and one planned for operation during the Sixth Five Year Plan period. The most important is the acid converter - basic open hearth process used in the Ukraine at Yenakiyevo, Dnepropetrovsk, Dneprodzerzhinsk, Makeyevka, and Stalino and in the Urals at Chusovoy. The other process, the basic open hearth - acid electric,

* The term basic refers to acidity or basicity of refractory lining, which has been predetermined by available raw materials and the type of steel to be produced.
** Following p. 32.

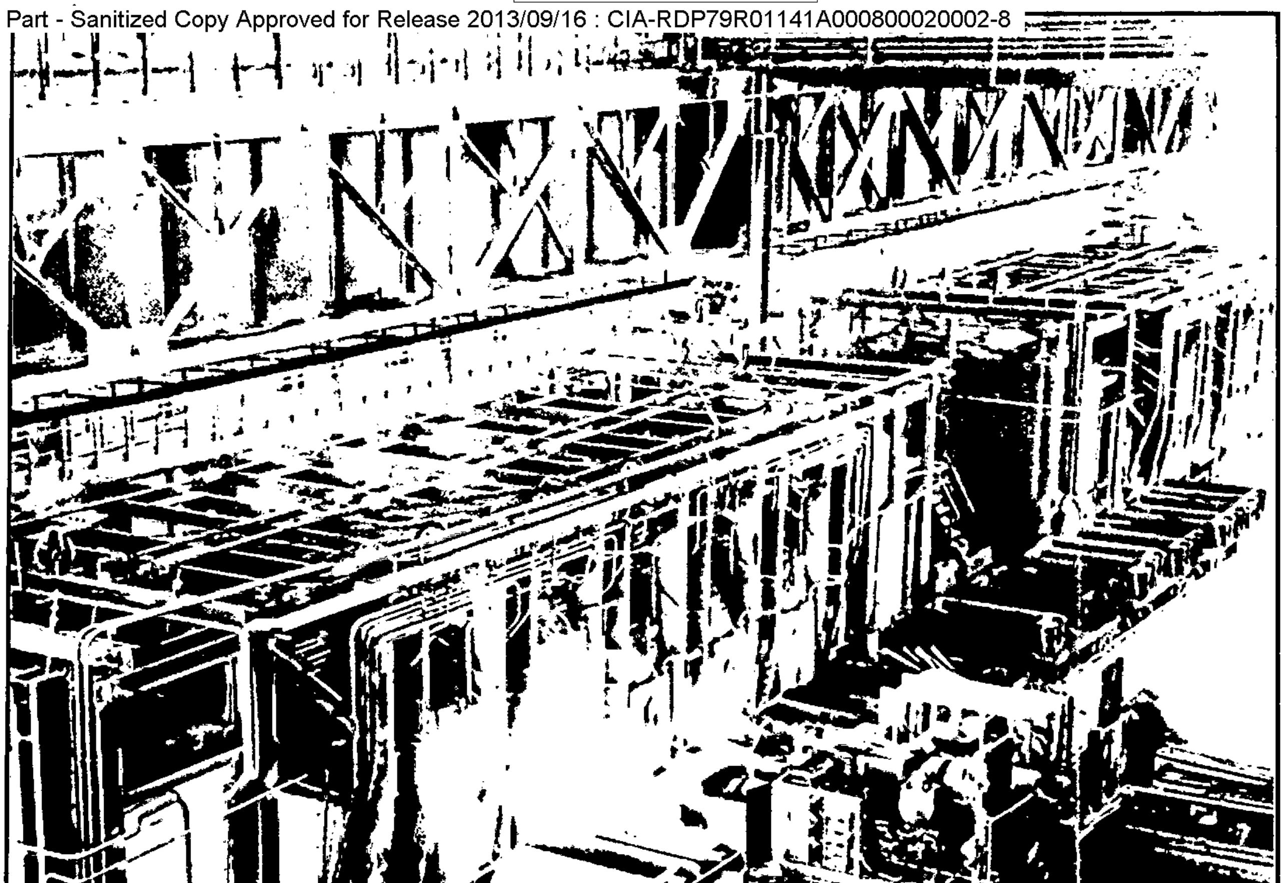

Figure 6. A 150-Ton Furnace in the Open Hearth Shop of the Sumgait Tube Plant, 1955.

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is used at the Bolshevik and Kirov plants in Leningrad, and also at Zaporozh'ye. Under consideration for adoption during the new Plan period is the Bessemer converter - basic electric furnace process. 68/

The use of ferrous metallics in the USSR, by steelmaking process, in 1955 is shown in Table 9.

Table 9

Use of Ferrous Metallics in the USSR
by Steelmaking Process a/
1955

	Percent of Total		
Process	Pig Iron	Scrap	Iron Ore b/
Open hearth	56	40	4
Electric	3	94	3
Bessemer	90	6	4

a. 69/
b. Given in terms of metallic content.

An approximate measure of the increase in productivity of Soviet open hearth furnaces over a period of years is afforded by the open hearth coefficient, or index of utilization. A coefficient of 6.19 signifies that 6.19 tons of steel were produced from each square meter of hearth area in a 24-hour period. An index of utilization for open hearth furnaces in the USSR in 1937, 1940, and 1950-56 is shown in Table 10.*

* Table 10 follows on p. 34.

Table 10

Index of Utilization for Open Hearth Furnaces in the USSR a/
1937, 1940, and 1950-56

Metric Tons per Square Meter of Hearth per 24 Hours

Year	Index	Year	Index
1937	4.35	1952	6.19
1940	4.37	1953	6.50
1950	5.81	1954	6.69
1951	6.10	1955	6.95
		1956 (Plan)	7.44

a. 70/

A comparison of the Soviet index of utilization with results achieved by US open hearth furnaces indicates that during 1954 Soviet furnaces were 10 percent more productive in terms of production per unit of hearth area.* Data on a few of the best Soviet plants suggest a productivity rate 10 percent higher than that of the best US plants. 72/

The superior productivity of the Soviet furnaces probably is the result of a combination of practices, not all of which are necessarily economical from the US point of view. Soviet metallurgists charge a higher percentage of hot metal in most of the larger plants, use oxygen more extensively, employ more basic refractories in furnaces, and, on the average, have larger furnaces. Although all these factors tend to raise productivity per unit of hearth area, cost considerations also are involved. Soviet high hot-metal practice results from a scarcity of scrap, which is available in the US at prices which make it economical to use in greater quantities.

* The US index is derived from the 1954 average of all plants of a major US producer of steel. 71/

E. Finished Steel.

Finished steel, the end product of the ferrous metallurgical industry, includes the total production of rolled, drawn, forged, and cast products. In total production of these items the USSR ranks second in the world and is the largest producer of rails, rail accessories, and railroad car wheels. To meet the 1960 Plan goal, an annual growth rate of 3.5 million tons will be required, a rate substantially greater than the rate of 2.8 million tons achieved during the Fifth Five Year Plan period. Estimated production of finished steel in the USSR in 1913, 1928, 1930-40, and 1945-60 is shown in Table 11. 73/

Table 11

Estimated Production of Finished Steel in the USSR a/
1913, 1928, 1930-40, and 1945-60

Million Metric Tons

Year	Production	Year	Production
1913	3.6	1946	9.6
1928	3.4	1947	11.1
1930	4.6	1948	14.2
1931	4.3	1949	18.0
1932	4.4	1950	20.9
1933	5.1	1951	24.0
1934	7.0	1952	26.8
1935	9.4	1953	29.4
1936	12.5	1954	32.1
1937	13.0	1955	35.3
1938	13.3	1956	38.3
1939	12.7	1957	41.5
1940	13.1	1958	45.0
1945	8.5	1959	48.7
		1960 (Plan)	52.7

a. 74/. Recent evidence, as yet inconclusive, indicates that production of steel castings may not be included in production of finished steel.

Finished steel is produced in all regions of the USSR and is closely related to production of crude steel, as shown by the 1955 regional production in Table 3.* The relation of production to consumption varies from region to region. The two largest producing areas, the Ukraine and Urals, consume only 60 to 75 percent of their production whereas consumption in the Moscow-Leningrad area is 6 times greater than production. 75/

Finished steel is produced in about 188 enterprises in the USSR. Of this number, 78 produce only steel castings and are, for the most part, captive foundries subordinate to other ministries. Approximately 20 plants are small sheet mills which do not produce their own steel but obtain sheet bar and slabs from other plants. For the production of semifinished steel the Soviet steel industry has 44 blooming and slabbing mills and 38 billet mills. The industry also has 9 rail-structural mills, 5 wheel mills, 97 bar mills, 23 rod mills, 63 tube mills, 43 plate mills, and more than 180 hot and cold strip and sheet mills, of which only a few are of the highly productive continuous type shown in Figure 7.** The type of finished product produced at each plant in 1955 and the plant location is shown in the Supplement to this report, Table 1.

The continuing development of the economy of the USSR is reflected in the shifting pattern of grades and types of finished steel produced. In the USSR, finished steel is categorized as "ordinary" or "quality" steel.*** Quality steels are those with closely controlled chemical compositions and mechanical properties. Carbon steels may be considered quality steels when specifications require special processing and control, and all alloy steel is of a quality grade. 76/

During early Five Year Plans, when the USSR was engaged primarily in construction activities, the proportion of ordinary grades of steel was high. Under the influence of armament requirements during World War II the product mix departed radically from the normal peacetime pattern.

* P. 25, above.

** Following p. 36.

*** The Soviet categories are not comparable with the US categories of carbon, alloy, and stainless. Although the US alloy and stainless categories are found completely within the Soviet "quality" category, US carbon grades may be found in both the Soviet "ordinary" and "quality" categories.

50X1

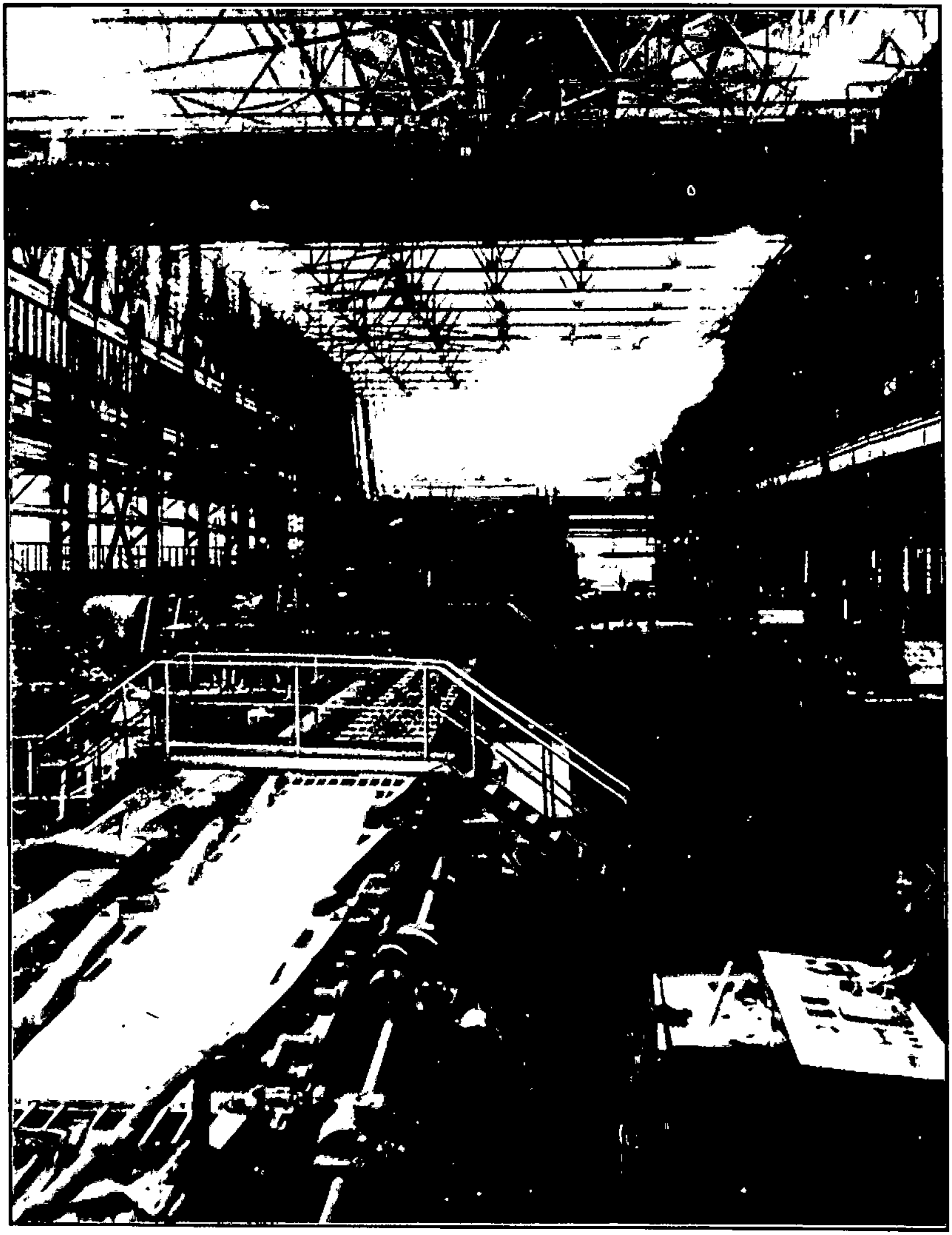
Figure 7. A 66-Inch Continuous Hot Sheet Mill in the Rolling Mill Division of the Zaporozh'ye Steel Plant, 1955.

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50X1

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CIA-RDP79R01141A000800020002-8

At the height of the war, quality steel accounted for 60 percent of the production, compared with 20 percent in 1940. The planned production of quality steel in 1950 amounted to 19.3 percent of the total, but actual production was 25.8 percent of the total. The greater amount of quality steel actually produced probably reflects the demand for Soviet war materiel during the Korean War. The ratio of production of quality finished steel to total finished steel in the USSR in 1930-47 and 1950-55 is shown in Table 12. 77/

Table 12

Ratio of Production of Quality Finished Steel to Total Finished Steel in the USSR a/ 1930-47 and 1950-55

Year	Percent	Year	Percent
1930	5.0	1942	50.0
1931	10.1	1943	62.2
1932	15.4	1944	55.0
1933	18.1	1945	48.0
1934	18.5	1946	22.0
1935	17.7	1947	21.0
1936	20.0	1950 (Plan)	19.3
1937	19.3	1950 (Actual)	25.8
1938	20.3	1951	30.0 b/
1939	23.2	1952	27.0 b/
1940	24.3	1953	20.0 b/
1941 (Plan)	24.8	1954	20.0 b/
1941 (Actual)	30.0	1955	20.0 b/

a. 78/
b. The figure is estimated.

Because the Soviet category of quality steel is too general to be revealing without further breakdown, examination of the product mix for finished steel provides the best indicator of economic and military intentions. Under mobilization for war, production of castings and forgings increases significantly, and production of other types of products, such as rails, decreases. Apparently this occurred during the Korean conflict.

Until 1955, when the USSR announced the actual production of rails, rail accessories, wheels, and pipe and tube, there had been no information available on actual production by type of finished steel since 1938. Annual percentage increases have been announced occasionally for rails and pipe but for none of the other types comprising the product mix. Estimates of production in 1955 by type of finished steel, other than figures officially announced, are derived from inspection of the general directives of the Fourth, Fifth, and Sixth Five Year Plans and are believed to be accurate within a range of error of plus or minus 15 percent. Production of finished steel in the USSR, by major types, in 1955 is shown in Table 13. 79/

Table 13

Production of Finished Steel in the USSR, by Major Types a/
1955

Product	Part of Total (Percent)	Amount (Million Metric Tons)
Rails	5.7	2.025
Rail accessories	1.4	0.505
Wheels	1.1	0.405
Pipe and tube	9.7	3.400
Heavy sections	12.5	4.410
Light sections	27.3	9.650
Wire rod	6.1	2.145
Sheet	13.4	4.710
Strip	2.1	0.755
Plate	11.3	3.985
Forgings	1.8	0.640
Blooms and billets	2.6	0.900
Steel castings	5.0	1.770 b/
Total	100.0	35.300

a. 80/. See footnote a to Table 11, p. 35, above.
b. The 1960 goal for production of steel castings is 4 million tons.

Changes in the relative importance of the various types of finished steel composing the product mix were slight during the Fifth Five Year Plan period. Rails, rail accessories, and car wheels decreased slightly in importance, and pipe, wire rod, sheet, strip, and plate increased. In the Sixth Five Year Plan period, a greater share of the product mix will be composed of pipe, light sections, wire rod, sheet, and strip. In the future the USSR intends to put greater emphasis on production of the flat-rolled products, sheet and strip, and eventually to raise the share of those products to 40 or 45 percent of the product mix. At present, 16 percent of the Soviet product mix is sheet and strip (in the US it is 43 percent). 81/

Production of hot and cold rolled sheet and strip, electrical sheet, and tinplate in the USSR in 1955 is shown in Table 14.

Table 14

Production of Hot and Cold Rolled Sheet and Strip, Electrical Sheet, and Tinplate in the USSR a/
1955

Million Metric Tons

Product	Production b/
Hot rolled sheet	3.060
Cold rolled sheet	1.053
Electrical sheet	0.286
Tinplate	0.226
Hot rolled strip	0.566
Cold rolled strip	0.180

a. 82/
b. There is some loss of metal entailed in manufacturing the products listed in Table 14 from the sheet and strip categories shown in Table 13, p. 38, above.

The theory employed by Soviet steelmakers with respect to the quality of production is one of "make it good enough for the job and no better;" a theory which, in some cases, is counter to US practice, where more than the requisite quality is often specified. There is evidence that some Soviet products are rolled to obsolete specifications which do not fulfill present-day requirements satisfactorily. As an outstanding example, the Ministry of Ferrous Metallurgy has failed to organize the production of wide-flange structural shapes, which are superior to standard structural sections in weight-to-strength ratios and which in the US have replaced completely the standard section in certain applications. 83/

The supply of finished steel in a planned economy should be large enough to enable all sectors of the economy to fulfill their annual plans. In theory the adequacy of finished steel supplies is guaranteed by government approval of the annual economy-wide material balance plan, which gives the distribution of steel to the various ministries and provides for the amount to be set aside for emergencies and state reserves. In spite of this careful planning and the overfulfillment of the Fifth Five Year Plan goal for finished steel by 1.3 million tons, there have been consistent indications of steel shortages. 84/

The shortage of steel in the USSR was indicated generally by the remarks made in an October 1954 speech by F.S. Petrusha, a Deputy Minister of Ferrous Metallurgy, who stated that "the metallurgical industry is far from supplying fully the requirements of the national economy." Petrusha's statement is bolstered by the many critical editorials and persistent demands published in Soviet newspapers and trade journals urging the "economizing" of steel in all applications. A more specific indication of the status of the steel supply is a decree ordering the extensive use of reinforced concrete as a substitute for steel in construction work. 85/

The primary cause of shortages in the Soviet supply of steel is the rapid growth of the steel consuming industries. Although the steel industry has achieved remarkable increases in production, it has not kept pace with the growth of its principal consumers -- the construction, machine building, and metal processing industries. Deficiencies in supply have been further aggravated by failures in 1953, 1954, and 1955 to fulfill the goal for some types of finished steel, even though the over-all goal was met; in 1954, heavy and light sections were under plan by 155,000 tons, wire by 85,000 tons, and wheels by 25,000 tons. 86/

The effect of shortages in the supply of steel during 1955 is difficult to assess. It is probable that heavy industry and defense, with their high priorities, suffered little, but the light and consumer industries and the export market may have suffered considerably.

The annual increment of 3.5 million tons of finished steel required to meet the Sixth Five Year Plan goal of 52.7 million tons is consistent with the 4.6-million-ton annual increase planned for crude steel. The Plan also provides for an 82-percent increase in production of rolling mill equipment, compared with a 52-percent increase in production of finished steel. Whether or not the greater increase in production of rolling mill equipment will be sufficient to offset the tremendous underfulfillment (production was about 25 percent under Plan) of production of rolling mill equipment during the Fifth Five Year Plan period is questionable. 87/ In addition to providing the necessary facilities for Soviet steel plants, the metallurgical equipment plants must meet commitments for the European Satellites, Communist China, India, and possibly other Free World countries. Although rolling mill capacity probably will be available to meet the 1960 goal for finished steel, there may be some underfulfillment in providing equipment for replacement and modernization. 88/

F. Alloy Steel.*

The production of rolled alloy steel in the USSR during the period of the Fifth Five Year Plan amounted to 8.7 million tons, 89/ 5.9 percent of total Soviet production of rolled steel. The comparable figure in the US for the same period was 28.9 million tons, 7.7 percent of total US production of rolled steel. Although the USSR produced 39 percent as much rolled steel as did the US during the Plan period, Soviet production of alloy steel was equal to only 30 percent of that of the US. 90/ The approximate equality of US and Soviet defense expenditures, 91/ when related to the great superiority of the US in tonnage of alloy steel produced, suggests that much of Soviet production of alloy steel is channeled into defense industries at the expense of

* Alloy steel is steel in which one or more elements have been blended to give it special properties that cannot be obtained in carbon steel. Alloy steel falls into the Soviet quality category, defined on p. 36, above.

general industrial usage. This conclusion has been confirmed by examination of Soviet industrial machinery and equipment, which contain carbon steel in numerous parts which in the US would be made of alloy steel.

As it is in the US, production of alloy steel in the USSR is widespread geographically; about one-fourth of all Soviet steel plants produce some type of alloy steel. Probably the most important individual plant, although not the largest, is the Electrostal' metallurgical plant near Moscow, where new types of alloy steel are first put into production. [redacted] 50X1

[redacted] 50X1

Soviet production of alloy steel by grade or by type is not published, and there is little information on the use of specific alloys in particular applications. In Soviet scientific literature, however, there is considerable discussion of the characteristics and properties of both experimental and standard alloys. Government specifications (GOST's) and some prices are available.

GOST specifications have been issued for substantially all those grades of alloy steel that are in general use in the US, and Soviet technical literature contains abundant evidence that the USSR is familiar with US production, processing, heat treating, and finishing techniques. The distribution of production between full- and low-alloy, stainless, heat-resistant, and tool steels, however, is not known.

Much research has been done in the USSR on the substitution of the more plentiful alloying elements for those in short supply and on the reduction of the over-all alloy content. Chrome, manganese, and silicon are used wherever possible to conserve relatively scarce and high-cost nickel, molybdenum, and cobalt for essential industrial and defense-related uses. 92/

The USSR produces essentially the same types of stainless steel as does the US -- generally, however, with a somewhat higher carbon content. The use of straight chrome and austenitic types substituting manganese for most of the nickel appears to be encouraged over the use of the popular 18-percent chrome, 8-percent nickel types.

Although precipitation-hardening stainless steel, which is becoming increasingly important in the US for industrial use and aircraft and guided missile applications, has been discussed in Soviet literature, there is no evidence of its production. 93/

[redacted] 50X1

Soviet specifications for magnet steel include aluminum-nickel, nickel-iron, Alnico, and chrome-cobalt-molybdenum compositions. The USSR is fully aware of modern technology in the field of cobalt-bearing magnetic steel and oxidic ceramic materials. The increasing application of the Alnico type of magnets in a variety of Soviet communications and electronic equipment indicates a growing competence in their production. 95/

In the field of high temperature the USSR successfully produced cobalt- and nickel-base alloys of the Nimonic-80 type soon after World War II. Soviet metallurgists, moreover, reduced the quantity of scarce alloys such as cobalt in some alloy compositions but retained necessary performance characteristics. 96/ Although the USSR is known to have conducted extensive research on the development of chromium-based high-temperature alloys, there has been no indication that the efforts have been successful. 97/

References in the Sixth Five Year Plan to expanding production of high-purity metals and a technical article on furnace construction suggest that the USSR has mastered the principles of the recently developed consumable electrode vacuum melting furnace. 98/

Published directives of the Sixth Five Year Plan are uninformative regarding total future production of alloy steels. The data disclosed are limited to percentage increases for certain special categories. Capacity for producing stainless steel and heat-resistant alloys is to increase 3.2 times; that for heat-resistant alloys alone, more than 6 times. Production of transformer steel is planned to increase 2.1 times; dynamo steel, 97 percent; and low-alloy steel, 17 times. These are impressive increases, when compared with the 52-percent expansion in total production of rolled steel prescribed in the Plan or with probable growth rates in the US. No mention is made of the standard grades of engineering steel that constitute 65 to 70 percent of alloy steel shipments in the US, and it is possible that the planned increase in the total production of alloy steel in the USSR may be more in line with the 52-percent increase planned for total production of rolled steel. 99/

Some tentative conclusions can be drawn from the Sixth Five Year Plan. The increases in production of transformer and dynamo steels are not inconsistent with planned expansion in the production and consumption of electric power; those for stainless steel and heat-resistant alloys suggest a major development of applications in gas turbines and atomic energy, both military and civilian, and increasing requirements of the power generating, petroleum, and chemical industries for corrosion- and heat-resistant materials. The spectacular 17-fold increase provided for low-alloy steel, which in the US accounts for approximately 10 percent of total production of alloy steel, probably is calculated on a considerably lower base than that used in the US. The principal usage of this category of alloy steel in the US is in the automotive, rail transportation, and machinery and industrial equipment industries. It is possible that the USSR plans to use low-alloy steel in engineering applications for which full-alloy steel is specified in US practice.

G. Other Iron and Steel Products.

1. Wire and Other Manufactured Products.

The Soviet steel industry like most steel industries of the world has facilities for the processing of finished steel into manufactured metal products (*metiz*); such production is controlled by the Main Administration of Metal Products (Glavmetiz). Processing is largely confined to the manufacture of carbon, alloy, and stainless wire; barbed wire; steel cable; welding rod; and nails, but other products such as rail accessories (splice bar and tie plate) also are manufactured. More than one-half of the Soviet production of wire rod is consumed by the steel industry itself in the manufacture of these products. 100/

2. Consumer Goods.

In addition to the normal complement of products found in the usual steel plant, an unusual quantity of consumer goods is produced in Soviet plants. During 1954, for example, the Ministry of Ferrous Metallurgy accounted for the manufacture of 25 percent of total Soviet production of beds, which were to be produced largely from defective and scrap pipe and tube. The Magnitogorsk combine and the Chelyabinsk pipe and tube mill each have a capacity of 300,000 beds per year. Between 1946 and 1953 the Elektrostal' metallurgical plant near Moscow produced more than 10 million knives, forks, and spoons. Most Soviet steel plants are committed by plan to the production of household articles, such as pots and pans, stamped from scrap metal. 101/

3. Gray and Malleable Iron Castings.

Most medium and large Soviet plants, regardless of their product, have one or more foundries for the production of gray or malleable iron castings. A small proportion of the Soviet iron foundry capacity is located in steel plants, where the production is consumed in the manufacture of molds, rolls, and casting plates for use within the steel plants. Foundries range in size from the large facilities at machine building plants, such as Uralmash and Kramatorsk, with annual capacities of about 200,000 tons of iron castings down to little 1-cupola furnace operations with an annual production of less than 1,000 tons. Many foundries, such as those found in automobile or tractor plants, are highly specialized, and others produce a wide variety of castings. The 1955 production of gray iron and malleable iron castings is estimated to have been 6,436,000 and 558,000 tons, respectively. The 1960 goals for production of gray and malleable iron castings are 13,350,000 and 650,000 tons, respectively. 102/

V. Production of Raw and Alloying Materials.

A. Basic Raw Materials.

1. Coking Coal and Coke.

The USSR is the world's second largest producer of coke for metallurgical use. The 1955 Soviet production of 43.6 million tons represented about 16 percent of the world total, and within the Sino-Soviet Bloc the USSR accounted for 68 percent of the total Bloc production of 64.2 million tons. The 55.1 million tons of coking coal mined in the USSR during 1954 amounted to 16 percent of all production of Soviet coal mines. In spite of the large production of coke the supply of metallurgical grades available for use in blast furnaces is barely adequate. 103/

a. Coking Coal.

The expansion of ferrous metallurgy in the USSR has resulted in rapidly growing demands for coking coal, and its production is given a high priority by Soviet planners. In contrast to the directives of the Fifth Five Year Plan, which stated that the production of coking coal was to increase not less than 50 percent, the directives of the Sixth Five Year Plan call for an increase of about 85 percent. Because the production of coke is to be increased only 48 percent during the Sixth Five Year Plan period, the scheduled rise in production of coking coal reflects the declining quality of the coal.* In 1955, 1.5 tons of coking coal, as mined, were required per ton of coke produced, and in 1960 the requirement will rise to 1.8 tons. 104/

The principal coking coal basins in the USSR are the Donets Basin (Donbas), the Kuznetsk Basin (Kuzbas), the Karaganda Basin, and the Kizel Basin.** The Donbas provides 60 percent and the Kuzbas 30 percent of all Soviet coking coals, and although reserves are adequate for centuries it is probable that mining capacities in these basins will limit production to levels slightly above current ones. The largest expansion is going on at the Karaganda field, which eventually is to supplant the Kuzbas as a major source of coking coal for the Urals. 105/

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* Exports, possible new uses, and sharp expansion in other present uses are not considered to be significant.
** See the map, Figure 8, inside back cover.

Extensive reserves of coking coal near Vorkuta in the Pechora Basin are being developed. At present they supply the new Cherepovets blast furnaces near Leningrad and in the future will supply plants in the northern Urals. During 1954 the fields at Tkvarcheli and Tkibuli in the Georgian SSR started to produce for the blast furnaces at Rustavi. The development and further exploration of the large reserves near Aldan in southern Yakutskaya ASSR will be pushed during the next 10 to 15 years. In addition, coals with coking characteristics are known to exist in deposits or basins at Noril'sk, Irkutsk, Bukachacha, Búreya, Suchan, and on Sakhalin Island. 106/

Coking coals of the Donbas and the Kizel Basin are coked locally, but all of the coking coals of the Karaganda Basin are coked in the Urals. Between 62 and 63 percent of the coking coals of the Kuzbas are coked in the Urals, the remainder at Stalinsk and Kemerovo. Transportation costs represent about one-third of the cost of the coking coals of the Karaganda Basin delivered to the Urals and about one-half of those of the Kuzbas, which must be hauled 2,000 kilometers. The long rail hauls required for one-quarter of Soviet coking coals constitute the major potential vulnerability of the coking coal industry. 107/

The quality of coking coals probably is the chief limiting factor in the coking coal base of the USSR. Both the ability of a coal to coke and the quality of the coke are determined by the chemical and physical properties of the coal. The widespread lack of coals with optimum chemical and physical properties requires the blending of several types having somewhat inferior properties. These can be blended, however, only if their properties are complementary. Coals with complementary properties are produced in the Kuzbas and the Donbas, and the problem of blending is an intrabasin one. Because only small quantities of poor coking coals are available in the Urals, however, this area depends on the Kuzbas and the Karaganda Basin for the better grades. 108/

More than 95 percent of the coking coal mined in 1954 was mechanically cleaned. In spite of the increases in impurities in coking coal as mined, the USSR generally has succeeded, through heavy investment in coal cleaning plants, in obtaining a cleaned product with an ash and sulfur content* slightly lower than that of the coal cleaned before 1940. The ash content of all cleaned Soviet coking coal decreased from 10.8 percent in 1940 to 10.2 percent in 1955, and the sulfur content decreased from 1.4 to 1.2 percent. 109/

b. Coke.**

The USSR is the world's second largest producer of coke. On 1 January 1956 the Soviet capacity was equal to 69 percent of that of the US. To meet the Plan goal for 1960, an average annual growth rate of 4.2 million tons will be required, a rate which is substantially greater than the rate of 3.2 million tons achieved during the Fifth Five Year Plan period. Estimated production of high-temperature coke in the USSR in 1913, 1922, 1928-40, and 1945-60 is shown in Table 15.*** 110/

The 1955 regional distribution of coke production is shown in Table 3.**** Production of coke is closely associated with production of pig iron in blast furnaces, and coke plants, with their attendant byproduct facilities, usually are combined with or located close to integrated steel plants. 50X1

50X1

More than 90 percent of all coking coal consumed in the USSR is used to make high-temperature coke for the ferrous metallurgical industry.† The remainder is used in chemical plants, in nonferrous metallurgy, and for transport. Because of the great consumption of high-temperature coke in ferrous metallurgy, it is sometimes referred to as "metallurgical coke." Soviet coals coked at temperatures lower than 900° centigrade are called medium- and low-temperature cokes and also may be referred to as semicoke, gas coke, brown-coal coke, and char.

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* For a discussion of the effects of ash and sulfur content, see p. 112, below.

** The term coke refers to high-temperature coke produced in byproduct slot-type ovens at temperatures above 900° centigrade and to any high-temperature coke that may be produced in beehive ovens.

*** Table 15 follows on p. 50.

**** P. 25, above.

† Coke used in smelting pig iron in the USSR must be in lumps 40 millimeters in diameter or greater, but some pieces as small as 25 millimeters are tolerated in small blast furnaces.

Table 15

Estimated Production of High-Temperature Coke in the USSR a/
1913, 1922, 1928-40, and 1945-60

Million Metric Tons

Year	Production	Year	Production
1913	4.4	1946	13.5
1922	0.2	1947	15.3
1928	4.2	1948	18.7
1929	5.9	1949	22.2
1930	6.2	1950	27.7
1931	6.8	1951	30.4
1932	8.4	1952	33.5
1933	10.2	1953	36.6
1934	14.2	1954	40.3
1935	16.8	1955	43.6
1936	19.9	1956	47.2
1937	20.0	1957	51.1
1938	20.3	1958	55.3
1939	20.7	1959	59.8
1940	21.1	1960	64.6
1945	12.0		

a. 111/

In the USSR the byproducts of coking are the primary sources of the major aromatic chemicals -- benzol, toluol, and, to a lesser extent, phenol. Other byproducts of importance are ammonia (90 percent of which is converted to ammonium sulfate for fertilizer), xylol, cresol, and naphthalene. The estimated production of selected coke-chemical byproducts in the USSR in 1955 is shown in Table 16.*

* Table 16 follows on p. 51.

Table 16

Estimated Production of Selected Coke-Chemical Byproducts in the USSR a/
1955

Byproduct	Yield per Ton of Coke (Kilograms)	Production (Thousand Metric Tons)
Benzol	7.75	338
Toluol	1.93	84.1
Phenol	0.309	13.5
Xylol	0.67	29.2
Cresol	0.429	18.7
Ammonia b/	4.0	174
Naphthalene	2.32	101

a. 112/
b. Ninety percent of the ammonia is converted into ammonium sulfate at the byproduct plant.

After the valuable byproducts are stripped out, the remaining coke gas is widely distributed as a fuel in the steel plant and for municipal use. In the Ukraine, a number of important cities are linked by a network of coke-gas pipelines. 113/

2. Iron Ore.

a. General.

The USSR is second only to the US as the world's leading producer of iron ore. Because of the increasing reliance of the US on imports and the role of the USSR as an exporter to the European Satellites, Soviet production of iron ore may exceed that of the US by 1960.

Production of iron ore in the USSR has risen steadily since the end of World War II to an all-time high in 1955 of an estimated 71.9 million tons of commercial-grade ore.* 114/ To attain this rate of production, an all-out effort was required of the iron mining industry during both the Fourth and Fifth Five Year Plan periods. The outstanding achievement of the Fourth Five Year Plan period was the complete rehabilitation and extensive renovation of the mines in the Krivoy Rog Basin.

Although it was officialy announced that the production goal for iron ore set by the Fifth Five Year Plan had been attained, criticism was later directed at the Ministry of the Construction of Metallurgical and Chemical Industry Enterprises for having failed to fulfill by 26 million tons the Plan goal for putting new gross productive capacity into operation. 115/ Because this amount is more than one-half of the increase in rate of gross production claimed for the period, much of the capacity not constructed must have been intended to replace obsolete or depleted installations. Thus the production goal probably was achieved by sacrificing quality and utilizing existing facilities more intensively than was originally planned. Numerous reports of ore of inferior quality being received at metallurgical plants, both in the USSR and the European Satellites, tend to confirm this conclusion.

Estimated production of commercial-grade iron ore in the USSR in 1938-60 is shown in Table 17.**

Estimated production of commercial-grade iron ore in the USSR, by economic region, in 1940, 1950, and 1955 is shown in Table 18.***

The principal areas in the USSR that produce iron ore are in the southern Ukraine and the Ural Mountains. These areas accounted for 94 percent of total Soviet production in 1940, 85 percent

* Commercial ore is iron ore as received at the steel plant. Usually concentrating and some sintering has been done at the mine.

** Table 17 follows on p. 53.

*** Table 18 follows on p. 54.

Table 17

Estimated Production of Commercial-Grade Iron Ore in the USSR 1938-60

Million Metric Tons

Year	Production	Year	Production
1938	26.5 a/	1950	39.7 c/
1939	28.0 a/	1951	40.0 d/
1940	29.9 b/	1952	52.0 d/
1941	22.7 a/	1953	58.0 d/
1942	8.5 a/	1954	64.3 e/
1943	9.7 a/	1955	71.9 e/
1944	12.0 a/	1956	78.8 d/
1945	16.6 a/	1957	86.6 d/
1946	20.3 a/	1958	95.0 d/
1947	24.4 a/	1959	104.1 d/
1948	29.2 a/	1960 (Plan)	114.3 f/
1949	35.0 a/		

a. 116/
b. 117/
c. 118/
d. This figure is interpolated.
e. 119/
f. 120/

in 1950, and about 87 percent in 1955. West Siberia, the central European USSR, and the Transcaucasus, in that order of importance, accounted for most of the remainder in 1955. In spite of their relatively small production, these latter deposits are important sources of ore for local iron and steel plants.

Table 18

Estimated Production of Commercial-Grade Iron Ore in the USSR, by Economic Region
1940, 1950, and 1955

			Percent of Total
Economic Region	1940 a/	1950 a/	1955
III (South)	67.5	52.0	56.2 b/
VIII (Urals)	27.0	33.4	30.5 c/
IX (West Siberia)	1.7	6.5	6.1 d/
VII (Central)(Tula and Lipetsk)	3.8	2.5	7.2 e/
Others	0	5.6	
Total	100.0	100.0	100.0

a. 121/
b. 122/
c. 123/
d. 124/
e. This figure is total production minus production of Regions III, VIII, and IX.

The Sixth Five Year Plan directs that Soviet production of iron ore be raised 59 percent by 1960, an increase estimated at 42.4 million tons of commercial-grade ore. 125/ To aid in achieveing this goal, important new mines are to begin producing in the Kursk-Belgorod district of the central European USSR, at the Kustanay and Atasuskiy deposits in Kazakhstan, at Gora Kachkanar in the Urals, and at the Abakan and Korshunovsk deposits in East Siberia.

The Abakan mine will be the largest in the Kuznetsk metallurgical combine, and it is planned that the mine will release the combine completely from its dependence on Magnitogorsk iron ore. The Kustanay deposits, near the confluence of the Ayat' and Tobol Rivers, are being developed as an important source of iron ore for Magnitogorsk, Chelyabinsk, and other metallurgical centers in the southern Urals. The Sokolovskiy-Sarbaisk ore concentration combine, currently the largest construction project of the iron ore industry, will process Kustanay ore. This combine is to have a capacity of 10 million tons of crude ore per year and 5.6 million tons of concentrates by 1960. 126/ The Atasuskiy deposits are being developed to provide ore for the Karaganda metallurgical combine. Development and survey work is also in progress at the Korshunovsk deposit in Irkutskaya Oblast and at an undesignated iron ore deposit in southern Yakutskaya ASSR to provide local ore bases for proposed new metallurgical centers to be constructed in Siberia within the next 10 to 15 years.

In addition to the stress placed on increasing production of iron ore during 1956-60, great emphasis is attached to improving the quality of the ore before it is charged into the furnaces. This results, in part, from the declining iron content and increasing proportion of fines in run-of-mine iron ores and, in part, from an appreciation of the increased efficiency in blast furnace operation obtainable by introducing advanced techniques in preparation of ores.

The declining iron content of the available ores is indicated by the Soviet statement that by 1960 it will be necessary to mine 1.44 tons of crude iron ore to obtain 1 ton of ore of commercial grade, compared with 1.23 tons of crude ore in 1955 and 1.08 tons in 1940. 127/ The increasing percentage of fines is an even greater problem, however. On the average, 40 percent of the iron ore mined in the USSR is less than 10 millimeters in size, and in some mines in the Krivoy Rog area and at Kerch' fines represent as much as 80 or 100 percent of the ore mined. 128/

To reduce excessive losses and other difficulties in handling and smelting ore fines, the USSR is agglomerating ore on a rapidly expanding scale. Production of ore agglomerate increased from about 6.4 million tons in 1950 to approximately 33.2 million tons in 1955. 129/ The Sixth Five Year Plan sets a 1960 production goal of 73 million tons of ore agglomerate, nearly two-thirds of the estimated production of commercial-grade ore in that year. 130/ Although born of necessity, the increasing use of ore agglomerate as a furnace charge in the USSR is resulting in additional positive benefits, such as increased furnace productivity and a lower rate of coke consumption. Similar measures are being taken by the US steel industry, although not on as broad a scale as that contemplated in the USSR.

Probably the most important problem in the Sixth Five Year Plan period, as it affects the iron mining industry, is the attainment of the goal for construction of new productive capacity for iron ore. Originally set at 84 million tons in the Sixth Five Year Plan, the goal was raised to 91 million tons when the shortfall in the Fifth Five Year Plan was announced. 131/ The Fifth Five Year Plan goal, estimated at 67 million tons of new productive capacity for iron ore, was underfulfilled by approximately 26 million tons, and the failure was attributed to weaknesses in planning and management. 132/ Such weaknesses were presumably still present in February 1956, when the Soviet press criticized the implementation of programs for development at Kustanay and various iron ore deposits in the Urals and for construction at ore processing installations in the Ukraine. 133/ Continued delays in these projects, it was pointed out, would jeopardize further development of metal production at the Magnitogorsk combine and at other steel plants in the Urals and the Ukraine.

b. Reserves.

The iron ore resources of the USSR are among the greatest in the world. According to the 1938 survey, issued by the Union Geological Fund of the USSR, Soviet reserves of workable iron ores amounted to about 10.9 billion tons with an average iron content of 45 percent. Of this total, approximately 4.5 billion tons were classified as "proven" reserves. In addition, Soviet reserves of iron quartzites (similar to the taconites of the Mesabi Range in the US) were estimated at 256.7 billion tons, of which 11.6 billion tons were classified as "proven" reserves.

Because of extensive programs of geological exploration and surveying and technological improvements in ore extraction and utilization since World War II, the "proven" iron ore reserves of the USSR now probably surpass the estimates made in 1938, in spite of a greatly increased rate of exploitation in the intervening years. Theoretically, "proven" reserves of workable iron ore in the USSR could support the 1955 Soviet production rate for pig iron of 33.3 million tons for about 60 years, and the 1960 goal for pig iron production of 53 million tons could be maintained for about 38 years. 134/

In spite of intensive exploration, it is likely that very few new deposits actually have been located. Soviet claims of a new discovery frequently refer to a rediscovery or a more detailed investigation of a deposit already charted before World War II. Thus accretions to the total Soviet ore reserves appear to have been primarily the result of extending known ore bodies and transferring ores from one reserve category to another. Furthermore, the average quality of the iron ores has declined steadily, in both chemical composition and physical structure. It now appears that Soviet geologists in former years tended to overestimate the quality of ore reserves, particularly the more important deposits such as those in Krivoy Rog and Magnitogorsk. The expanding use of low-grade iron ores in the USSR is evidence of the declining quality of Soviet iron ore resources.

The most highly utilized iron ore deposits in the USSR are those in the Krivoy Rog Basin in the Ukrainian SSR. These deposits, estimated to contain 1.7 billion to 2.4 billion tons of 50 percent iron content or better, are the largest deposits of high-grade ore now being worked and will remain so for many years. 135/ In addition to their high iron content, Krivoy Rog ores are desirable for their low silica, low phosphorus, and low sulfur content. Recent reports indicate, however, a rising average content of these impurities. The friability of the ores, moreover, is a distinct hindrance to their utilization and has caused increasing difficulties to the Ukrainian steel industry and to European Satellite consumers.

The largest iron ore deposit in the USSR is at Kerch', in the eastern part of the Crimean peninsula. Total reserves are believed to exceed 2.7 billion tons. 136/ The average iron content ranges from 30 to 40 percent, the composition of the ore is complex, and the ore is difficult to utilize; but the favorable occurrence and geographic location of the Kerch' deposit make it potentially one of the most economical to mine of all iron ore deposits in the USSR.

Deposits of iron ore in the central European USSR, located near Kursk, Belgorod, Tula, and Lipetsk, are important because of their close proximity to blast furnaces at Tula and Lipetsk. The Kursk magnetic anomaly is located near many of the metallurgical centers of the Ukraine. The Kursk deposit consists of 336.7 million tons of high-grade iron ore, plus tremendous reserves of low-grade iron quartzites. 137/ In spite of these favorable factors, complicated hydrogeological conditions and an intricate chemical composition have hampered large-scale exploitation of these ores up to the present time.

About 200 known iron ore deposits are in the Urals. In 1938 the total probable reserves were given as more than 2.4 billion tons, of which 1.17 billion tons were classified as "proven" reserves. 138/ These deposits are characterized by the exceptional purity of some of the ores, primarily the Bakal ores, and by the alloying admixtures of other ores at Vysokaya, Blagodat', Khalilovo, and Titanogorsk. The largest concentrations of iron ore are in the Bogoslovsk, Tagilo-Kushva, Alapayevsk, Bakal, Magnitogorsk, Beloretsk, and Khalilovo areas.

Certain other iron ore deposits in the USSR are important because they support local steel industries. They are the Dashkesan deposits in the Transcaucasus, the Gornaya Shoriya deposits south of Stalinsk in West Siberia, the Yena-Kovdora and Olenogorsk deposits of the Kola Peninsula, the Balyaginskiy deposit in East Siberia, and the Nikolayevsk deposit in the Soviet Far East. Other deposits are important because they are scheduled to supplement existing sources of supply or to serve as ore bases for future planned metallurgical centers. Among these are deposits at Kustanay and Atasuskiy in Kazakhstan, the Abakan-Minusinsk deposit, the Angara-Ilimsk (Korshunovsk) deposit, the Argun' River deposit, the Lower Angara deposit, and an undesignated deposit -- possibly the Batomsk deposit near Aldan in the Yakutskaya ASSR in East Siberia.

The Kustanay deposits, after almost 10 years of geophysical and geological prospecting, are now being developed for large-scale open-pit mining. These deposits, claimed to possess reserves equal in magnitude to the Krivoy Rog Basin and containing ore averaging 45 percent iron content, but high in silica, will be a major source of ore for metallurgical plants in Kazakhstan and the southern Urals, including Magnitogorsk. 139/ 50X1

c. Principal Producing Areas.

Except during World War II and the rehabilitation period that followed, Krivoy Rog has long been the largest iron ore producer in the USSR, and plans indicate that it will remain so for many years. These mines accounted for about 47 percent of the iron ore produced in the USSR in 1950, and for approximately 45 percent in 1955. 140/ After World War II, 34 mines were restored and modernized, and efforts were made to mechanize development and mining operations. There are now approximately 40 mines in the area with a combined annual production of about 32 million tons of commercial-grade iron ore. 141/ In addition to supplying the metallurgical industry in the Ukraine, these mines are the source of almost all the iron ore exported to the European Satellites. 142/

The declining physical quality of Krivoy Rog iron ores and the mine-to-mine variations in their chemical composition and particle size made it increasingly difficult to obtain a product of constant quality. Agglomerating facilities have been constructed at Krivoy Rog and at most of the Ukrainian metallurgical plants supplied by these mines to process the fines, which average about 50 percent of all ore mined in the area. Existing agglomerating capacity, however, is inadequate. Many of the 58 new agglomerating lines to be put into operation in the USSR in 1956-60 probably are designated for the Krivoy Rog area. 143/

The expanded Soviet requirements for iron ore and the increasing depth of formations containing higher grade ores have led to the exploitation of poorer (less than 46 percent iron) but more accessible iron ores in the Krivoy Rog Basin. The large deposits of iron quartzites, frequently located at the surface, also are being exploited extensively and are to be used on a much larger scale. Construction of the new Southern Enriching Combine (UGOK), designed to process the quartzites (30 to 40 percent iron) to yield a finished self-fluxing concentrate averaging 58 to 60 percent iron, was started at Krivoy Rog in early 1952. Although the combine was one of the most important projects in the Soviet iron mining industry at that time, construction lagged consistently. It was not until September 1955 that the first plant of the combine was put into operation. A second plant, possibly another unit of the combine, reportedly is under construction and is scheduled to begin operating in 1957. 144/

The deposits at Kerch' are said to be the most economically exploitable iron ore deposits in the USSR. For this reason, considerable effort has been made to expand production at Kerch'. In spite of the favorable characteristics (geological occurrence, geographic location, and the like) of the Kerch' ores, their complex chemical composition (high phosphorus content and the presence of arsenic and vanadium) has for years retarded a more extensive development. The high phosphorus content (averaging 1.2 to 1.3 percent) has been a primary deterrent to greater utilization in the USSR and in the European Satellites, where production of Thomas steel is small. Production of iron ore in the Kerch' district in 1950 was about 2 million tons, and it increased during the Fifth Five Year Plan period to about 7 million to 8 million tons in 1955. 145/ Plans call for an ultimate capacity of at least 10 million tons per year. 146/ The principal consumer of Kerch' iron ore, after agglomeration at the Kamysh-Burun concentrating plant, has been the Azovstal' plant in Zhdanov, where utilization probably is accomplished by blending with low-phosphorus ores. Recent information indicates that East Germany and Poland are now receiving ore from Kerch'.

Iron ore in the Central Region (Region VII) of the USSR, although it accounted for only 2.5 percent of total Soviet production in 1950, is important because of its geographic location. 147/ The mining centers are around three towns -- Tula, Lipetsk, and Kursk. The Kursk district is currently the most important and also offers great potentialities for future development and expansion. The tremendous reserves of low-grade iron quartzites and the large reserves of rich ore in the Kursk magnetic anomaly (KMA) have long attracted Soviet interest. Large-scale exploitation of the ores has been slow, however, because of technical difficulties. Before the German invasion, only minor quantities of ore were extracted -- mainly for experimental purposes. In 1945 a special trust (Kmastroy) was created to develop and exploit the KMA. For 10 years, considerable effort and increasingly large budget appropriations have been directed toward the development of an economical method of exploiting both the iron ore and the iron quartzites. Among the plans for the area was the development of a mine with an initial annual production capacity of 500,000 tons of iron quartzites. 148/ Actual accomplishments during 1946-55 are unknown. The continued interest in the project is indicated, however, by plans to construct, during 1956-60, additional new mines in the Kursk-Belgorod area.

The mines at Tula and Lipetsk are small and have been in operation for a number of years. The ores require concentration, and, in view of the declining quality and quantity of the reserves, little expansion in production is expected.

Exploitation of the Olenogorsk and Yena-Kovdora iron ore deposits began in 1955 to provide the iron ore base for the new Cherepovets metallurgical plant. All of the ore mined, which contains 33 to 35 percent iron, requires concentration. Efforts to utilize at the Cherepovets plant the titaniferous magnetite ores of the Karel'-skaya ASSR deposits have thus far been unsuccessful.

Production at the Dashkesan deposits started in 1948. Plans called for the annual mining of 2 million tons of iron ore, to be shipped to metallurgical plants at Rustavi and Sumgait. 149/ Two mines -- one open-pit and one underground -- produce low-quality ores (34 percent iron) that require concentration. Both mines are believed to be operating at near capacity to meet the requirements of the two new blast furnaces at Rustavi.

The iron ore industry of the Urals, which accounted for 33.4 percent of Soviet production in 1950 and about 30.5 percent in 1955, is more diversified and, in some respects, more complex than is the iron ore industry of the Ukraine. 150/ In contrast to the fairly concentrated operations of the Ukraine, production of iron ore in the Urals is scattered from Ivdel' in the northern Urals to Khalilovo in the south. The largest producing areas in the region are at Magnitogorsk, Nizhniy Tagil, Kushva, and Bakal.

For years Magnitogorsk was the principal source of high-quality Urals iron ore, and after the loss of the Ukraine in World War II it was the largest producer in the USSR. Near the end of World War II, it was discovered that, contrary to former beliefs, scarcely one-fourth of the remaining ores at Magnitogorsk were of first quality. The remaining three-fourths had an increasing sulfur content and a decreasing iron content, necessitating extensive processing. In 1946 the Soviet press stated that the high-grade ores at Magnitogorsk might not last for more than 15 years. 151/ It now appears, however, that increased utilization of the lower grade deposits by means of extensive beneficiation may extend this period substantially. In 1954, Magnitogorsk reportedly mined about 20 million tons of ore to obtain 10.8 million tons of commercial-grade ore, roughly one-half of the total estimated production of commercial-grade iron ore in the Urals. 152/ Efforts are being made to relieve Magnitogorsk from supplying ore to the metallurgical centers of the southern Urals and to the Kuznetsk metallurgical combine at Stalinsk about 2,000 kilometers to the east by developing alternate sources of supply for these plants. These objectives ultimately will be realized when the Kustanay and Abakan deposits have reached full production.

An unusual aspect of the iron ore industry in the Urals is the polymetallic nature of some of the ores exploited. The ore extracted at Vysokaya Gora near Nizhniy Tagil contains 50 to 55 percent iron and enough chalcopyrite (1.5 percent copper) to permit the extraction of copper as a byproduct, but whether or not this is being done is not known. The Blagodat' Gora mine east of Kushva annually produces at least 1.5 million tons of iron ore, which is processed to yield a byproduct containing titanium. 153/ Ore from the Bulandikha mine, largest in the Bakal district, contains 40 to 45 percent iron (which is concentrated to 54 percent iron) and enough manganese to reduce or eliminate the customary manganese charge in the blast furnace. Bakal district ores, because of their low sulfur and phosphorus content, are considered to be the best iron ores in the Urals.

Nearly all of the iron ore mined in the Urals must undergo beneficiation in one form or another. This has been necessary since World War II, and it is certain to become an increasingly important phase of mining operations in future years. While the transition of the older Urals iron mines from open-pit to underground operations to maintain production of high-grade ore has progressed, rapidly increasing requirements for iron ore have made it necessary to exploit poorer ores near or at the surface. The Kachkanar ore concentrating combine (in Sverdlovskaya Oblast) -- to be constructed during 1956-60 -- is destined to handle such ores. Furthermore, the occurrence of the high-grade ores obtained from deep mines is such that their extraction involves contamination with gangue material, necessitating treatment for these ores as well.

Production of iron ore in West Siberia is concentrated in the Gornaya Shoriya district. Production, believed to have increased from about 2.8 million tons in 1950 to 4.6 million tons in 1955, is consumed entirely by the Kuznetsk metallurgical combine at Stalinsk. 154/ Ore from the Tashtagol mine, largest in the region, contains an average of 50 percent iron and is the only Gornaya Shoriya iron ore which does not require beneficiation. Other producing mines in the district are the Sheregesh mine and the Shalym mine, the ores of both of which are processed at the Mundybash agglomeration plant.

Under development since the end of World War II, the Abakan deposit east of Stalinsk is intended to replace Magnitogorsk as a source of part of the iron ore requirements of the Kuznetsk combine.

Construction of the Abagursk agglomeration plant, to process Abakan ores, began in 1946. The first section was scheduled to begin production in 1948. The most retarded construction project of the Soviet iron mining industry, neither the mine nor the agglomerating plant were in operation at the end of 1955 although production was then scheduled to begin in mid-1956. 155/ Delayed construction of a rail line from Stalinsk to Abakan, originally scheduled for completion in 1950 but not in operation until 1955, probably contributed to the slow development of Abakan.

Aside from Abakan, the Balyaginskiy mine, 25 kilometers northwest of Petrovsk-Zabaykalsk, is the only mine in East Siberia known to be in operation. The mine supplies a small quantity of iron ore to the steel plant at Petrovsk. Development of an iron mine at Korshunovsk, in the Angara-Ilimsk deposit, is scheduled during 1956-60, as is the prospecting and further surveying of an undesignated iron ore deposit (possibly Batomsk) in Yakutskaya ASSR.

In the Far East the development of iron ore deposits in the Malyy Khingan district to provide a sufficient ore base for an integrated operation at the Amurstal' steel plant at Komsomol'sk has never proved feasible. Ore for this purpose possibly may be obtained from deposits now being prospected in southern Yakutskaya ASSR. Small quantities of iron ore, for direct charging into the open hearth furnaces at Amurstal', are now being obtained from a small deposit at Nikolayevsk.

50X1

3. Manganese Ore.

a. General.

Among the major steel producing countries of the world the USSR is the only one that is self-sufficient in manganese. The USSR is not only the world's largest producer of manganese but is also -- because of ironmaking practices arising primarily from the nature of its iron ore and coking coal -- the largest consumer and a substantial exporter. Possession of one-third of the world's known manganese reserves assures an adequate Soviet supply for at least a century.

Ninety percent of Soviet reserves and production of manganese are concentrated in two areas. One major producer, Nikopol', supplies the Ukrainian steel industry, which produces 48 percent of the Soviet production of pig iron. The other area, Chiatura, in the Georgian SSR, supplies the major portion of high-grade ore for production of ferromanganese and supplies ores to manganese-deficient areas in the USSR and for export. Although manganese production goals for the USSR as a whole were not announced, the Georgian SSR Sixth Five Year Plan calls for a 50-percent increase in production.

As the steel industry of the USSR was expanded toward the east, emphasis was directed toward the discovery of local sources of high-grade manganese to eliminate the long haul from Chiatura. Thus the Fourth, Fifth, and Sixth Five Year Plans have included such exhortations as "In the eastern areas of the country, to increase by every means the search for new deposits of ... manganese ores for the production of ferromanganese metal." Recently, Kazakh SSR has claimed sufficient reserves of high-grade manganese to support production of ferromanganese, probably at the projected ferroalloy plant at Pavlodar. 156/ The 50-percent increase in 1960 planned production at Chiatura, which is only slightly lower than planned increases in the production of pig iron and steel, and the continuing search for new manganese deposits in the east indicate, however, that Chiatura will continue for some time to be the major supplier for the industry east of the Ukraine.

b. Reserves.

Total Soviet reserves of manganese ore are estimated to be 816 million tons out of a Sino-Soviet Bloc total of 872 million tons. Approximately one-third of these reserves are "proven." [redacted] 50X1 50X1

Chiatura. The Chiatura manganese mines are located near the village of Chiatura on the southern slope of the Caucasus Mountains in the Georgian SSR. The manganese ore bed is 1,250 to 1,900 feet above the bottom of a valley in an area of canyon-like valleys. The deposits cover an area of 130 square kilometers. 157/

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CIA-RDP79R01141A000800020002-8

Published 1938 estimates were 146 million tons of "proven" reserves and 63 million tons of "probable and possible" reserves. 158/ Present unofficial estimates are 150 million tons of "proven" reserves and 30 million tons of "probable and possible" reserves.

The manganese ores consist of pyrolusite, psilomelane, manganite, wad, and carbonates. The carbonate ores, discovered since 1938, have only recently been used in production of ferromanganese. The quantity of these ores is unknown and is excluded in the estimates of reserves. 159/ The raw ore, containing 25 to 47 percent manganese, concentrates to as high as 55 percent. 160/ High silica and phosphorus present a problem in some grades, but Chiatura ores are generally among the best in the world.

The long-wall retreating method* of mining is used in the underground mines. 161/ In spite of the rugged terrain, open-pit mining has increased. In 1950, after 3 years of stripping overburden, the first open-pit mine was started, and others have since come into production. The ratio of open-pit to underground mining is not known. 162/

Complete mechanization of the manganese mines was a goal of the Fifth Five Year Plan. Drilling, ore breaking, and mine transport have been completely mechanized, but approximately one-half of the ore is still loaded manually. 163/

The introduction of modern concentrating equipment has increased the production of high-grade concentrates and has made it possible to produce a 30- to 33-percent manganese concentrate from tailings. 164/ It is probable that by consolidating operations the number of concentrating plants has been reduced from the 17 existing in 1937. One large new plant was recently placed in operation, and two more are under construction. 165/

Completion of the Chiatura-Zestafoni wide-gauge railroad in September 1956 is expected to eliminate a long-standing problem. Previously, ore shipments destined for points beyond Shorapani had to be transferred at that rail junction from narrow- to wide-gauge cars. The elimination of this bottleneck had been planned since 1949. 166/

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* Haulage roads and airways are first driven to the boundary of the ore bed, and then the bed is mined, in a single face without pillars, back toward the shaft.

Nikopol'. The Nikopol' manganese deposits cover an area of approximately 275 square kilometers on the east side of the Dnieper River and are divided into two distinct fields, one northwest and the other northeast of the town of Nikopol'. 167/ The Nikopol' deposits are the largest in the world, on the basis of both raw ore and metallic content, and contain 65 percent of Soviet manganese reserves. Total reserves in 1938 were estimated at 522 million tons, of which 78 million tons were "proven." 168/ As a result of geological surveys made during the period of the Fourth Five Year Plan, "proven" reserves are now estimated at 139 million tons and "probable and possible" reserves at 370 million tons. A complete survey of the deposits has never been published. 169/

Nikopol' ore consists of pyrolusite with an admixture of psilomelane and bog manganese. It contains a larger amount of gangue and phosphorus than does Chiatura ore, but it is less friable. Manganese content is relative low, 28 to 33 percent, and silica content is high, 42 percent. All of the ore is washed. 170/

Concentrates contain from 40 to 50 percent manganese with a ratio of manganese to iron higher than 10. The better grades of concentrates are used for production of ferromanganese at the Zaporozh'ye ferroalloy plant, sometimes blended with Chiatura ore.

Nikopol' manganese mines were completely reconstructed after World War II. Reconstruction plans called for complete mechanization of cutting, loading, and hauling and provided that by 1956 one-half of the production was to be from open-pit mines. In 1955, however, the Nikopol' mines were severely criticized for low labor productivity, for delays in introducing new equipment, and for not developing open-pit mines faster. 171/ Press reports indicate some progress in remedying these defects.

By 1948 the four concentrating plants in operation before the war were repaired, and plans were made for the building of new concentrating plants at some of the larger mines. 172/ Two new plants, including electromagnetic separators, are known to have been completed.

Eastern Areas. Exploration has revealed more than 200 manganese deposits in the Urals, Central Asia, Siberia, and the Soviet Far East. With few exceptions, these deposits are small and of low grade and are exploited principally to supply local blast furnaces. Emphasis on the discovery of additional sources of manganese in the East has been stressed in every Five Year Plan since World War II. Except for the announcement by Kazakh SSR that plans have been made to produce ferromanganese from local ores, there has been no evidence that the search has been successful.

c. Production.

Estimated production of manganese ore in the USSR, by producing area, in 1940 and 1945-55 is shown in Table 19.*

The principal areas of production of manganese in the USSR, currently estimated to supply about one-half of world production, have changed little since World War II. Although Chiatura contains only one-quarter of the reserves, it produces nearly 60 percent of the total -- probably because of the higher quality of its deposits. Nikopol', with two-thirds of the reserves of the USSR, accounts for less than one-third of its production.

Postwar planning in the USSR called for a sharp increase in production of manganese to meet the needs of the steadily expanding iron and steel industry. Reconstruction was accomplished in a relatively short period, considering the extent of wartime damage, and by 1949 production had equaled its prewar peak of about 3 million tons. 173/ Production in 1955 was 61 percent greater than in 1950. 174/

Production in the Urals, Central Asia, and Siberia was greatly stimulated by the German invasion and is gradually increasing, but not in proportion to the increases at Chiatura and Nikopol' or to the expansion of production of pig iron and steel. Ores of ferromanganese grade produced in the Urals, Central Asia, and Siberia total approximately 200,000 tons, less than one-half the requirements of local steel plants. 175/ Deficiencies are covered by shipping high-grade concentrates from Chiatura or ferromanganese from southern ferroalloy plants. 176/

* Table 19 follows on p. 68.

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Table 19

Estimated Production of Manganese Ore in the USSR, by Producing Area
1940 and 1945-55

	Nikopol'		Chiatura		Eastern Areas		
Year	(Thousand Metric Tons)	(Percent of Total)	(Thousand Metric Tons)	(Percent of Total)	(Thousand Metric Tons)	(Percent of Total)	Total (Thousand Metric Tons)
1940	850 a/	33	1,560 b/	61	150 c/	6	2,560
1945	320 d/	22	830 e/	56	330 f/	22	1,480
1946	480 g/	27	950 h/	52	380 i/	21	1,810
1947	550 j/	26	1,100 k/	53	430	21	2,080
1948	620 l/	27	1,200 m/	52	480	21	2,300
1949	880 n/	29	1,700 o/	55	500	16	3,080
1950	975 p/	28	1,950 q/	56	550	16	3,475
1951	1,260 r/	30	2,350 s/	57	550	13	4,160
1952	1,260 t/	30	2,420 u/	57	550	13	4,230
1953	1,400 v/	31	2,540 w/	56	600	13	4,540
1954	1,460 x/	30	2,840 y/	58	600	12	4,900
1955	1,670 z/	30	3,160 aa/	56	770	14	5,600 bb/

a. 177/. All tonnage figures are given in terms of 35 percent (or more) manganese content.
b. 178/
c. 179/
d. 180/
e. 181/
f. 182/
g. 183/
h. 184/
i. Production data for the eastern areas from 1946 through 1955 are estimated.
j. This figure is interpolated.
k. 185/
l. 186/
m. 187/
n. 188/
o. 189/
p. 190/
q. 191/
r. 192/
s. 193/
t. Production is assumed to have remained at the 1952 level.
u. 194/
v. 195/
w. 196/
x. 197/
y. 198/
z. 199/
aa. 200/
bb. 201/

d. Consumption.

Approximately 90 percent of the manganese consumed in the USSR is used by the iron and steel industry. The remainder is used in manufacuturing chemicals, glass, dry batteries, nonferrous alloys, and miscellaneous products. The unusually high rate of consumption by ferrous metallurgy* arises from the practice of charging substantial quantities into the blast furnace to supplement the characteristically low-manganese Soviet iron ores and to aid in eliminating the relatively high sulfur content of coke, particularly that of Donbas origin. This practice, which does not require ore of metallurgical grade, is estimated to account for 80 percent of the consumption of manganese ores and concentrates by the iron and steel industry (70 percent on a metallic basis).

Additions of manganese for deoxidization and desulfurization in the steelmaking furnace are in line with normal practice in other countries. The use of manganese as an alloying additive in substitution for less abundant materials is encouraged, and there is evidence of the production of electrolytic manganese metal for low-carbon manganese steel.

Particularly after the USSR terminated exports of manganese ore to the US in 1949, Soviet production appeared to be considerably in excess of requirements for domestic consumption and exports, and a stockpile of 4 million to 5 million tons may have been accumulated. In 1955, however, exports of about 937,000 tons probably absorbed any surplus production in that year.

B. Alloying Materials.

1. General.**

The USSR is unique among industrialized nations in being substantially self-sufficient in all of the principal alloying metals. Soviet reserves of chromite are among the largest in the world, and the production of nickel, tungsten, molybdenum, and vanadium are --

* In the USSR, 25 kilograms of metallic manganese are used per ton of steel produced; in the US, 6 kilograms per ton are used.
** See the map, Figure 9, inside back cover.

or soon will be -- at least adequate for current industrial requirements. Only in the supply of cobalt is there a shortage sufficient to cause an extensive substitution of less satisfactory materials.

Self-sufficiency has not been achieved, however, at low cost. Although the reserves of chromite are economically exploitable and some nickel ores compare favorably with those of the great Canadian deposits, a considerable part of the nickel produced in the USSR and most of the other alloying metals are extracted from lean, complex ores, frequently in remote regions under adverse climatic conditions. The high internal prices of these materials -- relative to the costs of other materials used by the steel industry -- reflect the high costs of production.

2. Chromite.

a. Reserves.

The USSR claims to have the world's largest reserves of chromite.* Although no official estimates of reserves have been released since 1939, there is considerable evidence that reserves are more than adequate for the foreseeable future. 202/

The Donskoye deposits in Kazakh SSR contain by far the largest known reserves. Thirty occurrences within a radius of 40 kilometers have been reported. Most Donskoye ore is of metallurgical grade, requires little or no concentration, contains up to 60 percent chromic oxide (Cr_2O_3), and has a low silica content and a chrome-to-iron ratio as high as 4 to 1. The ore is, however, quite friable; the fines range up to 40 percent of production. 203/

In the Urals there are chromite deposits estimated at 16 million tons in 1939, but less than 1 million tons are of metallurgical grade. Reserves in the Saranovskiy deposit are estimated at 14 million tons. These ores are of refractory grade, ranging from 20 to 42 percent Cr_2O_3 with relatively high ferrous oxide (FeO) and aluminum oxide (Al_2O_3) content. 204/ Relatively small reserves, apparently of chemical grade, have been reported in the Lake Sevan area of the Armenian SSR.

* Chromite reserves of the Union of South Africa, probably the largest in the Free World, are estimated at 100 million to 150 million tons.

b. Production.

Production of chromite in the USSR began in the second half of the nineteenth century, when mining began on a small scale in the Urals. Operations were confined to the deposits in the Urals until 1938, when development of Donskoye began. The Donskoye deposits approximately doubled total production during the following 5 years. 205/ After the modernization of the Donskoye mines in 1945, production -- stimulated by exports -- continued to increase, and in 1949 it reached a peak of 910,000 tons. Although exports were drastically reduced in 1949, production was not cut back immediately, and a substantial stockpile of chrome ore probably was accumulated. 206/ Since 1951, production appears to have been held at levels approximating requirements for consumption and for small but increasing exports. Soviet production of chromite now comprises about 20 percent of total world production. Estimated production and exports of chromite by the USSR in 1937-55 is shown in Table 20. 207/

Table 20

Estimated Production and Exports of Chromite by the USSR
1937-55

Thousand Metric Tons

Year	Production			Exports
	Urals a/	Donskoye b/	Total	
1937	217 c/	0	217	Negligible
1938	220	20 d/	240	0
1939	245	80 e/	325 f/	0
1940	240	120 g/	360	29 h/
1941	240	120	360	0
1942	238	120	358 h/	27 i/
1943	240	200	440 j/	90 k/
1944	240	200	440	101 k/
1945	200	250	450	150 k/
1946	200	340 l/	540	89 m/
1947	195	480 n/	675	249 o/
1948	55 p/	525 q/	580	365 r/
1949	70	840 s/	910	106 t/
1950	86	770 u/	856	69
1951	114	456 v/	570	10
1952	125	450	575	14
1953	138	600	738	28
1954	167	600	767	76
1955	183	600	783 w/	95

a. Production figures for the Urals are given in terms of 35 percent Cr_2O_3.
b. Production figures for Donskoye are given in terms of 48 percent Cr_2O_3.
c. 208/ h. 213/ m. 218/ r. 223/
d. 209/ i. 214/ n. 219/ s. 224/
e. 210/ j. 215/ o. 220/ t. 225/
f. 211/ k. 216/ p. 221/ u. 226/
g. 212/ l. 217/ q. 222/ v. 227/
w. 228/

All of the metallurgical-grade chromite mined in the USSR comes from the Donskoye deposits. 229/ In 1948 there were three open-pit mines in the area. 230/ Most of the ore for domestic consumption is shipped on the Kandagach-Orsk rail line to the Aktyubinsk ferroalloy plant, which produces 80 to 90 percent of the Soviet requirements for ferrochrome. 231/

The Saranovskiy deposits, in Sverdlovskaya Oblast in the Urals, are the principal source of chromite of refractory grade. Principal consumers are the large magnesite refractory plant at Chelyabinsk 232/ and the Ordzhonikidze plant at Chasov Yar in the Ukraine. 233/ Another user will be a chrome-magnesite refractory plant being built at Zaporozh'ye. 234/

Chemical-grade chrome ore is produced at Pervoural'sk in Sverdlovskaya Oblast for consumption in the nearby Krompik chemical plant, 235/ and in the Lake Sevan area of the Armenian SSR to supply the requirements of the Yerevan bichromate plant. 236/ Metallurgical-grade chrome ore, if it is low in silica, is also suitable for chemical use, and some Donskoye ore appears to be consumed for this purpose at a chromite plant at Dzhambul in Kazakh SSR. 237/

3. Tungsten.

a. Reserves.*

There are no authoritative data on which to base a quantitative estimate of resources of tungsten in the USSR. The latest official figure, 13,700 tons, was published in 1933. 238/ That amount, however, is only one-fourth of the quantity of tungsten estimated to have been produced since 1933. Because more than two-thirds of current production is obtained from deposits known in the 1930's, it is likely that no major new discoveries have been made and that the increased production has come from the extension of ore bodies previously known.

On the basis of this assumption, fairly firm conclusions can be drawn concerning the characteristics of the ores being exploited. In general, the ores are low-grade and complex, and the tungsten is

50X1

associated with molybdenum, manganese, gold, tin, and other minerals. These complex ores require extractive metallurgy involving costly processes for the recovery of the contained minerals. Of about 40 or 50 known tungsten deposits, only a few have been capable of sustaining production for an extended period of time.

b. Production.

Production of tungsten in the USSR began in 1916, when a total of 39 tons of concentrates was produced, but it did not achieve importance until the Dzhida mines and concentrating plant in East Siberia were put into operation in 1935. 239/ Production was further increased in 1940 by the opening of the Tyrny-Auz deposits in the Caucasus and a concentrating plant at Chita in the Transbaykal. 240/ These operations and mines and plants at Chorukh-Dayron, Akchatau, and numerous smaller mines widely distributed in the Urals, Central Asia, and the eastern USSR are the present sources of production. At most installations, tungsten concentrates are produced as coproducts or byproducts, along with molybdenum, tin, gold, and other nonferrous metal concentrates.

The USSR has released no information on the production of tungsten since the Fourth Five Year Plan, which set a goal of 7,500 tons for 1950. There is considerable indirect evidence that production in 1950 probably was no larger than 4,500 tons and that the planned 1950 level of production may not have been attained until 1955. Estimated production of tungsten in the USSR in 1938-55 is shown in Table 21.*

* Table 21 follows on p. 74.

Table 21

Estimated Production of Tungsten in the USSR
1938-55

Metric Tons

Year	Production	Year	Production
1938	500 a/	1947	2,640 b/
1939	N.A.	1948	3,260 d/
1940	800 a/	1949	3,880 d/
1941	1,700 a/	1950	4,500 e/
1942	N.A.	1951	5,100 d/
1943	1,470 b/	1952	5,700 d/
1944	N.A.	1953	6,300 d/
1945	1,700 c/	1954	6,900 d/
1946	1,900 b/	1955	7,500

a. 241/. Production figures are given in terms of 60 percent tungstite (WO_3).
b. 242/
c. 243/
d. This figure was interpolated.
e. 244/

The Sixth Five Year Plan calls for a 1960 production of tungsten concentrates 57 percent above that of 1955, indicating that planned production in 1960 may be on the order of 11,000 to 12,000 tons. 245/

Tungsten and molybdenum concentrates -- about three-fourths of the total are tungsten concentrates -- are produced at Tyrny-Auz, the largest producer of tungsten in the USSR. 246/ The mine, a subsurface operation in mountainous country, produced 350 tons of tungsten concentrates in 1941, just before it was destroyed by the Germans. 247/ Production in 1955 is estimated to have been about 5,000 tons of tungsten concentrates, two-thirds of the estimated total Soviet production.

The status of the Dzhida tungsten combine is unknown. The Dzhida deposits were discovered in 1931, and until the end of World War II they accounted for more than 60 percent of all tungsten produced in the USSR. 248/ During the war years, reserves of ore reportedly were heavily depleted by intensified production.

The success of the USSR in recovering tungsten, tin, molybdenum, and other metals from complex ores indicates an advanced state of technology in extractive metallurgy. Specific reference has been made to the hydrometallurgical treatment of ores and to the use of autoclaves* to increase product yields.

c. Supply and Consumption.

In the USSR, as in the US, the estimated supply of tungsten in 1955 apparently was greatly in excess of current consumption requirements. The apparent supply of tungsten in the USSR and in the US in 1955 is shown in Table 22.

Table 22

Apparent Supply of Tungsten in the USSR and in the US a/
1955

Thousand Pounds

Supply	USSR	US
Production	7,840	15,670 b/
Imports	21,855 c/	20,735 b/
Total	29,695	36,405

a. All data are given in terms of contained tungsten.
b. This figure is a US Bureau of Mines estimate.
c. 249/

* Autoclaves are used for a leaching process involving a combination of heat and pressure in a controlled atmosphere.

Of the 36.4 million pounds of tungsten available to the US in 1955, only 8.96 million pounds were reported as consumed. The remainder, approximately 78 percent of the available supply, was consigned principally to the national stockpile.

The amount of tungsten consumed in the USSR is not known. If Soviet usage of tungsten were the same as US usage, in terms of the relative production of steel,* Soviet consumption in 1955 would have been only 3.8 million pounds. The USSR is known, however, to encourage the substitution of tungsten for molybdenum wherever that can be done, and consumption of tungsten in relation to production of steel probably is greater in the USSR than in the US. Because the Soviet military hard-goods program is believed to be at least equal in magnitude to that of the US the use of tungsten in applications with military implications (high-temperature alloys, hard alloys, HVAP cores) may equal or exceed US consumption for these purposes. In view of the lower over-all industrial production of the USSR, however, it is not probable that total consumption of tungsten exceeded that of the US. On this basis, domestic production in 1955 would have approximated requirements, and substantially all of the tungsten imported from Communist China would have been available for stockpiling.

The US supply of tungsten has been greatly increased in recent years by expansion programs initiated during the Korean crisis. As a result, stockpile objectives have been attained, and drastic cutbacks in procurement are scheduled. Soviet supplies may have reached a comparable level since the Communization of China, and the policy of continued expansion of the production of tungsten in both the USSR and Communist China is difficult to reconcile with the apparent facts unless the USSR has developed uses that the US has not.

4. Molybdenum.

a. Reserves.

Molybdenum occurs in the USSR in relatively small, widely distributed deposits, frequently in combination with copper and tungsten. Although the molybdenum content of the ores is generally low, averaging not more than 0.5 percent, the recovery of other metals makes economically feasible the exploitation of molybdenum ores.

* 0.085 pound of tungsten per ton of steel.

The extent of Soviet reserves of molybdenum has not been disclosed, but a 1947 Soviet announcement stated that reserves would meet requirements for many decades. 250/ During the Fifth Five Year Plan, prospected reserves of molybdenum were increased 69 percent, and the Sixth Five Year Plan calls for an extension of 65 to 70 percent. 251/ [redacted] 50X1

50X1

The most important single source of molybdenum is the copper-molybdenum deposit at Vostochno Kounradskiy in Kazakh SSR, directly east of the main Kounradskiy copper mine. The ore, which is mined principally for its molybdenum, contains 0.8 percent molybdenite (0.48 percent molybdenum). This deposit is one of the two largest in the USSR. 252/ The other is the tungsten-molybdenum deposit at Tyrny-Auz, where recoverable molybdenum reserves were estimated at 2,500 tons in 1940 and reportedly have been extended since that time. 253/

About 66,000 tons of molybdenum can be ascribed to low-grade copper deposits located at Kounradskiy and Boschekul' in Kazakh SSR and Pirdoudan and Agarak in the Armenian SSR. 254/ Boschekul' is the only deposit currently not in production.

b. Production.

Before World War II, production of molybdenum in the USSR was negligible. Following the solution of problems of extractive metallurgy presented by polymetallic ores, significant production began in 1939-40 with the development of the Tyrny-Auz tungsten-molybdenum deposit. Extraction of molybdenum from the Kounradskiy copper mine began shortly thereafter. By 1942 the deposit at Vostochno Kounradskiy and numerous small mines, notably in East Siberia, were in production. Thus, in spite of the destruction of Tyrny-Auz by the Germans in 1942, wartime demands resulted in increasing annual production, from 350 tons in 1940 to a wartime peak of 1,500 tons in 1944. 255/

Intense efforts to increase national production continued in the postwar era. Technological improvements were made, and Tyrny-Auz was restored. Tyrny-Auz recently installed autoclaves -- evidence of continued technological improvements in metal extraction on a par with the newest methods developed in the Free World. 256/ The two Armenian copper deposits, Agarak and Pirdoudan, were developed during the Fourth Five Year Plan. 257/ The amount of molybdenum recovered from these deposits is still small. 258/ The estimated supply of molybdenum in the USSR in 1940 and 1942-55 is shown in Table 23.*

The increased rate of production attained during 1945-50 was not sustained during the Fifth Five Year Plan. The decrease in production from 1950 to 1955 was offset in part by imports from Communist China. The diversion of approximately one-half of the Chinese Communist production to the European Satellites, beginning in 1952, indicates an improved supply in the USSR.

The production rate of molybdenum is to double during the Sixth Five Year Plan period. 259/ In addition to a possible expansion of the capacity of the Chelyabinsk ferroalloy plant, the principal producer of ferromolybdenum for the steel industry, the Plan calls for the production of ferromolybdenum at the new plant to be constructed at Pavlodar in Kazakh SSR 260/ and at a plant for the extraction of molybdenum, probably as a powder, in Krasnoyarskiy Kray. 261/

What little is known of the quality of the molybdenum-containing ores exploited in the USSR indicates that average costs are relatively high. This indication appears to be supported by the internal ruble price for ferromolybdenum. In 1950 the ruble price was approximately 33 times the US dollar price. 262/ In 1950 the ruble/dollar ratio was 9 for ferrochrome, 11 for finished steel, and 37 for nickel.

c. Consumption.

In terms of the production of steel in the USSR and the US the supply of molybdenum available for consumption (production plus imports less exports) in the USSR in 1955 was equivalent to about two-thirds of US consumption per ton of steel produced in that year. In addition, the US placed a substantial quantity in the strategic stockpiles, and it is probable that Soviet consumption was further reduced for the same purpose. The twofold increase in molybdenum availability incorporated in the Sixth Five Year Plan is therefore consistent with the present relatively low supply and with the

* Table 23 follows on p. 79.

Table 23

Estimated Supply of Molybdenum in the USSR a/
1940 and 1942-55

Metric Tons

Year	Production b/	Imports c/	Apparent Supply
1940	350	150	500
1942	650	2,350	3,000
1943	1,155	1,830	2,985
1944	1,500	1,810	3,310
1945	1,450 d/	740	2,190
1946	1,125 d/	N.A.	1,125
1947	2,175	N.A.	2,175
1948	2,550	N.A.	2,550
1949	2,800	N.A.	2,800
1950	3,045	125	3,170
1951	3,345	515	3,860
1952	3,645	280	3,925
1953	3,945	290	4,235
1954	4,245	290	4,535
1955	4,400 e/	300	4,700

a. It is assumed that all reported molybdenum concentrates contain 65 percent molybdenite (the molybdenum content of molybdenite is 60 percent).
b. 263/
c. 264/
d. The decrease in production during 1945 and 1946 could be explained by the transfer of scarce metallurgical equipment and specialists from areas which were developed during the war to Tyrny-Auz in the Transcaucasus as part of the restoration program.
e. 265/. The estimate is based on a statement that Kazakh SSR produced 22 percent of Soviet molybdenum.

magnitude of Soviet expansion goals in the electric power, chemical, petroleum, and armaments industries -- all of which are large consumers of molybdenum steel. The provision of facilities in Krasnoyarskiy Kray for the extraction of high-purity molybdenum indicates an increased Soviet interest in the use of this metal in gas turbines and other high-temperature applications and in electronics.

5. Vanadium.

The USSR has extensive reserves of polymetallic ores, principally titanomagnetites, containing traces of vanadium. In aggregate these ores contain sufficient vanadium for any foreseeable demand. The deposits are found principally in four areas: the Kola Peninsula, the Kerch' Peninsula, the Urals, and Kazakh SSR. [redacted] 50X1 50X1

The first Soviet attempt to extract vanadium from the iron ores in the Kerch' Peninsula took place in 1932 at the Kerch' metallurgical works. Calcium vanadate, a catalyst, was obtained from blast furnace slag after the slag was crushed, calcined, and leached. 266/ Other experiments in utilizing the polymetallic vanadium-bearing ores of the Kola and Kerch' Peninsulas were partially successful, and construction of a plant at Chusovoy in the Urals was planned to make ferrovanadium for the Chusovoy steel plant, a large producer of vanadium steels. In 1935-36 a process for extracting vanadium from Ural titanomagnetites was started on a production basis. Currently this plant is the main source of vanadium in the USSR. 267/ In addition, it is likely that uranium mining in Kazakh SSR yields vanadium as a byproduct. The Kola and Kerch' vanadium-bearing iron ores may continue as a source of vanadium through utilization in natural alloy pig iron. Estimated production of vanadium in the USSR in 1946 and 1951-55 is shown in Table 24.*

It is possible that there is an important deposit of vanadium ore in Kazakh SSR. References to such a deposit have appeared since 1944, and in 1955 it was claimed that in the Kara-Tau Mountains,

* Table 24 follows on p. 81.

Table 24

Estimated Production of Vanadium in the USSR
1946 and 1951-55

Metric Tons

Year	Production a/
1946	425
1951	535
1952	645
1953	675
1954	700
1955	725

a. Tonnage figures are given in terms of metallic equivalent of ferrovanadium (40 percent vanadium content). For methodology, see Appendix B.

Kazakh SSR had the largest reserves of vanadium in the world. 268/ Such a deposit would support the production of ferrovanadium in the new ferroalloy plant to be built at Pavlodar during the Sixth Five Year Plan period. 269/ In this event the costly processing at Chusovoy probably would be discontinued.

6. Nickel.

a. General.

The USSR has the world's second largest nickel industry. Soviet production is about one-fourth that of Canada, the largest producer. Since 1948, Soviet production has been sufficient to meet essential consumption and stockpiling requirements and to provide some exports -- usually involving nickel-containing equipment in return. Soviet production of nickel in 1955, when related to steel production, was about equal to US consumption per ton of steel produced.

The increased production from 29,000 tons in 1950 to 44,000 tons in 1955 called for in the Fifth Five Year Plan was fulfilled only to the extent of 40,000 tons. The Sixth Five Year Plan goal of 65,000 tons by 1960 appears, however, to be within Soviet capabilities, in view of expansion projects under way. This objective is related to a 17-fold planned increase in the production of low-alloy steel and a 3.2-fold increase in production of stainless and heat-resistant alloys. Because it is unlikely that there will be a substantial increase in the availability of nickel to the US, the achievement of the Soviet aims may result in a production of nickel alloys in the USSR considerably higher than that in the US, in relation to the production of steel in the two countries.

The USSR also proposes to build during the Sixth Five Year Plan period a plant for the production of carbonyl nickel (Mond process) in Krasnoyarskiy Kray. 270/ This plant probably will use nickel matte from Noril'sk. The Mond process produces pure nickel, and it is significant that this kind of nickel has applications in the atomic energy industry. 271/

b. Reserves.

At the beginning of the Fifth Five Year Plan, prospected reserves of nickel in the USSR were estimated at 900,000 tons. 272/ By 1955, prospected reserves had been increased 94 percent, which brought the total to 1.75 million tons. 273/ The Sixth Five Year Plan calls for a third increase in prospected reserves which would make total reserves 2.3 million tons in 1960. 274/ This figure is equal to approximately one-half of Canada's current reserves. At the projected 1960 rate of consumption, 65,000 tons, the Soviet reserves would last 35 years. Most of the projected exploration for new reserves will be undertaken in the Pechenga and Noril'sk areas, known to have deposits which have never been fully explored. The USSR is preparing a new nickel deposit near Nikel', the location of the Pechenga nickel combine. 275/

The principal nickel deposits of the USSR are located at Pechenga and Monchegorsk on the Kola Peninsula; at Rezh, Revda, and Verkhniy Ufaley in the central Urals; at Orsk, Aydrlinskiy, and Novo-Troitsk in the southern Urals; at Noril'sk in East Siberia; and at Kimpersayskiy and Buranovo Shelekta in Kazakh SSR. [redacted] 50X1

50X1

c. Production.

The production of refined nickel in the USSR dates from 1934, when the nickel refinery at Verkhniy Ufaley in the central Urals began operations. During the middle and late 1930's the Soviet government intensified its efforts to expand the nickel industry in an attempt to keep pace with the growing demand for nickel brought about by the armament program and the increase in production of alloy steel. By 1939, integrated nickel combines had been put into operation at Orsk in the southern Urals and at Monchegorsk on the Kola Peninsula. In 1938 a third combine was started at Noril'sk in East Siberia, and in 1942 it was put into partial operation. Production of nickel expanded almost tenfold between 1934 and 1940 -- from 860 tons to 8,500 tons. Estimated production of nickel in the USSR in 1945-55 and 1960 is shown in Table 25.

Table 25

Estimated Production of Nickel in the USSR
1945-55 and 1960

Metric Tons

Year	Production	Year	Production
1945	15,200 a/	1951	31,000 d/
1946	16,200 b/	1952	33,000 d/
1947	21,000 c/	1953	35,000 d/
1948	23,600 d/	1954	37,000 d/
1949	26,400 d/	1955	40,000 f/
1950	29,000 e/	1960	65,000 g/

a. 276/
b. 277/
c. 278/
d. This figure is interpolated.
e. 279/
f. 280/
g. 281/

None of the three nickel combines started during the 1930's had been fully completed at the outbreak of World War II. Much of the equipment from the Monchegorsk combine was evacuated to Orsk, which became the chief center of production of refined nickel during the war years.

In the postwar period the Monchegorsk combine and the Orsk refinery were rehabilitated and enlarged beyond their prewar capacities, and additional capacity was built at Noril'sk. In 1950 a double-track rail line was completed from Noril'sk to Dudinka on the Yenisey River, which can be reached 3 months out of the year by ocean-going vessels by the northern sea route. A rail line from Noril'sk to the industrial regions of the USSR by way of Dudinka, Igarka, and Vorkuta is now nearing completion.

Acquisition of the Pechenga mine and smelter from Finland in 1944 made an important contribution to the Soviet nickel industry. Construction of the Pechenga smelter was started by a subsidiary of the International Nickel Company in 1935 and completed under Finnish-German occupation. Operated by the Germans during World War II, the Pechenga smelter had an annual capacity of 10,000 tons of nickel matte. The USSR completed restoration of the Pechenga smelter, and it is believed to have been operating at its full original capacity by 1951. In 1951 a Finnish company completed reconstruction of the power plant at Yaniskoski, which serves the Pechenga smelter. A second power plant, being built at Rajakoski by the same company, is scheduled for completion in late 1956. Recent reports indicate that in the near future this company will begin work on a third power plant for the USSR at Kolttakengyas, near the Russian-Norwegian border. The completion of these power plants, all with approximately the same capacity, will represent a threefold increase in the electric power supply of the Pechenga area, and because there are no other large power consumers in this area the expansion indicates that a sizable expansion of nickel production is contemplated -- including, perhaps, the addition of an electrolytic refinery. At present, nickel matte from the Pechenga smelter is sent to Monchegorsk for refining. [redacted] 50X1

50X1

7. Cobalt.

Before World War II, consumption of cobalt in the USSR was minor and was supplied almost entirely from imports. During and immediately after the war the growth in the use of cobalt in sintered carbides, in permanent magnets for telecommunications and radar, and in high-temperature applications associated with gas turbines and jet engines prompted extensive exploration for cobalt-bearing ores.

The greater part of the 50,000-ton Soviet reserve of cobalt occurs in combination with nickel ores. These ores are chiefly on the Kola Peninsula, near the lower Yenisey River at Noril'sk, in the Urals, and in Kazakh SSR.

In the USSR, cobalt also occurs with ores containing iron, manganese, copper, and other elements. These ores, which account for approximately 25 percent of the supply, are found principally in the Urals, the Transcaucasus, and the Soviet Far East. Other complex polymetallic ores, mostly in Altayskiy Kray and in the Transbaykal area, present extractive difficulties and are not being exploited. Estimated reserves and production of cobalt in the USSR, by economic region, in 1955 are shown in Table 26.*

Because cobalt occurs principally as a constituent in nickel ores and nickel-copper ores, the production of cobalt is administered in the USSR by the Main Administration of Nickel and Cobalt of the Ministry of Nonferrous Metallurgy. Cobalt produced in the nickel combines at Monchegorsk, Orsk, Ufaley, and Noril'sk is recovered in local refineries. Cobalt-containing matte from the Pechenga smelter probably is refined at Orsk or Monchegorsk. Because of the decline in reserves of nickel in the Verkhniy Ufaley area, it is probable that cobalt concentrates from other sources -- principally Dashkesan in the Transcaucasus and Seymchan in the Far East -- are treated in the Verkhniy Ufaley refinery.

The first commercial production of cobalt in the USSR took place at the South Ural Nickel Combine, at Orsk, in 1947. Production has grown steadily, and now the USSR is the second largest producer of cobalt in the world. Estimated 1955 production was 1,220 tons, 10 percent of Free World production and equivalent to approximately one-third of US consumption in that year.

* Table 26 follows on p. 86.

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CIA-RDP79R01141A000800020002-8

Table 26

Estimated Reserves and Production of Cobalt in the USSR
by Economic Region
1955

Metric Tons

Economic Region		Reserves a/	Production
I	(North and Northwest)	8,000	200 b/
V	(Transcaucasus)	N.A.	120 c/
VIII	(Urals)	13,000	585 d/
X	(Kazakhstan and Central Asia)	7,500	120 e/
XI	(East Siberia	13,500	120 f/
XII	(Far East)	N.A.	75 g/
	Total		1,220

a. Reserves are stated in terms of cobalt content of the ores as determined by the composition of the ores and the estimated recovery rates. 50X1

50X1

b. 282/
c. 283/
d. 284/
e. 285/
f. 286/
g. 287/

Cobalt is the only alloying material probably in short supply in peacetime in the USSR. The more essential uses of cobalt are closely associated with military applications, and perhaps for this reason no direct references are made to cobalt in official announcements. Soviet expenditures for military purposes are estimated to be approximately equal to those of the US, and a supply of cobalt amounting to only one-third of US consumption (not including quantities consigned to the US stockpile) would be adequate only for uses of the highest priority.

There is considerable additional evidence that the Soviet supply of cobalt is below desired levels. The occasional references to cobalt in the technical literature usually are made in connection with the development of substitutes. Sintered tungsten carbide cores in Soviet HVAP shells recovered in Korea used nickel instead of cobalt as a binder, a substitution which reduces the effectiveness of the missile. Soviet researchers are now working toward the development of chrome-based, high-temperature alloys and ceramic tool bits, partly for the purpose of reducing cobalt requirements.

The 1950 price of cobalt in the USSR is a further indication of scarcity. The ruble price is 103 times the US dollar price, compared with a ruble/dollar ratio of 37 for nickel and an average ruble/dollar ratio of 11 for finished steel products.

The high price of cobalt in the USSR serves both to discourage nonessential use and to offset the high cost of indigenous production. The ores exploited generally are below Free World commercial standards. Concentrates produced in the remote Bol'shoy Canyon region near Seymchan are flown to Magadan and shipped west for refining.

Substitution by the European Satellites, particularly East Germany, of inferior materials for cobalt, and the devious and costly attempts of the Satellites to relieve their chronic shortage by covert importations from the West, clearly indicate that Soviet shipments to the Satellites are severely restricted.

8. Ferroalloys.

a. General.

The ferroalloys produced in prerevolutionary Russia were ferromanganese, spiegeleisen, and low-grade ferrosilicon (silvery pig) produced in the blast furnaces of Ukrainian steel plants. The First Five Year Plan recognized the need for electric furnace ferroalloys, especially for special and quality steels. The first planned production started in 1931 at the Chelyabinsk ferroalloy plant, and the Zestafoni and Zaporozh'ye ferroalloy plants were operating in 1932. Except for the World War II years, no ferroalloys have been imported by the USSR since 1935.

Expansion of ferroalloy plant capacity was emphasized in the Third Five Year Plan, which was called the "Five Year Plan for Special Steels," and since 1942, production has kept pace with the demands of the Soviet iron and steel industry, both in volume and variety of types. The USSR now exports relatively small quantities of ferroalloys to the other nations of the Sino-Soviet Bloc, primarily on a spot basis.

b. Production.

More than 95 percent of Soviet production of ferroalloys consists of ferromanganese (including spiegeleisen), ferrochromium, and ferrosilicon. Some standard-grade ferromanganese (70 to 75 percent manganese), all spiegeleisen (10 to 25 percent manganese), and all low-grade ferrosilicon (10 to 17 percent silicon) are produced in blast furnaces. These products account for approximately 735,000 tons, two-thirds of total production of ferroalloys. Capacity is virtually unlimited in that conventional blast furnaces are used; it is Soviet practice to operate blast furnaces on ferroalloys, when desired, usually near the end of a furnace campaign.

All of the five major electric furnace ferroalloy plants are served by hydroelectric power. In addition, Zestafoni and Zaporozh'ye are near the world's largest deposits of manganese, at Chiatura and Nikopol', respectively. Aktyubinsk is 80 kilometers from the large metallurgical-grade chromite deposits at Donskoye, and the Chelyabinsk and Stalinsk plants are adjacent to steelmaking consumers of ferroalloys. The operation of some of these plants (Zaporozh'ye especially) is subject to seasonal variations in the water supply.

Production of electric furnace ferroalloys in 1955 is estimated at 421,000 tons, one-third of the total Soviet production of ferroalloys. Estimated production of electric furnace ferroalloys in the USSR in 1931-55 is shown in Table 27.* Estimated production of blast furnace and electric furnace ferroalloys in the USSR, by type, in 1955 is shown in Table 28.** [redacted] 50X1
50X1

* Table 27 follows on p. 89.
** Table 28 follows on p. 90.

Table 27

Estimated Production of Electric Furnace Ferroalloys in the USSR a/ 1931-55

Metric Tons

Year	Production	Year	Production
1931	4,600	1943	225,000
1932	15,000	1944	225,000
1933	21,000	1945	225,000
1934	67,000	1946	258,000
1935	94,000	1947	275,000
1936	125,000	1948	290,000
1937	172,000	1949	305,000
1938	190,000	1950	315,000
1939	210,000	1951	330,000
1940	225,000	1952	345,000
1941	200,000	1953	360,000
1942	200,000	1954	380,000
		1955	421,000

a. For methodology, see Appendix B.

c. Ferromanganese.

Almost all of the production of ferromanganese in the USSR is divided about equally between Zaporozh'ye and Zestafoni. Zaporozh'ye, which obtains most of its supply of ore from Nikopol',

Table 28

Estimated Production of Blast Furnace and Electric Furnace Ferroalloys in the USSR, by Type a/
1955

Metric Tons

Type	Blast Furnace	Electric Furnace	Total
Ferromanganese			750,000
Spiegeleisen (10 to 25 percent manganese)	425,000		
Standard (70 to 75 percent manganese)	165,000		
Electrothermic (76 to 80 percent manganese)		160,000	
Ferrochrome		120,000	120,000
Ferrosilicon			245,000
Silvery pig (10 to 17 percent silicon)	145,000		
Electrothermic (45, 75, and 90 percent silicon)		100,000	
Ferromolybdenum (55 percent molybdenum)		9,000 b/	9,000
Ferrovanadium (40 percent vanadium)		1,800 b/	1,800
Other		30,000 c/	30,000
Total	735,000	421,000	1,156,000

a. For methodology, see Appendix B.
b. The estimate is based on all of the supply of molybdenum and vanadium being used to produce ferroalloys.
c. The estimate is based on US analogy and includes ferrophosphorus, ferroboron, ferroniobium, ferrotungsten, and ferrotitanium.

70 kilometers distant, is also conveniently located near consumers in the Ukraine, which provides 35 percent of Soviet production of steel. Ferromanganese is produced only when power from the Dnieper hydroelectric plant is plentiful. A 40-percent increase in the production of all ferroalloys at Zaporozh'ye is called for during the Sixth Five Year Plan period. 288/

Ferromanganese is produced at Zestafoni from Chiatura ore, which comes a distance of approximately 15 kilometers. Power is supplied by a nearby hydroelectric plant on the Rion River. Capacity at Zestafoni recently has been increased to provide additional ferromanganese to replace some of the manganese ore formerly shipped to the Urals and, presumably, smelted there in blast furnaces. The Sixth Five Year Plan specifies a 155-percent increase in the production of all ferroalloys. 289/

d. Ferrochrome.

Production of electric furnace ferrochrome in 1955 is estimated at 120,000 tons, 80 to 90 percent of which was produced at the Aktyubinsk ferroalloy plant. Production, which started there in 1945, is based on the extensive high-grade chromite deposits at Donskoye, 80 kilometers south of Aktyubinsk. 290/

Most of the remaining supply of ferrochrome in the USSR is made in the Chelyabinsk ferroalloy plant. Production here was originally based on local ores, but in recent years these have been replaced by Donskoye ores. Products from the new plant at Pavlodar will include ferrochrome and probably will provide for most of the increased requirements of this ferroalloy. 291/

e. Ferrosilicon.

Unlike that of other ferroalloys, the production of electric furnace ferrosilicon is almost evenly divided among the five major ferroalloy plants. The dispersed production of ferrosilicon results from the widespread occurrence of silicon-bearing minerals and the universal use of ferrosilicon in the steelmaking process. Production of electric furnace ferrosilicon in 1955 is estimated at 100,000 tons and of blast furnace ferrosilicon at 145,000 tons. 292/

Although the Sixth Five Year Plan does not specify an increase in the production of ferrosilicon, additional supplies undoubtedly will be required for the general expansion in steelmaking and for the 2.1-fold increase called for in the production of transformer sheets. These requirements probably will be provided for in the general expansion planned for production of ferroalloys.

f. Other Ferroalloys.

Ferrotungsten and ferromolybdenum were first produced in 1932 and 1935, respectively, at Chelyabinsk, which is still believed to be the major producer. Although there have been references to the production of these ferroalloys at Zestafoni and Zaporozh'ye, production is believed to be irregular at best.

Since 1936, ferrovanadium has been produced by the aluminothermic process at the Chusovoy ferroalloy plant in the Urals. Nearby Kushva titanomagnetite ores are processed at the Gornoblagodatskaya concentrating plant and the Chusovoy steel plant by a complex and costly process. The production of ferrovanadium at Chusovoy probably will be discontinued on the advent of the new plant at Pavlodar in Kazakh SSR, which will manufacture that ferroalloy from deposits of indigenous ores which are claimed to constitute the largest vanadium reserves in the world. 293/

Ferrotitanium is produced at the Klyuchevsk ferroalloy plant by the aluminothermic method. 294/ The Ural titanomagnetites serve as raw material for this plant and for the Chusovoy ferroalloy plant. 295/

It is estimated that an additional 550,000 tons, a total of 1.75 million tons, of ferroalloys will be needed by 1960 to support the increased production of carbon and alloy steel called for by the Sixth Five Year Plan. It is intended to achieve this additional production by the construction of new plants, by the expansion and improvement of existing facilities, and by changes in technological practices.

Two new electric furnace plants are called for -- one at an unspecified location in the Ukraine and one at Pavlodar in Kazakh SSR. 296/ Expansion plans for existing plants are not disclosed beyond the provision that 250 million rubles are to be spent for "rebuilding and reequipping" Zestafoni. 297/ In addition, pressure on electric furnace capacity will be relieved by using oxygen to produce in the blast furnace some types of ferroalloys now being made in electric furnaces.

VI. Trade.

A. General.

The USSR is a net exporter of iron and steel and of almost all of the metallic raw and alloying materials that are used in their production and for which trade data are available. The only exceptions are tungsten and molybdenum ores and concentrates, production of which is supplemented by imports from Communist China.

Exports of the ferrous metallurgical industry's products have increased substantially since 1950, and except for shipment of finished steel, these exports reflect growing proportions of the industry's production. Although net exports of finished steel have more than doubled since 1950, they continue to represent only about 2 percent of Soviet production. Considerably larger proportions of the raw materials produced in the USSR are exported. In 1955 the USSR exported the equivalent of 17 percent of the manganese produced in that year, 12 percent of the iron ore and chromite, and 11 percent of the nickel. Soviet foreign trade in ferrous metallurgical raw materials in 1950-55 is shown in Table 29.* Soviet foreign trade in ferrous metals in 1950-55 is shown in Table 30.**

Soviet trade in steelmaking and alloying materials reflects a pattern of commitments to the European Satellites, a desire -- supported by abundant reserves of some ores -- to earn foreign exchange, and a need to supplement domestic supplies of some ores. Iron ore, by far the largest item of export in both tonnage and value, is exported solely to the Satellites and amounts to more than one-half of the apparent consumption of these iron-deficient countries. Exports of coke also support the Satellite steel industries.

Soviet exports of manganese continue to offset European Satellite shortages and are appearing in increasing quantities in Free World trade agreements. Soviet chromite is exported almost exclusively to the Free World. Satellite imports of chromite come from Albania, apparently by agreement.***

* Table 29 follows on p. 96.
** Table 30 follows on p. 98.
*** Continued on p. 100.

Table 29

Soviet Foreign Trade in Ferrous Metallurgical Raw Materials
1950-55

Thousand Metric Tons

Trade	1950	1951	1952	1953	1954	1955
Exports						
Iron ore (50 to 54 percent Fe)						
Bloc	2,072 a/	3,453 b/	5,065 a/	5,875 a/	6,757 a/	8,729 c/
Manganese ore d/						
Bloc (25 to 40 percent Mn)	204	205	304	442	394	400
Non-Bloc (45 percent Mn)	101	51	94	162	383	537
Total	305	256	398	604	777	937
Coke e/						
Bloc	N.A.	N.A.	61	386	162	420
Non-Bloc	N.A.	35	26	10	2	102
Total	N.A.	35	87	396	164	522
Scrap e/						
Bloc	247	N.A.	Negligible	2	N.A.	1
Non-Bloc	N.A.	N.A.	N.A.	81	51	120
Total	247	N.A.	Negligible	83	51	121
Chromite (48 percent Cr_2O_3)						
Bloc	5 f/	10 g/	14 h/	16 i/	14 j/	7 k/
Non-Bloc	64 l/	N.A.	0	12 m/	62 n/	88 o/
Total	69	10/	14	28	76	95

Table 29

Soviet Foreign Trade in Ferrous Metallurgical Raw Materials
1950-55
(Continued)

Thousand Metric Tons

Trade	1950	1951	1952	1953	1954	1955
Exports (Continued)						
Nickel (metal) p/						
Bloc	2.5	2.8	2.6	3.6	3.2	4.3
Imports						
Tungsten (68 percent WO3) q/						
Bloc (Communist China)	9.9	10.4	14.2	15.7	17.1	18.5
Molybdenum (metallic equivalents) r/						
Bloc (Communist China)	0.125	0.515	0.28	0.29	0.29	0.30

a. 298/. All figures in this table are minimum figures.
b. 299/
c. 300/
d. These estimates are based on miscellaneous data available in CIA files.
e. These estimates are based on miscellaneous data available in CIA files.
f. 301/
g. 302/
h. 303/
i. 304/
j. 305/
k. 306/
l. 307/
m. 308/
n. 309/
o. 310/
p. These estimates are based on miscellaneous data available in CIA files.
q. 311/
r. 312/

Table 30

Soviet Foreign Trade in Ferrous Metals a/
1950-55

Thousand Metric Tons

Trade	1950	1951	1952	1953	1954	1955
Exports						
Pig iron						
Bloc	173	210	748	483	377	386
Non-Bloc	0	10	15	9	381	665
Total	173	220	763	492	758	1,051
Crude steel						
Bloc	87	107	80	106	Negligible	N.A.
Non-Bloc	Negligible	2	1	63	222	41
Total	87	109	81	169	222	41
Finished steel						
Bloc	417	436	386	755	875	930
Non-Bloc	29	62	65	98	172	326
Total	446	498	451	853	1,047	1,256

a. These estimates are based on miscellaneous data available in CIA files. All figures in this table are minimum figures.

Table 30

Soviet Foreign Trade in Ferrous Metals
1950-55
(Continued)

Thousand Metric Tons

Trade	1950	1951	1952	1953	1954	1955
Imports						
Pig iron						
Bloc	N.A.	N.A.	N.A.	160	200	200
Finished steel						
Bloc	24	26	31	223	228	210
Non-Bloc	35	23	78	105	157	127
Total	59	49	109	328	385	337

Soviet exports of nickel are limited to the European Satellites and Communist China on a restricted basis, and to a considerable extent the nickel is returned to the USSR in alloy steel or as components of manufactured items.

Soviet imports of tungsten and molybdenum from Communist China represent substantially the total Chinese Communist production of these minerals.

In the Sino-Soviet Bloc sector, Soviet exports of pig iron serve to relieve the iron deficiencies of the European Satellites, principally those of East Germany and Czechoslovakia, and much finished steel is shipped to Communist China to supplement China's growing but still small production of steel. It is probable that exports of finished steel to China are offset, to a considerable extent, by Chinese shipments of pig iron to the Soviet Far East and Siberia.

Trade with the Free World in pig iron and steel, however, appears to reflect political as well as economic considerations. In 1954, significant exports of pig iron began as a part of trade agreements providing for substantial Soviet imports of other commodities. Of total exports of pig iron to non-Bloc countries in 1955, the UK accounted for 40 percent; Belgium-Luxembourg, 20 percent; West Germany and Italy, about 15 percent each; and Argentina, 9 percent.*

In 1955, about 30 percent of exports of finished steel to non-Bloc countries were consigned to Argentina. Other major Free World importers are Finland, on an exchange agreement, and India, which is to receive a total of 1 million tons in 1956-58. Since 1953, Turkey, Libya, and Afghanistan have been small purchasers.*

Soviet imports of finished steel in 1955 were largely from within the Sino-Soviet Bloc, principally from Czechoslovakia and Poland. The USSR has been a consistent bidder for finished steel in Free World markets, however, and recently acquired 8,000 tons of sheet steel in the US.

Soviet imports of iron and steel scrap and some alloying materials (cobalt, nickel, molybdenum, columbium) from the Free World

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* These estimates are based on miscellaneous data available in CIA files.

have been restricted by COCOM controls. Of finished steel, however, only alloys of embargoed metals and special forms of pipe and tubing are controlled. A major impediment to the conversion of Soviet requests for finished steel items, particularly sheet and strip, into imports has been the recent world shortage of steel and the desire on the part of Free World producers to sell their production in a dependable market.

B. Raw Materials.

1. Iron Ore.

Soviet exports of iron ore increased from 5 percent of annual production in 1950 to 12 percent in 1955. The USSR has become the principal external source of iron ore for the European Satellites, supplying an estimated 51 percent of the total Satellite requirements in 1955. About three-fourths of Soviet shipments are to Czechoslovakia and Poland. The only current Soviet imports are small, sporadic shipments from Communist China. 313/

2. Manganese Ore.

Soviet exports of manganese ore have increased threefold since 1950, but they are still lower than they were before World War II, when manganese was 1 of the 6 major Soviet export items and accounted for about 3 percent of the value of all exports. It was not until 1954 that the USSR was able to offset the loss of the US market, which resulted from the Soviet withdrawal from the world market in 1948 and the development of other sources of supply by Free World consumers. Before World War II the US took 30 percent of Soviet exports of manganese and in 1948 imported 387,000 tons -- the equivalent of 62 percent of Soviet exports and one-fourth of US requirements. 314/ Since 1952, when manganese again was offered to the Free World, an increasing volume has been shipped to the UK, France, Belgium-Luxembourg, and the Netherlands. The UK and France combined took about one-fourth of the total Soviet exports of manganese in 1955 and 43 percent of the manganese shipped to non-Bloc countries. Intra-Bloc shipments are to East Germany, Poland, and Czechoslovakia, Satellites which are dependent on Soviet supplies for 75 to 90 percent of their imports of manganese. 315/

3. Coke and Scrap.

The limited data available indicate that about 80 percent of the exports of coke are to Rumania (370,000 tons in 1955), Hungary, East Germany, and Finland. 316/ There is no evidence of significant shipments of scrap from the West to the USSR since COCOM controls were applied to scrap in 1950. The USSR had trade agreements providing for exports to Finland amounting to 70,000 tons in 1953 and 50,000 tons in 1954 and 1955, and for shipments of 70,000 tons to Argentina in 1955. 317/

4. Chromite.

Western European countries, particularly Sweden, France, and Norway, are the principal current markets for Soviet exports of chromite. Shipments to Western Europe have increased considerably since 1952, when the USSR abandoned the policy, adopted in 1950, of refusing to sell chromite to the West. The increase, however, has not offset the Soviet loss of a market in the US, which absorbed 357,000 tons of Soviet metallurgical-grade ore in 1948 -- equal to 98 percent of Soviet exports and to 42 percent of the US supply in that year. Small quantities of chromite are supplied to the European Satellites. 318/

5. Nickel, Tungsten, and Molybdenum.

The USSR has been a net exporter of nickel since 1948. Most of the nickel has been shipped to other countries of the Sino-Soviet Bloc, principally to East Germany and Czechoslovakia, and returned to the USSR in nickel-bearing alloys, frequently as components of machinery and equipment. 319/

Imports from Communist China provide about 70 percent of the Soviet tungsten supply and about 6 percent of Soviet molybdenum requirements. 320/

C. Ferrous Metals.

1. Pig Iron.

Increasingly large shipments to non-Bloc countries, particularly the UK and Argentina, account for the growing volume of Soviet exports of pig iron. Negotiations to supply Spain and Portugal with 55,000 tons of pig iron in 1956 have been reported. Most of the

Soviet exports to other countries of the Sino-Soviet Bloc were to East Germany (260,000 tons) and Czechoslovakia (120,000 tons), the two principal Bloc importers of Soviet pig iron during the postwar years. Communist China has an excess of pig iron, and it is likely that significant quantities of the surplus are being shipped to the Soviet Far East and Siberia, as reported in 1953. 321/

2. Finished Steel.

Soviet foreign trade in steel consists largely of exports of finished steel, but relatively small crude steel shipments also have been reported. Exports of finished steel to other countries of the Sino-Soviet Bloc and to the Free World are increasing, but net exports to Bloc countries in 1955 were about 3.5 times as large as those to the Free World. About 60 percent of net exports to Bloc countries and 48 percent of total net exports of finished steel in 1955 went to East Germany.* These shipments consisted of rails, rail accessories, wire and wire rod, pipe, heavy and light sections, strip, sheet, plate, forgings, and castings. Shipment of rails reached 100,000 tons in 1954, but only 50,000 tons were shipped in 1955.* Communist China, Rumania, and Bulgaria consume virtually all the remaining Soviet exports to Bloc countries.

Increased exports to non-Bloc countries since 1953 are primarily the result of the Soviet trade agreement with Argentina, which became effective in 1954. The USSR shipped 157,000 tons of finished steel in that year and 200,000 tons in 1955. Other major Free World importers are Finland and India. The USSR has had trade agreements with Finland since 1951, providing for annual shipments by the USSR averaging 50,000 to 60,000 tons. Of more recent origin are the agreements with India, under which the USSR shipped 50,000 tons in 1955 and is obligated to export a total of 1 million tons in 1956-58.*

Soviet imports of finished steel in 1955 were largely from within the Sino-Soviet Bloc, including 140,000 tons from Czechoslovakia and 70,000 tons from Poland. Communist China recently was reported to have sent wire and pipe to the USSR. 322/ The principal Free World sources were France (53,000 tons), Japan (47,000 tons), and Austria (19,000 tons).*

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* These estimates are based on miscellaneous data available in CIA files.

VII. State Reserves.

The USSR is maintaining reserves of materials which significantly increase the flexibility of the economy and provide a valuable asset in the event of war. These reserves, known as "state reserves," are distinct from the normal inventory (tekushchiy zapas) and emergency stocks (strakhovyy zapas) located at individual enterprises and under the control of the plant directors. State reserves are administered by the Main Administration of State Material Reserves attached to the Council of Ministers.

State reserves are classified in three categories. The first category consists of reserves maintained at plants and warehouses of the Ministry of Ferrous Metallurgy, representing at least a 3-month supply of selected inputs and finished products of an enterprise. These reserves may be borrowed to alleviate shortages and bottlenecks. The second category, also maintained at plants and warehouses of the Ministry, is the mobilization reserve. It consists of materials, usually tools, and raw materials that would be required to convert the enterprise to its mobilization plan and maintain production for a certain time period. The third category is kept at special bases of the Main Administration of State Material Reserves, located throughout the USSR, and is used only after all other stockpiles have been exhausted. For materials that may deteriorate in storage, there is a regular withdrawal and replenishment program.

At one time or another, additions to stockpiles in the first category are known to have included the following products of the ferrous metallurgical industry: chrome, nickel, cobalt, molybdenum, tungsten, and vanadium metal; ferrosilicon; pig iron; coke and coking coal; charcoal; mazut for open hearth furnaces; various types of finished steel; and alloy steel. Allocations to the second and third categories probably are similar. 323/

VIII. Inputs.

In estimating material input requirements and in drawing up material balances for the ferrous metallurgical industry, Soviet planners have established utilization norms, or input coefficients, for all types of material. Coefficients are usually based on a ton of production for which the input material was consumed. The major material inputs to the Soviet coke and byproducts industry, the blast furnace industry, the steel plant and rolling mill industry, the iron casting industry, and the steel castings industry are shown in Appendix A, Tables 40, 41, 42, 43, and 44.*

An input requirement of major importance in the iron ore mining industry, the manganese ore mining industry, and the electrometallurgical ferroalloy industry and its subsidiary mining activities is electric power, which in 1951 amounted to about 3.4 billion kilowatt-hours. Other inputs are not shown for these industries.

* Pp. 154, 155, 157, 160, and 162, respectively, below.

IX. Technology.

A. General.

Steel plant technology in the USSR generally is on a par with that of leading Western nations including the US. The results obtained by the application of technological advancements to the various metallurgical processes have had a significant effect on quality of product and on productivity in the Soviet steel industry. Although Soviet research and developmental ability is now of a fairly high caliber, fully capable of original research, many past achievements have been "borrowed" from German and US techniques.*

Most new steel plant technology is well known to all advanced industrial nations, and none has been as willing to adopt new techniques on as broad scale as has the USSR. The results of adopting practices only partially proved by experience have been mixed, but success has outweighed failure. The widespread adaptation of blast furnaces to high top pressure, contrary to the conservative approach of most US concerns, yielded significant returns, but the construction of 38 plants to produce continuously cast iron sheet apparently has been somewhat less than a complete success. The contrast of rapid introduction of new technology, as typified by the USSR, and the cautious approach of the US reflects a basic difference in the two economies. The controlled economy of the USSR can apply new methods even if subsidization is required, but in the US, the ability of the unit to operate at a profit is usually the determining factor.

The application of new technology in different sectors of Soviet ferrous metallurgy has varied markedly. Soviet research has been directed primarily to blast furnace and open hearth processes and to high-temperature alloy steel for military applications, whereas attention to rolling mill and finishing line technology has until recently been deferred. Investment in technological improvements in ore preparation and ironmaking and steelmaking at Magnitogorsk and Kuznetsk, for example, has been unstinted. A conscious effort has been made to outstrip the best plants in the world and to provide models for other Soviet steel works

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* An example is the high top pressure technique developed in the US, assiduously copied by the Russians and applied to their blast furnaces with great success. As in many other fields of endeavor, however, the USSR claims that the original inventor of the technique was Russian (Yesmansky, 1915) and not an American (Avery, 1930). 324/

in "socialist competition." As a result, these enterprises are not typical Soviet steel plants. Production of crude steel per worker at Magnitogorsk in 1955 was twice that of the industry average, and at the Kuznetsk open hearths, production was 11 percent better than at those at Magnitogorsk. 325/

During the Sixth Five Year Plan period, there will be increasing stress on the role of automation* in the Soviet steel industry. Prospects for increased production from automated facilities, according to Bulganin in 1955, are good: "In ferrous metallurgy, automation of blast and open hearth furnaces has raised their productive capacities by 7 to 10 percent and obtained a 6-percent economy in fuel. Experience at the Magnitogorsk plant has shown that automation of bar mills increases their rate of production by 15 to 20 percent, reduces power input, and makes work at mills much easier." Bulganin went on to say that in 1955 the rate of introducing automated facilities was not adequate. 327/

Because automation is based on mechanization, it will be necessary first for Soviet engineers to improve substantially the level of basic mechanization and modernization in many mills. Exemplifying the Soviet lag in some areas is the fact that certain steel plant finishing processes, mechanized in the US during the 1920's and 1930's, are still performed manually in Soviet plants. Such a seemingly insignificant improvement as fluorescent lighting, essential for adequate inspection of tinplate, was installed for the first time in a Soviet steel plant in November 1954. 328/

Research on scientific and technical problems in ferrous metallurgy is supported by many Soviet institutions. Foremost among these are the Metallurgical Institute imeni A.A. Baykov of the Academy of Sciences and the Central Scientific Research Institute of Ferrous Metallurgy. The Central Scientific Research Institute has a staff of 1,800 people, of which 950 are engaged in scientific research and 850 work in the practical application of new technology. In 1955 the Institute spent 39 million rubles on research and development. Other research is performed by affiliates of the Academy of Sciences and by metallurgical institutes. The various design bureaus of the Ministry of Ferrous Metallurgy (Gipromez, Giprostal', Giprokoks, and the like)

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* Automation is the evolvement of continuous production methods, as contrasted to batch operation methods, with as many automatic self-directing and self-inspecting features as may be economically justified. 326/

are responsible for putting new technological advances into operation. The importance attached to technical achievement in the USSR is perhaps best illustrated by the granting of 250 doctorates in metallurgy in the USSR during 1955. In the same period, only 58 were given in the US. 329/

B. Preparation of Iron Ore.

No other technological achievement holds as great a prospect for increasing the productivity of existing blast furnace installations as the careful preparation of raw materials, particularly iron ore and coking coal. Preparation of iron ore consists primarily of the concentration of raw ores at the mine; the agglomeration, or sintering, of ore fines at either the mine or plant; and the use of proper bedding and blending techniques at the steel plant.

The employment of self-fluxing sinter* in the blast furnace has been increasing steadily in both the US and the USSR. Several years ago at Magnitogorsk a small rise in the sinter rate to 50 percent resulted in a 6-percent increase in production of pig iron. By 1955 the sinter content had increased to between 85 and 90 percent of the charge, and productivity again increased. Some Ukrainian furnaces operate on an all-sinter charge. Although at least one US furnace has operated on 100-percent sinter, the blends of foreign and domestic ores available to US operators at present do not necessitate such extensive preparation of materials. Soviet designers have adopted the 6- and 8-foot Dwight-Lloyd type (US) sintering strands and have achieved rates of operation comparable to the US (30 tons per square meter of hearth per 24 hours). 330/

The cost of preparing sinter other than fines and flue dust is justified economically only for ores with certain characteristics. In such cases, blast furnace production may be increased as much as 20 percent, and the initial investment for sintering facilities to feed one blast furnace is considerably less than 20 percent of the cost of one furnace. The declining quality of Soviet iron ores (partly caused by the Soviet policy of mining all grades from a deposit), the competition among all sectors of Soviet heavy industry for investment funds, and the constant emphasis on increased production tend to encourage the greater use of sinter throughout the steel industry. By 1960,

* Self-fluxing sinter contains enough ground limestone to neutralize the acidic nature of the ore fines.

judging from the Sixth Five Year Plan 73-million-ton annual goal for production of sinter, the USSR will be using sinter at a greater rate than any other country.* 332/

C. Preparation of Coke and Coking Coal.

One of the most pressing problems in Soviet ferrous metallurgy is the procurement of supplies of coking coal of satisfactory quality. Technological improvements have been directed primarily toward maintaining and improving standards in the face of increasing demands, which doubled between 1940 and 1955. As a result of extensive investment in plants for the preparation of coal, some success has been achieved since 1940 in improving quality. The ash content of all coking coal has decreased from 10.8 percent in 1940 to 10.2 percent in 1955, and sulfur content has decreased from 1.4 percent to 1.2 percent. A 1-percent reduction in ash content raises blast furnace production 2.5 percent; the same effect is also achieved by a 0.1-percent reduction in sulfur content. By 1954, preparation of coal had reached a point where 95 percent of all coking coal was cleaned mechanically. 333/

Blends of various coking coals currently are being tested in Soviet coke ovens. These tests may provide the chief avenue for expanding the coking coal base by permitting the use of poorer coals in increasing amounts. Several substitute fuels have been tested, but the use of them is limited and costly. Chief among these is lignite, or brown-coal, coke. If the USSR is using these cokes, indications are that it is on a small scale. Other substitutes tested are heat-treated, high-volatile coal; peat briquettes; peat coke; peat semicoke; and lignite-charcoal-tar briquettes. In November 1955 an experimental unit for the continuous coking of coal went into operation at the Khar'kov coke-chemical plant. 334/

D. Blast Furnace.

The level of Soviet blast furnace technology compares favorably with that of the US. Probably the outstanding achievement of Soviet furnacemen has been the use of new technology in plants such as Magnitogorsk. Here cleaned coking coal, a self-fluxing sinter rate of 85 to

* US sinter capacity on 1 January 1955 was 29 million tons; estimated 1965 capacity will be about 58 million tons. 331/

90 percent, top pressure operation, and constant blast humidification have combined to give what are believed to be the most highly productive units in the world.* 336/

In 1954 the USSR claimed that 95 percent of all pig iron was produced in "automatically controlled" furnaces. Automatic control represents a level of mechanization and instrumentation usually associated with good US practice and is typified by the blast furnace control room of the Dneprodzerzhinsk plant shown in Figure 10.** 337/

Adoption of higher gas pressures in Soviet furnaces and outright conversion to high top pressure operation, pioneered in the US, have resulted in approximately a 10-percent increase in production of pig iron, a 5-percent decrease in consumption of coke, and a 30-percent decrease in the rate of flue dust. The 1955 Soviet claim that 60 percent of Soviet furnaces operate under higher gas pressures appears to have referred to pressures up to 6.5 pounds per square inch and not the 10 to 12 pounds per square inch commonly used in true high top pressure operation. Fifteen to 20 Soviet furnaces have been converted to these higher pressures, however, compared with 10 to 15 conversions in the US and 2 in the UK. 338/ Experiments with constant humidity control have met with considerable success, in spite of the increased blast temperature required.

Blast furnace refractories have been improved, carbon hearths put into use, and hearth cooling practiced. An interesting new development, tried on at least one furnace, is the use of lead-encased radioactive cobalt capsules in the refractory lining. When the refractory is eroded to a predetermined depth the capsule falls out, and the resultant increase in the radioactivity of the molten pig iron warns of the state of the lining. 339/

The prospective development of new blast furnaces at sites having only low-grade raw materials, coupled with the decreasing quality of ore and coke at existing locations, has led to a study of unconventional blast furnace processes. In view of the availability of

* The Magnitogorsk record is 2,200 tons per day. The US record, made by the Bethlehem Steel Company at Sparrow's Point, Maryland, is 1,800 tons per day. 335/
** Following p. 114.

surplus power at the contemplated sites, the Technical Council of the Ministry of Ferrous Metallurgy, has tended to favor the electric blast furnace rather than the low-shaft blast furnace. 340/

A comparison of the economics of the standard coke blast furnace process and of the electric blast furnace process indicates that the production of electric blast furnace pig iron, using concentrated low-grade iron ores and poor-quality coke, would be advantageous if located near cheap and abundant hydroelectric power, such as on the Angara, Amur, or Zeya Rivers in Siberia or in some areas of the Karel'skaya ASSR. Although furnace production is small compared with conventional furnaces, the low investment required has induced the Ministry of Ferrous Metallurgy to construct a large experimental furnace to study this relatively little-used process.* 341/

E. Steelmaking.

The level of technology in Soviet steelmaking compares favorably with that of the US, on which, in fact, Soviet furnace design and operation is based. Although Soviet steelmaking technology is most advanced in the application of oxygen in open hearth furnaces, other important developments are the extensive use of chrome-magnesite refractories, the use of large furnaces, continuous casting, and the formulation of plans to introduce the oxygen converter process.

The extensive use of oxygen in open hearth furnaces normally increases production of steel 10 to 17 percent and decreases conventional fuel inputs 5 to 10 percent. The first Soviet use of oxygen on an industrial scale occured in 1948. Maximizing production has always been the cardinal tenet in Soviet operations and seems to account for Soviet plans to use oxygen on a massive scale during the Sixth Five Year Plan period. By 1960, oxygen enrichment will be employed to produce a minimum of 45 percent of the open hearth production of steel. A recently constructed oxygen plant is the 10,000-cubic-meter-per-hour unit at Nizhniy Tagil shown in Figure 11.** 342/

* Other installations are found in Norway, Switzerland, India, and Italy.
** Following p. 116.

50X1

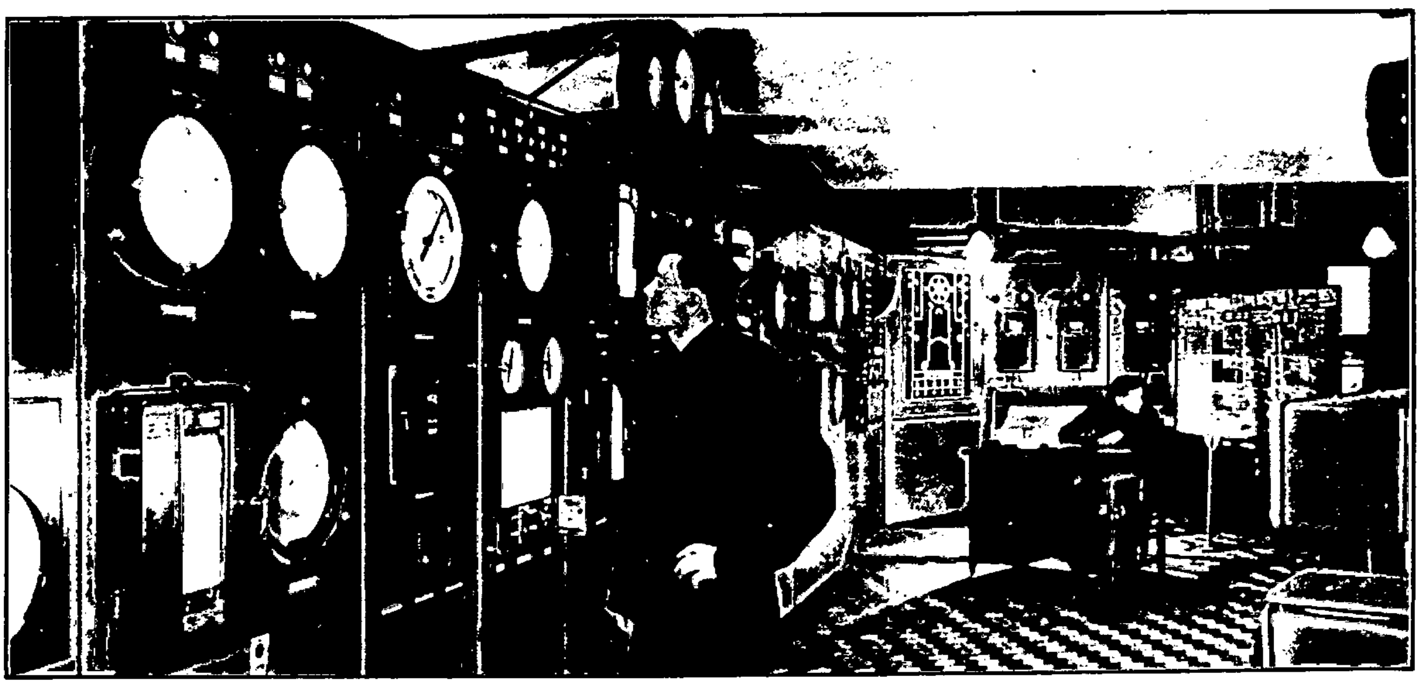

Figure 10. Blast Furnace Control Room of the Dneprodzerzhinsk Metallurgical Plant, 1955.

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50X1

The use of oxygen at Zaporozh'ye and the installation of chrome-magnesite roofs in the ten 200-ton open hearths effected a 20-percent increase in capacity between 1953 and 1955. Present enrichment practice at Zaporozh'ye is to add enough oxygen to raise the content of the intake air from 21 to 25 percent oxygen; Soviet operators believe that the content can be raised to 30 percent without destroying the furnace roof. The net result has been a 17-percent reduction in smelting time (smelting time decreased from 9.8 hours per heat to 8.1 hours) with a corresponding increase in annual furnace capacity. 343/

The oxygen converter is now in successful commercial operation in Austria, Canada, and the US. Although it is not in operation in the USSR, tests with experimental models have been carried out at Tula and Yenakiyevo. The Ministry of Ferrous Metallurgy intends to introduce this process during the Sixth Five Year Plan period. Bessemer converter plants at Dnepropetrovsk and Dneprodzerzhinsk are scheduled for conversion during 1956. The principal advantages of the process are its greater productivity when compared with conventional converters, its low investment and maintenance costs when compared with open hearth furnaces, and quality equal for some products to open hearth steel. 344/

The large-scale replacement of silica refractory brick by chrome-magnesite brick for roofs of open hearth furnaces has increased the productivity of Soviet furnaces by lengthening the time between repairs. The technology of chrome-magnesite refractories is well known the world over, but the cost discourages their wider application. It is probable that the USSR has introduced chrome-magnesite on a larger scale than has the US and has achieved slightly better roof life. Introduction of the all-basic furnace (one with chrome-magnesite hearth, wall, roof, checkers, and uptakes) is planned but will be deferred until most Soviet furnaces have had their roofs converted and until the productive capacity for chrome-magnesite refractories is increased. 345/

The technology of the operation of very large furnace units is restricted to the US and the USSR. At the present time, one 500-ton open hearth furnace is in operation at the Voroshilov Metallurgical Plant in Voroshilovsk. The world's largest open hearth, a 545-ton unit, is under construction at Weirton, West Virginia. Electric furnaces, which are now closely competitive on a cost basis with open hearths, are moving out of the traditional 25- to 50-ton size in both countries. The US has 180-ton units in operation, and the USSR is thinking in terms of 80- and 180-ton units. Such technical innovations as jet tappers and induction stirrers, used for open hearths and electric furnaces, respectively, are well established in the US but are only in the planning stage in the USSR. 346/

There are at least two continuous steel-casting installations in the USSR. The 50-ton-per-hour unit at Gor'kiy in the Krasnyy Sormovo Works is a twin-strand machine consuming the production of four open hearth furnaces. The other unit is at Tula. By eliminating the blooming mill unit, continuous casting permits a substantial saving in investment as well as an increase in yield. 347/

F. Alloy Steel.

Information on production technology applied to Soviet alloy steels -- as distinguished from alloy steel research* -- is scarce. The vacuum melting process, however, deserves mention. The process is in fairly wide use in the US, and its importance lies in the uniform high quality of the product for aircraft, electronics, specialty steel, and tool steel uses. Vacuum melting and casting is employed in the USSR, but to what degree and for what purposes are not known. 348/

G. Rolling Mill and Finishing Line.

The level of technology in Soviet rolling mill and finishing line equipment is notably inferior to that in the US, largely because in the USSR, emphasis has been thus far on the development of ironmaking and steelmaking facilities. Typical of obsolete practices in the Soviet design of rolling mills and finishing lines is the new 300-millimeter (mm) bar mill with hand-operated screw-downs (the large wheels on each stand) located at the Chelyabinsk Bakal plant. (See Figure 12.**) Soviet rolling mill designers and machine builders have achieved some success, however, with some of the simpler types of mills, particularly those for rolling blooms and rails. 349/

Basic organizational difficulties and obsolescent design and production techniques at heavy machine building plants like Uralmash and Novo-Kramatorsk resulted in an underfulfillment in the planned production of rolling mill equipment in 1953, 1954, and 1955.

* See IV, p. 23, above.
** Following p. 116.

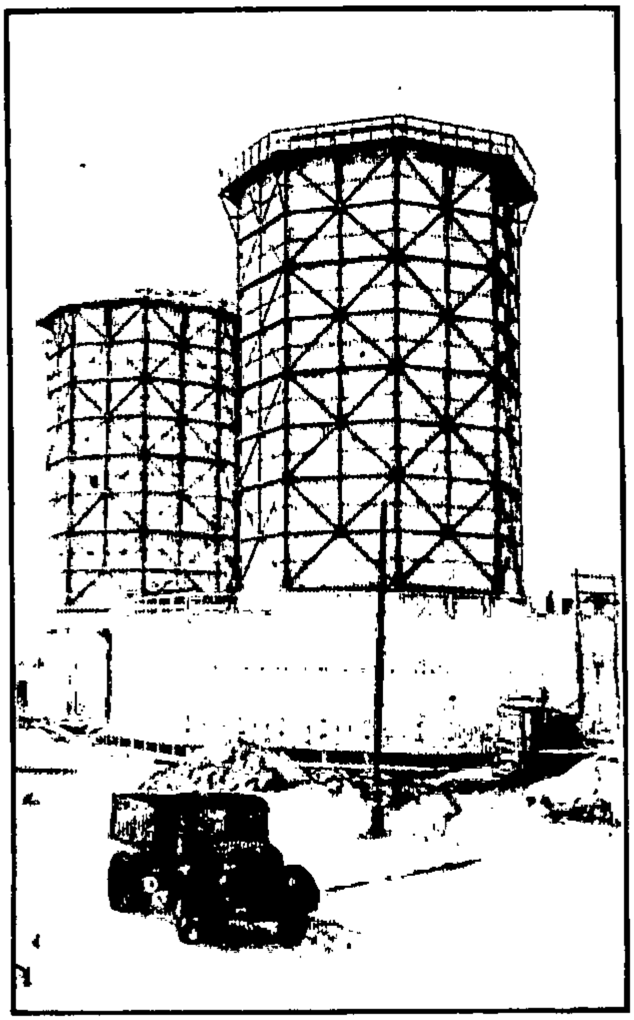

Figure 11. Oxygen Installation Under Construction at the Nizhniy Tagil Metallurgical Plant, 1955.

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50X1

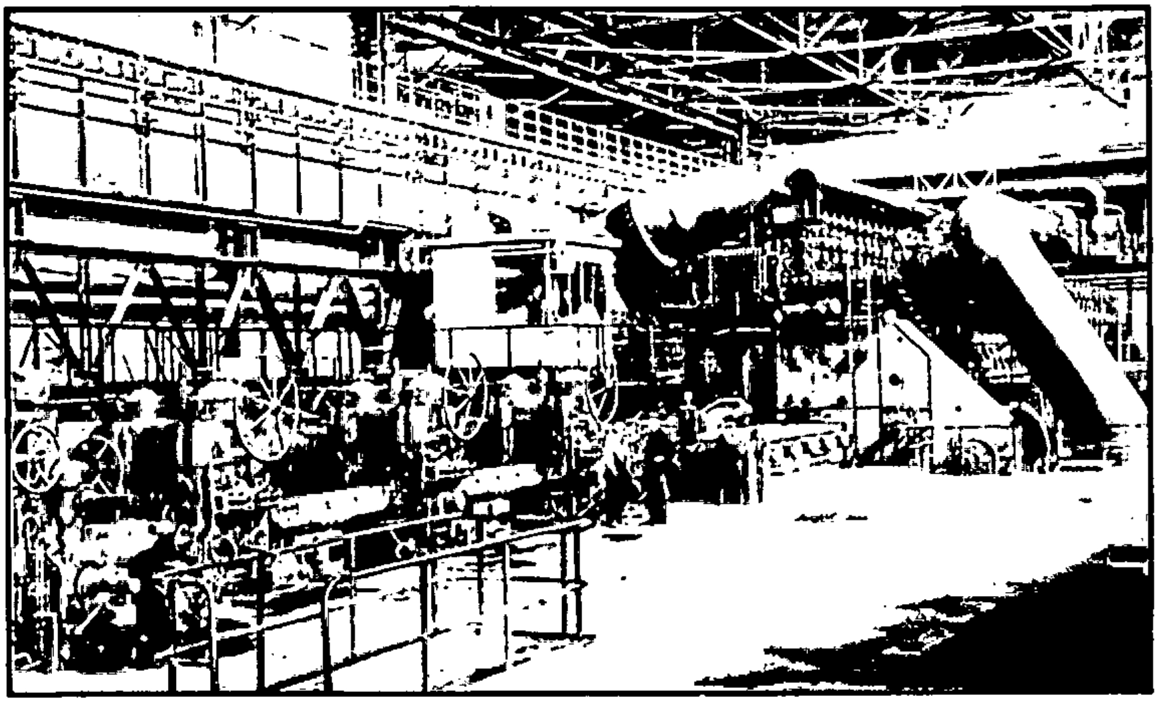

Figure 12. A 300-mm Bar Mill in the Rolling Mill Division of the Chelyabinsk Metallurgical Plant (Bakal), 1955.

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50X1

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During 1954 and 1955 the USSR undertook the design and construction of continuous hot and cold sheet and strip mills. At present the US has about 35 continuous hot sheet mills; the USSR has only 3 or 4 in operation and several under construction. 350/ The manufacture of these highly productive mills requires a considerable degree of technical competence, a competence that is confined primarily to two US companies. With the partial relaxation of COCOM controls in 1954, the USSR, believing that it could obtain prototypes for copying, placed an order for a 5-stand continuous cold strip mill with a British company that was building such mills under license from a US firm. When the embargo on rolling mills was not modified, the USSR renewed its own construction efforts on sheet and strip mills. Scheduled to go into operation at Magnitogorsk in the near future is a Soviet-designed and manufactured 10-stand, 4-high continuous hot sheet mill with a speed of 2,000 feet per minute. If this mill is 100 inches wide, as reported, it will be the widest in the world. Also under construction is a similar 68-inch mill.

There are numerous categories of final processing and finishing equipment important to high quality in the finished product. Since World War II, notable technical advances have been made in the US in electrolytic tinning lines and continuous pickling, annealing, and galvanizing lines. The degree to which the USSR has lagged in this field is highlighted by the existence in the USSR of only one electrolytic tinning line, only a few continuous pickling lines, and no known continuous sheet annealing or galvanizing lines. Facilities of this kind are common in the US. 351/

X. Costs.

A. Cost Accounting and Analysis.

The introduction and application of cost accounting procedures (khozrazchet) as a means of effective economic control in the Soviet steel industry lagged for some time behind the development of accounting procedures in other Soviet industries. Beginning in the latter years of the Fourth Five Year Plan, however, considerable attention was given to the improvement and enforcement of cost accounting in the steel industry. A stimulus was provided by the elimination of the subsidy, made possible by the 1949 increase in the wholesale price of steel products. Poor accounting procedures and incomplete knowledge of actual costs were partly responsible for the error in overestimating the price rise necessary for the elimination of the subsidy.* 352/

The USSR defines cost of production at the metallurgical enterprise (zavodskaya sebeststoimost' or fabrichnaya sebeststoimost') as the sum of the cost of raw materials, the cost of conversion, and general plant expenditures. When costs of warehousing and transporting finished products from the plant or warehouse of Glavmetallosbyt' to the consumer's freight station are added to the plant cost of production, the sum is known as the total cost of production (polnaya sebestoimost'). The value (stoimost'), or wholesale price of the product at the station of destination, is the sum of the total cost of production and the planned profit. Currently no turnover tax is applied to finished steel products. 353/

The system of cost accounting used in the Soviet steel industry does not differ markedly from systems in operation elsewhere. Analyses of costs are used to determine the profitability of the enterprise, process, and products; to assist in establishing prices; to determine planned costs and cost reductions for the next plan year; to compare actual and planned costs; and to determine whether or not planned cost reductions have been achieved.** 354/

* See XI, p. 125, below.
** It is important to note that when such statements are made as "the cost of production in ferrous metallurgy was reduced 3 percent in 1954 compared with 1953" and "the cost of production at Magnitogorsk is planned to be reduced 4.3 percent in 1954 compared with 1953," the statements normally are based on reductions in plant cost of comparable production (sravnemaya produktsiya), which compares the production of the same group of products for two different time periods. Such comparisons

B. Cost Structure.

The primary factors influencing costs in ferrous metallurgy are the level and degree of technical development, the organization of production, the level of wages, freight rates, and the wholesale price of raw and other materials purchased. The components of cost in the ferrous metallurgical industry of the USSR in selected years, 1930-55, are shown in Table 31.

Table 31

Components of Cost in the Ferrous Metallurgical Industry of the USSR a/
Selected Years, 1930-55

Percent

Items of Cost	1930	1933	1940	1948	1949 b/	1951 c/	1955 d/
Raw and primary material	25.8	22.7	41.0	31.8	32.5	43.8	42.0
Auxiliary and other material	7.0	8.1	7.1	6.2	5.1	5.5	5.6
Fuel e/	22.2	15.9	18.1	12.5	10.4	18.6	22.5
Electric power and steam e/	0.6	1.6	1.6	1.4	2.9	1.8	1.6
Basic wages and bonuses	34.9	39.2	22.2	39.5	38.8	23.3	20.7
Amortization	3.4	4.3	3.5	4.6	5.2	4.0	5.1
Other monetary expenditures	6.1	8.2	6.5	4.0	5.1	3.0	2.5
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0

a. 355/
b. These figures exclude the effects of the 1949 price change.
c. These figures include the effects of the 1949-51 price changes.
d. These figures are given in terms of current 1955 prices.
e. These figures include only that portion obtained from outside the industry.

do not necessarily reflect total cost conditions in the enterprise accurately; they do not account for the output of new, and hence noncomparable, products or production (nesravnemaya produktsiya).

The large increase between 1933 and 1940 in the relative cost of raw materials was caused by the increase in prices of these materials in 1936. After 1941 the decrease in the costs of raw materials was caused by increases in wage levels during and after World War II, while costs on materials were held almost constant. The upward adjustment in the price of raw materials in 1949 again caused an increase in the share of cost accounted for by raw materials.

The approximate relationship of components of cost in the steel industries of the US and the USSR in 1951 are shown in Table 32.

Table 32

Approximate Relationship of Components of Cost in the Steel Industries of the US and the USSR a/ 1951

Percent

Item of Cost	US	USSR b/
Materials and services	49.0	69.7
Wages	34.5	23.3
Amortization	3.4	4.0
Other	13.1 c/	3.0
Total	100.0	100.0

a. 356/
b. Soviet data include a greater amount of mining activity.
c. This figure includes provisions for taxes and interest charges.

Components of cost in the ferrous metallurgical industry of the USSR, by producing unit, in 1954 are shown in Table 33.*

* Table 33 follows on p. 122.

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Table 33

Components of Cost in the Ferrous Metallurgical Industry of the USSR by Producing Unit a/
1954

Percent

Item of Cost	Producing Unit: Iron Ore Mining	Limestone Quarrying	Coke-Chemical Plant	Integrated Steel Plant	Tube Mill
Raw and primary materials	0	0	82.4	27.5	67.9
Auxiliary and other material	19.5	14.3	2.1	6.1	2.5
Fuel b/	2.2	9.3	0	38.0	4.4
Electric power and steam b/	3.0	4.4	1.8	1.3	1.8
Basic wages and bonuses	59.5	54.3	8.5	15.4	18.2
Amortization	10.0	12.7	4.0	7.3	3.1
Other monetary expenditures	5.8	5.0	1.2	4.4	2.1
Total	100.0	100.0	100.0	100.0	100.0

a. 357/
b. These figures include only that portion obtained from outside the industry.

C. Cost-Price Relationship.

In the Soviet steel industry the difference between cost and price is termed profit (pribyl') or intraindustry accumulation (vnutri-promyshlennoye nakopleniye). Profits serve as an incentive toward and a measure of more efficient operation. Reductions in wholesale steel prices in 1952 and 1955 would seem to indicate that as annual planned decreases in the cost of production are made prices also are adjusted downward.

As a result of the 1949 price increase in the USSR, prices of steel exceeded costs for the first time since before World War II, and subsidization of the steel industry ended. All-union wholesale prices are based on the cost of production at an average or typical plant, however, and a number of enterprises with high production costs are operating at planned losses and are subsidized by low-cost operations elsewhere in the industry.

The cheapest steel in the USSR is produced by the Magnitogorsk complex, where low-cost iron ore and investment in technological improvements have resulted in lower costs -- in terms of per unit of output -- for raw materials, conversion, and labor. Pig iron, which is uniformly priced throughout the USSR, costs only one-half as much to produce at Magnitogorsk as it does in blast furnaces at Ukrainian plants. The cost of a ton of steel ingots at Komsomol'sk (Amurstal' plant) in the Soviet Far East is 1.5 times greater than at Magnitogorsk. At the many small plants of the Chief Directorate of Urals Metallurgy (Glavuralmet) the cost of pig iron is from 3 to 4 times greater than at the leading plants, and production per worker is only 40 percent of the average in the industry. 358/

XI. Prices.

A. System.

Wholesale prices (optovyye tseny) of finished steel in the USSR are established by the Main Administration of Metal Sales (Glavmetallosbyt) of the Ministry of Ferrous Metallurgy with the approval of the Soviet Council of Ministers. These delivered wholesale prices are uniform throughout the USSR -- that is, 1 ton of ordinary carbon bars costs 545 rubles whether it is sold in Leningrad, in Tashkent, or in Khabarovsk. Wholesale prices established for other products of the industry, such as pig iron or ferroalloys, are also believed to be uniform, or all-union, prices. Two known exceptions to this system are iron ore and coking coal, which are priced regionally, and it is probable that other ores are also priced regionally. 359/

Before 1951 a price system "f.o.b. the warehouse of the seller" (franko stantsiya otpravleniya) had been in effect. Since 1951 the price system "station of designation" (franko stantsiya naznacheniya) has been used. Under this system the wholesale price is quoted for steel delivered to the railroad station or steamship wharf designated by the buyer. This delivered price includes the cost of production, a planned profit (or loss), a nominal charge by Glavmetallosbyt for storage and handling, and an average transportation charge. Intraindustry transfers of semifinished steel are based on wholesale prices "station of designation." Currently, with a few minor exceptions, there is no turnover tax or sales tax applied to the products of the steel industry.* 360/

Although the wholesale price as described is believed to be in effect as the actual transfer or exchange price, additional charges are made for deviations from standard specifications. These "extras," as they are known in the US steel industry, are not applied as widely in the USSR as in the US, but in general, Soviet extras do cover the ordering of special shapes and sizes, added guarantees of physical and chemical specifications, and certain minimum quantities. (Steel plants will not ship less than carload lots without penalty.) Special prices to certain ministries can be permitted with the consent of the Council of Ministers, but none has been noted. 361/

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* A turnover tax is applied to the sale of blast furnace slag, distilled water, electric power, and manufactured metal products (metiz) sold outside the industry.

Soviet steel prices are found in the price catalogs of the Ministry of Ferrous Metallurgy and of other ministries consuming steel. The catalogs contain detailed price lists; extra charges (priplaty); deductions (skidki); and physical and chemical standards, or GOST's. The latest available set of these catalogs contains prices effective 1 July 1955. Another source of prices are the catalogs published by planning and construction organizations and designed for use in estimating construction costs. Prices in these lists are often highly aggregated, and in many cases, ruble prices are historic rather than current.

B. Policy.

The basic Soviet pricemaking policy is to set prices at a level at which the average plant can earn a profit for the state and for reinvestment.

The large upward revision in the price of steel in 1949 marked the end of the policy of subsidization that had existed before that time. The magnitude of those subsidies was revealed by the threefold increase in steel prices. In spite of this change in policy, at least one mill, the new Rustavi combine, operated at a planned loss in 1955. In effect, the level of all-union steel prices was not sufficiently high to counterbalance the effect of the Rustavi combine's dependence on high-cost and poor-quality Dashkesan iron ore* and Tkibuli and Tvarcheli coking coal. The new Northwest Metallurgical Combine at Cherepovets probably operated at a planned loss in 1955, and it is expected that subsidies will continue there for some time. The two plants enhance the self-sufficiency of the regions where they are located, and the government may feel that the losses are justified.** 362/

* Under the system of regional prices for iron ores, Dashkesan ore concentrates are 31 rubles per ton, and Krivoy Rog concentrates are only 22 rubles per ton.

** These losses, in whole or in part, may not be real, for the all-union uniform prices probably do not reflect the freight advantage of these two plants in their local markets: that is, the total cost of production (polnaya sebestoimost') of steel from the nearest alternative source may be greater in the Baku and Leningrad markets than the total cost of Cherepovets and Rustavi Steel.

Before the price changes of 1 January 1952 and 1 July 1955, Soviet price policy was designed to control the demand for the scarcer alloying materials. Inspection of 1950 ruble/dollar price ratios indicates that this policy was implemented by the establishment of a higher price on alloying ores and alloy steel, relative to ordinary or carbon grades, than would appear to be justified by cost relationships. A typical example was cold-rolled nickel-bearing stainless steel strip, with a ruble/dollar price ratio of 24 to 1 as against a ratio of 12 to 1 for cold-rolled carbon strip. These stainless steels contain only about 8 to 10 percent nickel. For almost pure nickel metal, the ruble/dollar ratio was 37 to 1, and for strategic cobalt the ratio was 103 to 1. Also, discriminatory pricing apparently was unemployed to discourage the demand by consumers for relatively scarce unalloyed nonstrategic items, such as hot-dip tinplate which has a ruble/dollar ratio of 43 to 1. 363/

Since the price changes of January 1952 and July 1955, evidence definitely indicates an adjustment of internal Soviet steel prices toward the price relationships found among steel products in the US. Proof of this is the preponderance of July 1955 ruble/dollar ratios for finished steel products, falling between 5 and 6 to 1 regardless of whether the steel is of a carbon, alloy, or stainless grade. This apparent modification of policy is best exemplified by nickel-bearing stainless types. In 1950, various stainless steel products had ratios 100 percent above the average for all finished steel, and in 1955 the ratios were both above and below, but quite close to, the finished steel average of 5.6. Pending the availability of more 1955 price data, the tentative conclusion is that the policy of discriminatory pricing is disappearing and that the actual cost of production seems to be the principal factor determining the price. 364/

Before 1951, Glavmetallosbyt supervised the allocation of steel but had no responsibility for the cost of freight; the consumer paid all freight charges but had no control over the selection of suppliers. Glavmetallosbyt had no tangible incentive to effect economies by the elimination of excessively long and needless transport. Partly for this reason the average haul of ferrous metals increased from 966 kilometers in 1940 to about 1,177 kilometers in 1951. 365/

The responsibility of Glavmetallosbyt was greatly increased by the change to pricing by station of designation and by the establishment of freight tariffs based on the average haul of 13 major categories of finished steel. As a result, if the actual transport distance is greater than the established norm, Glavmetallosbyt loses money; if it is less than the norm, Glavmetallosbyt makes a profit, part of which it retains. Average transport charges for ferrous metals constitute 5 percent of the wholesale price at the station of designation. The introduction of the new price system resulted in a 122-kilometer decrease in the average haul of ferrous metals between 1951 and 1955, although in the latter year it was still greater than in 1940. 366/

There is little available information on the Soviet policy for pricing exports to other countries of the Sino-Soviet Bloc and to the Free World. Pig iron, which for the last few years has been moving in quantity to the UK, Belgium, West Germany, and Italy, has been selling at less than domestic prices in those countries. In 1955, Soviet pig iron was selling at 267 West German Marks per metric ton c.i.f. Duisberg, which is 5 to 10 percent below the West German domestic price. Prices of the 1 million tons of finished steel to be shipped by the USSR to India over the next 3 years are variously quoted as equal to or greater than European Coal and Steel Community prices. 367/

C. Trends.

The historical trend of Soviet prices of finished steel has been one of relatively long periods of unchanged prices followed by large upward adjustments. Since 1 January 1950, however, the three price changes of 1 July 1950, 1 January 1952, and 1 July 1955 have been downward revisions.

During the period from 1928 to 1936, steel prices were held nearly constant, and the cost of production rose primarily because of increased wage rates. This necessitated subsidization of the steel industry. The prime objective of the 1936 upward price adjustment was the elimination of subsidies. After this adjustment, except for an average 30-percent price rise in 1939, steel prices remained constant until 1949. Although planning and production accounting were simplified by leaving prices unchanged, wartime inflation and rising costs of production again required heavy subsidies in the period after World War II. 368/

The price decrees of 1949, aimed again at the elimination of subsidies, raised steel prices threefold. The increase apparently was greater than necessary, and on 1 January 1950, prices of ordinary finished steel were cut almost 30 percent. Since 1950, prices of ordinary finished steel have decreased from 10 to 20 percent, and the decrease in the price of quality steels has been markedly greater.. 369/

Price changes in ordinary finished steel have not always been followed by changes in quality and in alloy grades. On the other hand, quality grades have been revised when no change was made in the price of ordinary steel -- for example, the small adjustment of 1946. Prices of quality steel have been characterized by considerably smaller fluctuations than have those of ordinary steels, except for the 1 January 1952 revision, which cut prices of stainless steel 35 to 45 percent. 370/

D. Ruble/Dollar Price Ratios.

A comparison of ruble prices for products of the Soviet ferrous metallurgical industry with dollar prices for comparable items produced in the US throws some light on the dollar value of the ruble, in terms of these products, and on the points of divergence of the two parallel price structures.

Ruble/dollar price ratios for a comprehensive list of products of the steel industry and Soviet wholesale prices for various years are shown in Appendix A, Table 44.* Weighted ruble/dollar ratios in sectors of the ferrous metallurgical industry of the USSR, by US Standard Industrial Classification Number, in 1950 and 1955 are shown in Table 34.**

Ratios of individual items indicate that over-all internal prices for Soviet iron and steel products in 1955 are basically related to cost and availability. The relatively low prices for electric furnace ferrosilicon, ferromanganese, and ferrochrome, for example, probably reflect both the abundance of these ores in the USSR and the low cost of the hydroelectric power serving some of the ferroalloy works.

* P. 162, below.
** Table 34 follows on p. 130.

Table 34

Weighted Ruble/Dollar Ratios in Sectors of the Ferrous Metallurgical Industry of the USSR, by Standard Industrial Classification Number a/
1950 and 1955

Classification Number	Sector	Ruble/Dollar Ratio
3311	Blast furnace (1950)	9.0
3312	Steel plant (1950)	11.0
3312	Steel plant (1955)	5.6
3313	Ferroalloy plant (1950) b/	7.5
3321	Gray iron foundry (1950)	11.6
3322	Malleable iron foundry (1950)	13.0
3323	Steel foundry (1950)	10.7
3391	Steel forging plant (1950)	13.8

a. 371/
b. Based on electric furnace ferrosilicon, ferromanganese, and ferrochrome.

XII. Investment.

Little information is available on the magnitude of investment in the ferrous metallurgical industry of the USSR. Capital outlays since the Fourth Five Year Plan (1946-50) can be estimated only by applying tenuous assumptions to inadequate data.

The Fourth Five Year Plan budgeted approximately 27 billion rubles* for investment in ferrous metallurgy. 372/ This program was not fulfilled, however, and actual investment has been estimated at about 23 billion rubles. 373/

During the period of the Fifth Five Year Plan (1951-55), construction for both ferrous and nonferrous metallurgy reportedly increased 1.8 times above that in 1946-50, 374/ but only 77 percent of the construction planned for the Ministry of Ferrous Metallurgy was accomplished. 375/ Assuming an equal rate of increase in investment in ferrous and in nonferrous metallurgy, expenditures for ferrous metals may have been about 41 billion rubles. Investment in iron ore mining, 7 billion rubles, 376/ presumably is included in the total for ferrous metallurgy as a whole.

The Sixth Five Year Plan (1956-60) provides for an increase of almost 100 percent in total capital investment in the Soviet ferrous metallurgical industry. 377/ This increase would indicate a level of investment approximating 80 billion rubles -- equal to about 13 percent of the planned capital investment in all industry and to about one-fifth of that in heavy industry. Apparently included in total investment are capital outlays of 20 billion rubles in iron ore mining. 378/ The almost threefold increase in capital expenditures in iron ore mining in 1951-55 reflects the heavy emphasis given in the current Plan to the expansion of ore production and the construction of ore treatment plants. It also reflects the fact that capital expansion in iron ore mining during the previous Five Year Plan was greatly below expectations. Presumably, a portion of the large increase planned for 1956-60 is, in effect, a carryover from the preceding period.

The planned 1956-60 increase of 100 percent in capital investment in the Soviet ferrous metallurgical industry is considerably

* Unless otherwise indicated, investment data are given in terms of 1955 prices.

greater than the planned percentage increase in steelmaking capacity because of (1) the substantially larger investment in facilities for mining and processing ores, (2) the apparently larger role of new plant construction as opposed to expansion of existing facilities as sources of additional capacity, and (3) increasing capital costs per unit of production.

The average capital cost of crude steel capacity to be added in 1955-60 apparently is about 3,000 rubles per ton. This is about 30 percent larger than the average of 2,300 rubles per ton indicated for the preceding Plan period. Capital costs of new construction at new plants, per ton of steel, have increased 15 to 20 percent since the beginning of the Fifth Five Year Plan period. 379/

During 1951-55, when the cost of a ton of added capacity in the USSR averaged about 2,300 rubles, the US cost averaged about US $211 per ton. Assuming that this ruble/dollar ratio of 11 to 1 is applicable to the current Plan period, the cost of an added ton of capacity in the USSR would be approximately US $273 in 1956-60. A figure for the US is not available for the same period, but the contemplated investment in the US iron and steel industry in 1956-58 will cost an average of about US $265 per ton.

The over-all calculated capital cost of 2,300 rubles per ton in the USSR in 1951-55 is in line with a similar figure calculated for the Rustavi metallurgical plant, much of which was constructed during 1951-55. Total investment at this plant is said to be 1.8 billion rubles, of which 1.5 billion were spent on the plant and 300 million on housing and other nonproductive facilities. 380/ This represents a capital outlay for production facilities of 2,500 rubles per ton of crude steel capacity, which, if converted on an 11 to 1 ruble/dollar ratio, is about US $227 per ton.

Funds allocated to an enterprise in the Soviet state budget provide the major source of investment capital. Expenditures also are made from the director's fund, which represents a portion of profits. Amortization accounts, accumulated on a specified percentage basis, provide funds for capital repairs and for replacement of worn-out equipment. 381/ At the present time, the director of an enterprise has authority to spend up to 3 million rubles without obtaining detailed clearance of a proposed project. A ceiling of 25 million rubles is imposed on chief directorates, and the Ministry of Ferrous Metallurgy may authorize expenditures of up to 130 million rubles without detailed approval from the Soviet Council of Ministers.

XIII. Employment, Labor Productivity, and Wages.

A. Labor Force.

In 1955, about 590,000 workers were employed in the Soviet ferrous metallurgical industry, including iron, manganese, chrome, and vanadium ore mining; limestone quarrying; ferroalloy plants; coke-chemical plants; and iron and steel plants. Another 40,000 to 70,000 persons were employed in the administrative structures of the Ministry of Ferrous Metallurgy, its chief directorates and trusts, and the Ukrainian Ministry of Ferrous Metallurgy. Not included in these figures are the employees of the Ministry of Nonferrous Metallurgy who are engaged in the mining of tungsten, molybdenum, nickel, and cobalt and who are estimated to number less than 30,000. The estimated labor force in the ferrous metallurgical industry of the USSR in 1955 is shown in Table 35.

Table 35

Estimated Labor Force in the Ferrous Metallurgical Industry of the USSR a/
1955

Sector of Industry	Number of Employees (Thousand)
Iron ore mining	71
Manganese ore mining	16
Limestone quarrying	9
Ferroalloy production b/	30
Coke-chemical plants	53
Iron and steel plants	411
Administration c/	40 to 70
Total	630 to 660

a. 382/. Employment figures shown in this table are closely comparable with the data shown in source 383/. In that source, employment is derived from a breakdown of the total industrial labor force. There were no known occurrences of slave labor in the industry during 1955. German prisoners of war were employed at the Revda and Pervoural'sk

Table 35

Estimated Labor Force in the Ferrous Metallurgical Industry
of the USSR
1955
(Continued)

steel plants in 1954. Whether or not any are still employed is unknown; but, in any case, they are no longer of importance in the labor force.

b. Included in this sector are chrome ore miners attached to the Aktyubinsk ferroalloy combine; not included are the fewer than 30,000 workers engaged in the mining of other alloying ores.

c. Administrative personnel at the enterprise level are included in other sectors.

The steel industry proper (excluding mining, quarrying, and production of ferroalloys employed 504,000 to 534,000 workers in 1955. The comparable labor force in the US steel industry in 1955 was 650,000. The Soviet Ministry of Ferrous Metallurgy employs more than 85 percent of the ferrous metallurgical labor force; the remainder are employed, for the most part, in nonintegrated steel plants controlled by other ministries. 384/

The Ministry of Ferrous Metallurgy classifies its personnel as either "industrial-production" or "nonindustrial." The latter category, which is relatively unimportant, includes people engaged in nonindustrial activities controlled by the plant director -- housing, schools and cultural affairs, canteens and company stores, transportation facilities outside of the plant, capital repair of buildings and equipment, and the like. The category of industrial-production personnel, which includes most of the employees within the plant, is subdivided further into manual workers of all skills; engineers and technical workers; apprentices and students; officeworkers; and guards, messengers, char force, and the like. An analysis of the 1955 industrial-production labor force at 4 Soviet steel plants typical of the industry shows that workers composed 81 percent; engineers and technicians, 9.7 percent; officeworkers, 4.2 percent; the guards, messengers, and char force category, 4.5 percent; and apprentices, 0.6 percent. 385/

Women constitute 20 to 30 percent of the labor force of a Soviet steel plant. In planning the industrial labor force the Ministry of Ferrous Metallurgy uses a 20-percent factor for the portion of women in the total. In actual practice, however, the number of female workers may reach 30 percent of the total, and in some plants about 40 percent of the labor force are women. In Soviet steel plants, women do virtually all kinds of work, including operating cranes and carrying bricks. 386/

About 39 percent of the workers at integrated steel plants in the USSR are engaged in basic production activity, 20 percent in maintenance and repair, 24 percent in transport, 6 percent in the generation of power, 3 percent in scrap preparation, 3 percent in technical and quality control, 3 percent in producing consumer goods, and 1.5 percent in plant laboratories. The number of workers engaged directly in production activities varies substantially from plant to plant. It reaches 60 percent in nonintegrated steel plants and drops to 19 percent at the Krivoy Rog iron ore mines, where there are only 7,600 miners in a labor force of 40,000. Production and employment at the Magnitogorsk steel plant in the USSR, by department, in 1955 are shown in Table 36.* 387/

B. Labor Productivity.

Changes in labor productivity in the Soviet steel industry are primarily reflections of the emphasis on capital investment and technological advancement, but the supply and skill of labor and the ability of the Ministry of Ferrous Metallurgy to organize the factors of production are elements of some significance. When correctly interpreted, the level of labor productivity, or production per worker, may serve as another tool with which to effect a comparison between the Soviet steel industry and the steel industries of other countries. A lack of detailed, industrywide postwar information permits, however, only general observations.

In the Soviet steel industry, labor productivity is considerably lower than it is in the US industry. In 1955, US production per worker was 163 tons of crude steel, and Soviet production per worker amounted to only 88 tons, equal to 54 percent of the US figure.

* Table 36 follows on p. 136.

Table 36

Production and Employment at the Magnitogorsk Steel Plant in the USSR by Department a/
1955

Department	Production	Employees
Iron ore mining		
Mining		878
Washing and dressing		1,071
Sintering		830
Transport and other		1,471
Total	10.80 million metric tons per year	4,250
Coke and byproducts	5,180,000 metric tons of coke per year	1,931
Blast furnace	5,450,000 metric tons of pig iron per year	791
Open hearth	5,790,000 metric tons of crude steel per year	2,270
Rolling mills	4,540,000 metric tons of finished steel per year	6,296
Refractory	131,000 metric tons of refractories per year	770
Foundry	216,000 metric tons of iron castings per year	1,106
Raw material handling		788
Powerhouses	273,000 kilowatts (capacity)	871
Electrical maintenance	350 motors per month	257
Pipe and weld shop		948
Mechanical maintenance	1,200 units per month	866
Laboratory and technical control		1,253
Engineering, technical staff, and main office		689

a. 388/

Table 36

Production and Employment at the Magnitogorsk Steel Plant in the USSR
by Department
1955
(Continued)

Department	Production	Employees
Rail transport	33,500,000 ton-kilometers per month	1,232
Loading and reloading	1,577,000 metric tons of material per month	456
Water	70,000,000 cubic meters per month	264
Storage		143
Guard force		483
Dining room staffs		858
Other		5,937
Grand total		32,459

A similar calculation for 1952 showed UK production per worker to be only 50 percent of that of the US. 389/

The salient achievements of labor in Soviet ferrous metallurgy are summed up by the following: "From 1928 to 1937 labor productivity in ferrous metallurgy increased 204.4 percent. If the productivity of one worker in 1940 is taken to represent 100 percent, then in 1954 labor productivity for the entire metallurgical industry increased 74.2 percent. Labor productivity increased 89.5 percent in the blast furnace shops, 80.9 percent in the open hearth shops, and 44.8 percent in the rolling mills. In 26 years (1928-1954) labor productivity in the ferrous metallurgical industry increased by seven times. The average increase for each year was 7.6 percent." In 1953 and the first 6 months of 1954, however, many enterprises -- and the industry as a whole -- did not fulfill plans for increasing labor productivity. Great improvement obviously has been made, but the 1928 productivity base was very low by any standards. Because the statistics on productivity are not defined, they can be used for comparative purposes only, and they must be used with great care. 390/

Within the USSR, between blast furnace and open hearth shops on the one hand and rolling mills on the other, and also among metallurgical plants, there exist vastly different levels of labor productivity. While the labor productivity in blast furnaces and open hearths was increasing from 80 to 90 percent between 1940 and 1954, labor productivity in rolling mills increased only one-half as much. This difference reflects the investment lavished on the technological improvement of blast furnaces and open hearths. The spread among plants is indicated by the fact that at Magnitogorsk, production of pig iron per worker was 3.5 times and of crude steel 2 times the average for the Ministry of Ferrous Metallurgy in 1955. The very high level at Magnitogorsk results from a supply of well-prepared raw materials; large, technologically advanced furnace units; and a concerted effort to provide for other steel plants a goal worthy of emulation in "socialist competition." 391/

Labor productivity in the Soviet steel industry is measured in three ways: by value of production; by physical production; and by a unit-accounting method which, by means of predetermined coefficients, reduces various kinds of production to one basic type. The value-of-production method, based on the evaluation of gross production, is the principle system in use. Before the change in wholesale prices in 1949, gross production was valued in terms of wholesale prices of 1926/27. The use of 1926/27 prices, which did not accurately reflect postwar labor costs, imparted an upward bias to statistics on labor productivity. Since 1949, gross production has been valued in current wholesale prices. 392/

C. Wages.

In the Soviet steel industry, wages range from 15 to 20 percent of the cost of production at integrated steel plants to 55 to 60 percent at iron mining installations. Between 1940 and 1953 the total wages of ferrous metallurgical workers increased 2.5 times. Because of inflation in the intervening years, however, the buying power of the workers did not increase at the same rate. Wherever possible, wages are based on progressive piecework and production norms for which basic wage rates are set. Wage rates remained almost constant between 1940 and 1953. Because total wages rose substantially, production norms must have been set at relatively low levels, and premiums for overfulfillment must have been substantial. In 1955 the norm was set at 80 percent of planned production. The worker received pay at double the wage rate for all additional production up to the

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planned production and at treble the rate for any production in excess of planned production. 393/

The average annual wage in the Soviet metallurgical industry during 1955 was 12,000 rubles. The 1954 average annual wage for the five major classifications of employees was as follows: workers, 12,800 rubles; engineers and technicians, 20,000 rubles; office-workers, 9,000 rubles; guards, char force, and the like, 5,000 rubles; and apprentices, 4,000 rubles. Wages in the Urals and Siberia are 20 percent greater than elsewhere in the USSR. 394/

On the basis of the amount of wages and premiums received, the best paid positions are those held by directors, engineers, foremen, senior rollers and melters, and underground miners. One typical plant manager received 7,000 rubles in 1 month in 1955 -- 4,000 rubles from base rates and 3,000 rubles in premiums. At the Krivoy Rog ore field, workers at the surface receive 1,000 rubles a month; auxiliary underground workers, 1,500 rubles; and underground miners, 2,000 to 3,000 rubles. In addition to tonnage premiums, bonuses are given for effecting certain operating economies. The wages, premiums, and bonuses earned by a steel melter (first helper) at the Zaporoz'he steel plant in March 1953 are shown in the following tabulation 395/:

Payments	Rubles
Basic wage for meeting production norm	1,268
Premium for above-norm production	529
Compensation for idle time during furnace overhaul	260
Bonus for good furnace maintenance	164
Bonus for saving electricity	218
Bonus for saving fuel	621
Other payments	169
Total	3,229

At the official exchange rate of 4 rubles to the dollar, the average 1955 wage in the Soviet ferrous metallurgical industry was US $3,000. In the US the average steel worker earned US $5,200 in 1955. The average Soviet engineer earned US $5,000 in 1955; the average director earned US $24,000. In terms of "real income" the Soviet worker fared even worse. The prices the average Soviet worker with an income of 1,000 rubles per month paid for food, clothing, and consumer durable goods in 1955 are shown in the following tabulation 396/:

Item	Ruble Price*
Butter, per pound	12
Meat, per pound	8 to 9
Eggs, per dozen	8.5
Black bread, per pound	2.5
Chocolate, per pound	49
Man's suit	1,400 to 1,500
Man's overcoat	700 to 1,200 to 2,000
Shirt	185
Women's shoes, per pair	267
Vacuum cleaner	500
Bicycle	600 to 700
Television set	1,100 to 2,700
Radio	170 up
Automobile	9,000 to 28,000 to 38,000

Against high prices the Soviet worker is required to pay must be measured the cost of housing, pensions, and other items of social benefit that are provided for him. A family of 4 would pay only about 48 rubles per month for their 36-square-meter (2 rooms, each 9 by 18 feet) apartment space.** A worker earning 1,000 rubles a month must set aside 13 percent of his earnings for income taxes, and he is under strong moral obligation to contribute 1 month's pay (8 percent) to the State Loan. After 1 year of service, the worker has his basic wage rate increased 10 percent periodically, up to a maximum of 30 percent at 15 years. After 20 years of service, provided he is over 50 years old, the worker receives a tax-free pension from the Ministry of Ferrous Metallurgy, which amounts to 50 percent of his average annual basic wage.*** The pension fund is administered by the trade union, which is also responsible for the allocation of housing, for operating plant health clinics, for supervising safety in the plant, and for other tasks. About 95 percent of Soviet workers belong to the union; dues are 1 percent of wages. 397/

* These are "State Shop" prices, some of which vary regionally.

** In the Fourth and Fifth Five Year Plan periods the Ministry of Ferrous Metallurgy constructed 7.9 million square meters of housing for its workers.

*** Social security is provided for by the enterprise, which must set aside for this purpose an amount equal to 7.9 percent of the wage bill.

XIV. Distribution and Consumption.

A. Distribution.

The distribution of finished steel, a "funded commodity" allocated only by authority of the Soviet Council of Ministers, is under the control of Glavmetallosbyt of the Ministry of Ferrous Metallurgy and is based on demands developed as part of the planning procedures. In addition to supervising direct shipments from steel plants to consumers, Glavmetallosbyt operates a system of warehouses at strategic locations throughout the country.* 398/

In general the Soviet distribution system appears to work reasonably well. Nevertheless, there are occasional stoppages of production because of inadequate steel supplies, and spot shortages occur with considerable frequency. The stoppages are caused principally by the constant pressure on producing and consuming plants to hold down inventories, by the difficulty of estimating requirements in advance, and by the bureaucratic delays involved in obtaining supplementary allocations.

Finished steel is shipped principally by rail. High tariffs and inadequate highways make shipment by truck generally impractical for distances greater than 10 kilometers. The north-south orientation of most Soviet waterways does not accommodate itself to the movement of finished steel, the bulk of which is east-west. Although water rates are low and water transportation is subsidized by artificially high tariffs of parallel rail shipments, the usual necessity for transshipment en route makes the combined rail-and-water tariff higher, in most cases, than that for all rail shipment. 399/

The average haul of ferrous metals from plants and warehouses to the consumer rose from 966 kilometers in 1940 to 1,177 kilometers in 1951, an increase of 22 percent. This rise reflected the increased crosshauling of steel products that resulted from the disproportionate expansion of steel consumption in the Central Region of the USSR -- particularly in the Moscow, Leningrad, and Gor'kiy industrial areas -- relative to the growth in production of finished steel in the Central Region. This region was a steel-deficit area in 1940. Between 1940 and 1951 the region's dependence on supplies

* See the map, Figure 13, inside back cover.

of steel produced elsewhere in the USSR increased as a result of an expansion of 61 percent in consumption as against an increase of only 7 percent in production of finished steel in the Central Region. The amount of finished steel shipped into the region increased from 4.2 million tons in 1940 to 7.5 million tons in 1951, much of which was transported long distances from steel plants in the eastern and southern areas.

Between 1951 and 1955 the average haul of ferrous metals in the USSR decreased to 1,055 kilometers, primarily as a result of a change in pricing policy.* 400/

The production and consumption of finished steel in the USSR, by geographic area, in 1940, 1951, and 1953 are shown in Table 37.

Table 37

Production and Consumption of Finished Steel in the USSR by Geographic Area a/
1940, 1951, and 1953

Million Metric Tons

	Production			Consumption		
Area b/	1940	1951	1953	1940	1951	1953
East	4.1	12.4	14.9	2.5	7.4	8.9
South	7.6	9.9	12.5	5.0	7.4	8.9
Central	1.4	1.5	2.0	5.6	9.0	11.6
Total	13.1	23.8	29.4	13.1	23.8	29.4

a. 401/. Consumption data do not make allowances for inventory changes, additions to stockpiles, and foreign trade in finished steel, which in 1953 amounted to 853,000 tons exported and 328,000 tons imported -- net exports of 525,000 tons.
b. East includes Economic Regions VI, VIII, IX, X, XI, and XII; South includes Economic Regions III, IV, and V; and Central includes Economic Regions I, II, and VII.

* See XI, p. 125, above.

B. Consumption.

The demand for finished steel in the USSR appears to be limited only by the availability of investment funds for the expansion of the consuming industries. Although particular allocations among industries may be more generous for political or strategic reasons, the over-all policy is to maintain a "tight" supply situation. Allocations are directed toward preventing the accumulation of excess inventories in producing and consuming plants. State reserves serve to absorb surpluses and to provide, at least partially, for unforeseen demands.

It appears that the rate of consumption of finished steel in relation to the gross national product (GNP) of the two countries is higher in the USSR than in the US. GNP in the USSR in 1955 was estimated at US $138 billion, equal to 36 percent of that of the US. To achieve this GNP the USSR consumed* an estimated 34.3 million tons of finished steel, 46 percent as much as the US.** The high Soviet rate of consumption of finished steel reflects, among other things, the larger share of GNP devoted to defense and investment, each of which is a heavy consumer of steel. Although the GNP in the USSR was only 36 percent of that in the US, Soviet outlays for defense were about equal to those in the US, and funds allocated to investment were equal to about 60 percent of those in the US. Investment in the USSR, moreover, is concentrated on heavy industry and transportation, which are large users of steel. 403/

Perhaps because a detailed account of the consumption of steel by industry or by ministry may be -- especially in a wholly planned economy -- an indicator of preparations for mobilization, the relaxation in the dissemination of industrial information that has taken place since Stalin's death has not been extended to the steel consumption aspect of the Soviet economy.*** Data on the allocation or distribution of finished steel to consuming industries have been carefully concealed since 1938. 404/

* Consumption is estimated on the basis of production less exports plus imports; no allowances are made for inventory changes.
** On a per capita basis, however, Soviet consumption of steel was relatively much lower (as was GNP). At 372 pounds per capita, Soviet consumption of steel was about one-fourth that of the US and one-half that of the UK and of West Germany. 402/
*** Information of a general nature concerning the consumption of finished steel products by type in the various sectors of the Soviet

A general indication of the pattern of Soviet steel consumption can be derived by regrouping the estimated finished steel product mix.* Such a regrouping intc "heavy" products (used primarily by heavy industry, construction, and rail transportation) and "light" products (used primarily for consumer goods) provides further evidence of the relatively larger consumption by heavy industry in the USSR than in the US. In 1955, for example, "heavy" products accounted for 56 percent of total Soviet production of finished steel but for only 31 percent of US production. 405/

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economy has been received recently. The need for further clarification precludes its use at present.

* See IV, p. 23, above.

XV. Capabilities, Vulnerabilities, and Intentions.

A. Capabilities.

The Soviet steel industry probably will meet the primary production goals of the Sixth Five Year Plan (1956-60) and thus will provide the planned support for the growing Soviet economy in 1960. The industry is self-sufficient in basic raw materials and employs technological practices that, in selected plants, compare favorably with Free World standards.

B. Vulnerabilities.

The Soviet steel industry would not necessarily be affected by external economic conditions. Economic self-sufficiency in steel has not been achieved, however, without cost. Dependence solely on internal resources for new and modern equipment has resulted in a lowering of the over-all efficiency of the Soviet industry and the continuance in operation of many obsolete facilities. The exploitation of remote and low-grade native resources of some alloying materials, particularly of cobalt, is a factor in the relative scarcity and high price of those materials.

A potential vulnerability of the industry is its major dependence on rail transportation, requiring the maintenance of an uninterrupted flow of raw materials and finished products between centers of production and consumption.

C. Intentions.

Currently planned increases in production of crude and finished steel in the USSR are commensurate with increases in other sectors of the Soviet economy and show no significant deviation or intention to do other than support the planned growth of the economy* and to provide for the needs of the European Satellites, particularly those for iron ore.

Intentions of the Soviet government to place the steel industry on a wartime footing or to initiate a mobilization program might be indicated by detailed information on the types of semifinished and finished steel produced, particularly of the alloy grades. Information of this nature, however, is closely concealed by the Soviet government.

* This planned growth is, however, heavily oriented toward military supporting industries.

APPENDIX A

STATISTICAL TABLES

Table 38

Distribution of Coke, Pig Iron, Crude Steel, and Finished Steel
in the USSR, by Republic
1955

Percent

Republic	Coke a/	Pig Iron b/	Crude Steel b/	Finished Steel b/
RSFSR	41.2	48.9	59.1	58.3
Ukrainian SSR	52.8	49.8	37.4	38.6
Belorussian SSR	0	0	0.1	0.1
Uzbek SSR	0	0	0.5	0.4
Kazakh SSR	0	0	0.5	0.7
Georgian SSR	1.3	1.3	1.3	1.6
Armenian SSR	0	0	Negligible	Negligible
Azerbaydzhan SSR	0	0	0.8	Negligible
Latvian SSR	0	0	0.2	0.3
Estonian SSR	0	0	Negligible	0
Kirgiz SSR	0	0	Negligible	0
Unallocated	4.7	0	0	0

a. These estimates are based on regional studies of the ferrous metallurgical industry of the USSR which are available in CIA files.
b. 406/

Table 39

Wholesale Prices and Ruble/Dollar Ratios
for the Ferrous Metallurgical Industry of the USSR
Selected Years, 1948-55

Product	Year of Price a/*	Price (Rubles per Metric Ton)	Ruble Dollar Ratio
Iron ore			
Krivoy Rog (60 percent iron) b/	1949	32.6	N.A.
Krivoy Rog (54 percent iron) c/	1955	31	N.A.
Krivoy Rog (gigant concentrates) c/	1955	21	N.A.
Krivoy Rog (average concentrates) c/	1955	25	N.A.
Magnitogorsk (58 percent iron lump) b/	1949	26.3	N.A.
Coke and coking coal			
Tkibuli and Tkvarcheli coking coal d/	1955	130	N.A.
Donbas coking coal c/	1955	About 170	N.A.
Foundry coke (Donbas) b/	1950	280	N.A.
High-temperature coke (Moscow) c/	1955	210	N.A.
High-temperature coke (Rustavi) c/	1955	280 to 300	N.A.
Manganese ore			
Nikopol' b/	1948	52	N.A.
Scrap			
Approximately No. 1 heavy melting d/	1949	227	12.6
Pig iron			
Bessemer pig d/	1950	400	7.7
Bessemer pig e/	1955	378	5.7
Basic pig d/	1950	476	9.0

* Footnotes for Table 39 follow on p. 153.

Table 39

Wholesale Prices and Ruble/Dollar Ratios
for the Ferrous Metallurgical Industry of the USSR
Selected Years, 1948-55
(Continued)

Product	Year of Price a/	Price (Rubles per Metric Ton)	Ruble Dollar Ratio
Pig iron (Continued)			
Basic pig e/	1955	383	5.9
Foundry pig (gray) d/	1950	427	8.7
Foundry pig (malleable) d/	1950	660	12.9
Foundry pig (malleable) e/	1955	452	N.A.
Blast furnace ferroalloys			
Ferromanganese (78 percent manganese) b/	1949	1,650	N.A.
Ferromanganese (78 percent manganese) d/	1950	1,487	7.8
Ferromanganese (78 percent manganese) e/	1955	1,080	N.A.
Spiegeleisen (18 percent manganese) b/	1949	770	N.A.
Spiegeleisen (18 percent manganese) d/	1950	600	8.6
Spiegeleisen (19 percent manganese) e/	1955	592	5.9
Ferrosilicon (10 percent silicon) b/	1949	750	N.A.
Ferrosilicon (16 percent silicon) f/	1950	720	9.0
Ferrosilicon (16 percent silicon) e/	1955	581	N.A.
Electric furnace ferroalloys			
Ferromanganese (80 percent manganese medium carbon) f/	1950	2,355	6.0
Ferromanganese (80 percent manganese medium carbon) e/	1955	1,495	N.A.
Ferrosilicon (75 percent silicon) d/	1950	1,650	7.4
Ferrosilicon (75 percent silicon) e/	1955	975	N.A.

Table 39

Wholesale Prices and Ruble/Dollar Ratios
for the Ferrous Metallurgical Industry of the USSR
Selected Years, 1948-55
(Continued)

Product	Year of Price a/	Price (Rubles per Metric Ton)	Ruble Dollar Ratio
Electric furnace ferroalloys (Continued)			
Ferrochrome (60 percent chromium) f/	1950	3,700	9.0
Ferrochrome (60 percent chromium) e/	1955	1,950	N.A.
Silico-manganese (17 percent silicon, 82 percent manganese) f/	1950	1,300	N.A.
Silico-manganese (17 percent silicon, 82 percent manganese) e/	1955	1,125	N.A.
Ferrotungsten (72 percent tungsten) f/	1950	56,100	N.A.
Ferromolybdenum (60 percent molybdenum) f/	1950	74,300	N.A.
Ferrophosphorus (17 percent phosphorus) e/	1955	1,055	N.A.
Ferrovanadium (40 percent vanadium) f/	1950	60,300	N.A.
Ferrotitanium (20 percent titanium) f/	1950	5,500	N.A.
Ferrotitanium (20 percent titanium) e/	1955	3,715	N.A.
Ferrocolumbium (35 percent columbium) f/	1950	200,000	N.A.
Nickel (99.95 percent nickel) f/	1950	36,000	37.2
Nickel (99.8 percent nickel) e/	1955	24,000	About 16
Cobalt (97 to 99 percent cobalt) f/	1950	456,000	103.4
Cobalt (98 percent cobalt) e/	1955	241,000	About 42
Refractories			
Chamotte (fire brick) b/	1950	220	N.A.
Dinas (silica brick) b/	1950	247	N.A.

Table 39

Wholesale Prices and Ruble/Dollar Ratios
for the Ferrous Metallurgical Industry of the USSR
Selected Years, 1948-55
(Continued)

Product	Year of Price a/	Price (Rubles per Metric Ton)	Ruble Dollar Ratio
Finished steel			
Rails (P-43) d/	1950	621	7.6
Rails (P-43) g/	1952	604	N.A.
Rails (P-43) e/	1955	565	N.A.
Rails (P-50) e/	1955	651	5.8
Rail accessory (two-flanged tie plate) d/	1950	590	6.4
Rail accessory (two-flanged tie plate) e/	1955	664	5.0
Wheels d/	1950	450 to 550	6 to 7
Pipe (seamless average excluding stainless) d/	1950	1,350	9.8
Pipe (seamless average excluding stainless) e/	1955	967	6.2
Pipe (seamless stainless) d/	1950	6,830	15.3
Pipe (welded average) d/	1950	1,420	10.4
Pipe (welded average) e/	1955	976	5.4
Heavy sections (channels) d/	1950	564	6.8
Heavy sections (channels) e/	1955	649	5.7
Heavy sections (I-beams) d/	1950	800	9.8
Heavy sections (I-beams) e/	1955	649	5.7
Heavy sections (angles) d/	1950	660	8.2
Heavy sections (angles) e/	1955	648	5.7
Light sections (light channels) d/	1950	587	6.3
Light sections (junior I-beams) d/	1950	815	8.8
Light sections (angles) d/	1950	650	8.7
Light sections (hot rolled bars) d/	1950	786	9.4
Light sections (hot rolled bars) e/	1955	652	5.3
Light sections (cold finished bars) d/	1950	1,172	8.9
Light sections (cold finished bars) e/	1955	1,059	5.4
Light sections (hot rolled alloy bars) d/	1950	1,218	8.9

Table 39

Wholesale Prices and Ruble/Dollar Ratios
for the Ferrous Metallurgical Industry of the USSR
Selected Years, 1948-55
(Continued)

Product	Year of Price a/	Price (Rubles per Metric Ton)	Ruble Dollar Ratio
Finished steel (Continued)			
Light sections (hot rolled alloy bars) e/	1955	1,460	6.7
Light sections (tool steel bars) d/	1950	25,760	6.1
Light sections (tool steel bars) e/	1955	20,400	5.5
Light sections (hot rolled stainless bars) d/	1950	10,320	14.7
Light sections (hot rolled stainless bars) e/	1955	4,330	4.2
Wire rod (ordinary) e/	1955	639	5.2
Wire rod (ordinary) d/	1950	777	8.1
Wire rod (quality) d/	1950	1,300	11.0
Sheet (hot rolled) d/	1950	828	9.8
Sheet (hot rolled) e/	1955	668	5.6
Sheet (cold rolled) d/	1950	960	9.7
Sheet (cold rolled) e/	1955	1,118	7.7
Sheet (galvanized) d/	1950	2,640	18.0
Sheet (tinplate) d/	1950	6,670	43.0
Sheet (electrical) d/	1950	2,350	8.5
Sheet (electrical) e/	1955	1,309	5.5
Sheet (stainless) d/	1950	13,360	15.0
Strip (hot rolled) d/	1950	891	8.0
Strip (hot rolled) e/	1955	789	6.3
Strip (cold rolled) d/	1950	1,670	11.7
Strip (cold rolled) e/	1955	1,050	5.6
Strip (stainless) d/	1950	17,500	21.2
Plate (ordinary) d/	1950	829	9.1
Plate (ordinary) e/	1955	616	5.4
Plate (quality) d/	1950	1,200	10.0

Table 39

Wholesale Prices and Ruble/Dollar Ratios
for the Ferrous Metallurgical Industry of the USSR
Selected Years, 1948-55
(Continued)

Product	Year of Price a/	Price (Rubles per Metric Ton)	Ruble Dollar Ratio
Finished steel (Continued)			
Plate (stainless) d/	1950	12,780	13.8
Blooms and billets (ordinary) d/	1950	611	7.6
Billets (forging quality) e/	1955	594	5.3
Blooms and billets (quality) d/	1950	1,727	10.4
Castings			
Gray iron (average) d/	1950	1,800	11.6
Malleable iron (average) d/	1950	3,940	10.7
Steel (average) d/	1950	3,880	10.7
Metal articles (metiz)			
Wire nails b/	1950	1,140	N.A.
Welding rod b/	1950	1,180	N.A.
Steel cable b/	1950	2,800	N.A.
Railroad spikes b/	1950	1,220	N.A.
Rivets b/	1950	1,350	N.A.

a. Prices for 1950 are those of 1 January 1950, and prices for 1955 are those of 1 July 1955, unless otherwise noted.
b. Prices are f.o.b. station of origin. 407/
c. Prices are f.o.b. station of origin. 408/
d. Prices are f.o.b. station of origin. 409/
e. Prices are delivered prices. 410/
f. Prices are f.o.b. station of origin. 411/
g. Prices are as unloaded at station of destination. 412/

Table 40

Selected Input Requirements for the Coke and Coke Byproducts Industry (SIC No. 2932) in the USSR a/
1955

Input	Unit	Amount
Coking coal b/	Million metric tons	59.8
Coke oven gas c/	Million cubic meters	5,280.0
Blast furnace gas d/	Million cubic meters	25,000.0
Electric power e/	Million kilowatt-hours	828.0
Refractories f/	Thousand metric tons	227.0
Process steam g/	Million metric tons	17.5
Water h/	Million gallons	69,400.0 (minimum)
Sulfuric acid (100 percent) i/	Thousand metric tons	470.0

a. The requirements are based on 1955 production of high-temperature coke of 43.6 million tons.
b. This estimate is based on a 73-percent yield of coke from coking coal. 413/
c. Thirty-one percent of all coke oven gas produced is used in coke plant operation. Every ton of coke yields 390 cubic meters of gas (43.6×10^6 coke x 390 x 0.31 = 5.28×10^9 m^3 gas). 414/
d. Twenty percent of all blast furnace gas produced is used in coke plant operation. Every ton of pig iron (including ferroalloys) yields 3,750 cubic meters of gas (33.3×10^6 x 3,750 x 0.20 = 25.0 x 10^9 m^3 gas). 415/
e. For each ton of coke produced, 19 kilowatt-hours (kwh) are consumed. 416/
f. The average coke oven produces 4,500 tons. A new coke oven requires 17,000 9-inch fireclay shapes and 26,000 9-inch silica shapes. A 9-inch fireclay shape and a 9-inch silica shape weigh 3.6 and 3.0 (kg), respectively. Annual maintenance requires 10 percent of the refractory material that new construction requires. In 1955, 3.3 million tons of new capacity came in, and 40.3 million tons had to be maintained. The number of new ovens: (3.3×10^6 + 4,500 = 734). The number of old ovens: (40.3×10^6 + 4,500 = 8,960). Fireclay for new ovens: (3.6 x 17,000 x 734 = 44.9×10^6 kg). Silica for new ovens: (3.0 x 26,000 x 734 = 57.2×10^6 kg). Fireclay for old ovens: (3.6 x 17,000 x 8,960 x 0.1 = 55.0×10^6 kg). Silica for old ovens: (3.0 x 26,000 x 8,960 x 0.1 = 70.0×10^6 kg). Total requirements: (44.9 + 57.2 + 55.0 + 70.0 = 227,000 tons). 417/
g. Steam requirements for byproduct plant operations amount to 0.4 ton per ton of coke. 418/
h. Minimum water requirements are 6 m^3 for every ton of coking coal charged. One cubic foot equals 7.48 gallons. 419/
i. 420/

Table 41

Selected Input Requirements for the Blast Furnace Industry (SIC No. 3311) in the USSR a/
1955

Input	Unit	Amount
Iron ore (54 percent iron) b/	Million metric tons	62.6
Coke c/	Million metric tons	31.2
Charcoal d/	Thousand metric tons	390.0
Manganese ore (40 percent manganese) e/	Million metric tons	1.53
Scrap and miscellaneous metallics f/	Million metric tons	1.97
Limestone g/	Million metric tons	16.6
Refractories h/	Million metric tons	0.113
Blast furnace gas i/	Million cubic meters	50,000.0
Electric power j/	Million kilowatt-hours	500.0
Water k/	Billion gallons	3.45

a. The requirements are based on 1955 total production of pig iron, including ferroalloys, of 33.3 million tons.
b. The average iron content of Soviet ores and concentrates, as charged, is estimated at 54 percent. The iron content of the ore comprises 94.5 percent of the metallic requirements. Efficiency of use of iron: 0.93 (33.3 + 0.54) (1.0 + 0.93) 0.945 = 62.6 million tons. 421/
c. The estimated rate for the USSR is 0.95 ton of coke per ton of pig iron. Total coked pig iron and ferroalloys: 32.8 million tons. 422/
d. Six cubic meters of charcoal are required to smelt 1 ton of charcoal pig. Charcoal pig production is estimated to be 1.5 percent of total production -- that is, 500,000 tons. A cubic meter of charcoal weighs 130 kg: (33.3 x 0.015) (6 x 0.130) = 390,000 tons of charcoal. 423/
e. The average manganese content of Soviet pig irons is 2 percent. About 55 percent of the manganese content comes from charging lower grade (average 40 percent manganese) ore. The efficiency of manganese ore in the blast furnace is 60 percent. (33.3 x 0.02 x 0.55) (1.0 + 0.4) (1.0 + 0.6) = 1.530 million tons. 424/
f. Of the metallic inputs to the blast furnace charge, 5.5 percent comes from scrap, mill scale, and open hearth slag. 425/

Table 41

Selected Input Requirements for the Blast Furnace Industry (SIC No. 3311) in the USSR a/
1955
(Continued)

g. This estimate is based on limestone requirements of 500 kg per ton of pig iron. 426/
h. This estimate is based on 3.4 kg of refractory brick needed for every ton of pig iron and does not include refractories for new construction. 427/
i. This estimate is based on 40 percent of the production of blast furnace gas being used in the blast furnace industry (25 percent in stoves and 15 percent in powerhouses). Gas production is 3,750 cubic meters per ton of pig iron, (33.3 x 3,750 x 0.40) = a total of 50 billion cubic meters. 428/
j. This estimate is based on 15 kwh per ton of pig iron.
k. This estimate is based on 391 kg of water required per ton of pig iron. At normal pressures and temperatures, water weighs 62.4 pounds per cubic foot, and 1 cubic foot equals 7.48 gallons.

Table 42

Selected Input Requirements for the Steel Works and Rolling Mill Industry (SIC No. 3312) in the USSR a/
1955

Input	Unit	Amount
Pig iron b/	Million metric tons	25.250
Scrap c/	Million metric tons	19.364
Iron ore (54 percent iron) d/	Million metric tons	3.411
Electric power e/	Million kilowatt-hours	10,200.0
Limestone f/	Million metric tons	3.360
Manganese ore (40 percent manganese) g/	Million metric tons	0.407
Refractories h/	Million metric tons	2.360
Fuel oil (mazut) i/	Million metric tons	1.570
Blast furnace gas j/	Million cubic meters	37,500.0
Coke oven gas j/	Million cubic meters	4,430.0
Coal for gas producers j/	Million metric tons	2.62
Electrodes k/	Million metric tons	0.053
Tin l/	Thousand metric tons	2.82

a. The requirements are based on a production of 45.3 million tons of crude steel in 1955 of which 3.22 million tons were part of the steel casting industry leaving 42.08 million tons as the production of the steel rolling and drawing industry. Of the 42.08 million tons, 38.37 million tons were produced in open hearth furnaces, 2.39 million tons in electric furnaces, and 1.32 million tons in Bessemer converters.
b. The percentage of metallics charged as pig iron (usually as hot metal) are: open hearth, 56 percent, electric, 3 percent; and converter, 90 percent. The efficiency of each process is: open hearth, 90 percent; electric, 93 percent; and converter, 90 percent. Total metallic input requirements (pig iron, scrap, and iron in iron ore) are: open hearth, 42.6 million tons; electric, 2.57 million tons; and converter, 1.47 million tons. Pig iron requirements are, therefore: open hearth, 23.85 million tons; electric, 0.077 million tons; and converter, 1.323 million tons -- a grand total of 25.25 million tons of pig iron. 429/
c. The percentage of metallics charged as scrap are: open hearth, 40 percent; electric, 94 percent; and converter, 6 percent. Total scrap inputs are: open hearth, 17.04 million tons; electric, 2.415 million tons; and converters, 0.088 million tons -- a total of 19.543 million tons. 430/

Table 42

Selected Input Requirements for the Steel Works and Rolling Mill Industry (SIC No. 3312) in the USSR a/
1955
(Continued)

d. Iron ore concentrates, as charged to furnaces for feed and charge ore and coolants, are estimated to average 54 percent iron. 431/ The percentage of metallics charged as 54 percent ore are: open hearth, 4 percent; electric, 3 percent; and converter, 4 percent. Total ore inputs are: open hearth, 3.16 million tons; electric, 0.142 million tons; and converter, 0.109 million tons -- a total of 3.411 million tons of 54 percent iron ore. 432/

e. This estimate is based on 242.5 kwh per ton of crude steel and includes all power necessary for rolling and finishing.

f. This estimate is based on an average use of 80 kg per ton of crude steel. 433/

g. An average of 10 kg of 40 percent manganese ore is added to each ton of open hearth steel. This amount is assumed to cover electric furnaces but not converters. 434/

h. Refractory brick requirements, not including new construction, amount to 16 kg per ton of crude steel. This includes reheating furnaces in the rolling mills. In addition, large amounts of refractory materials, usually powders, are required in the amount of 40 kg per ton of crude steel. 435/

i. About 4.5 million British thermal units (Btu) per ton of open hearth steel are required. Fuel oil (mazut) contains 39,600 Btu per kg, and therefore 113.5 kg of mazut are required per ton of crude steel produced in oil-fired furnaces. An estimated 20 percent of the open hearth steel is produced in oil-fired furnaces. Soaking pits require about 2 million Btu per ton of crude steel. About 20 percent of the soaking pits are oil fired. All finished steel is estimated to undergo one reheat at about an 80-percent yield where, again, 2 million Btu per ton are required. 436/ Open hearth oil would amount to (38.37 x 0.20) (113.5) = 872,000 tons. Soaking pits (38.37 x 0.20) $(2.0 \times 10^6 \div 39,600)$ = 388,000 tons. Reheating furnaces (38.37 x 0.20 x 0.80) $(2.0 \times 10^6 + 39,600)$ = 310,000 tons. 437/

j. Btu requirements for the 80 percent of open hearth furnaces not oil fired would amount to $(38.37 \times 0.80 \times 4.5 \times 10^6) = 138 \times 10^{12}$ Btu. Excluding oil-fired soaking pits, Btu requirements for the remainder would be [42.08 - (38.37 x 0.20)] 2.0×10^6 or 69×10^{12} Btu. For reheating furnaces the Btu requirement would be [42.08 - (38.37 x 0.20)] $[0.80 \times 2.0 \times 10^6]$ or 55×10^{12} Btu. Total Btu requirements are 263×10^{12} Btu. Total blast furnace gas production is 125×10^9 cubic meters of which 30 percent is used in steelmaking and finished operations; this would amount to 37.5×10^9 cubic meters. Blast furnace gas contains 3,570 Btu per cubic meter. Blast furnace gas, therefore, supplies $(37.5 \times 10^9 \times 3,570)$ or 134×10^{12} Btu of a total of 263×10^{12} Btu. Coke gas supplies 30 percent of the Btu requirements or $(263 \times 10^{12} \times 0.30)$ or 79×10^{12} Btu. Coke oven gas contains

Table 42

Selected Input Requirements for the Steel Works and Rolling Mill Industry (SIC No. 3312) in the USSR a/
1955
(Continued)

17,860 Btu per cubic meter. Total coke gas requirements would then be ($79 \times 10^{12} \div 17.860 \times 10^3$) or 4.43×10^9 cubic meters. Producer gas made in coal-fired gas generators would supply the remaining Btu, or 263 - 213) = 50×10^{12} Btu. Producer gas contains 4,760 Btu per cubic meter. Producer gas requirements are ($50 \times 10^{12} \div 4.76 \times 10^3$) = 10.5×10^9 cubic meters. One pound of dry coal produces 65.0 cubic feet of gas converted to cubic meters of gas per ton of coal is 4,013 (65 x 2,205 x 0.028). Coal required for gas generators is, therefore, ($10.5 \times 10^9 \div 4.013 \times 10^3$), or 2.62 million tons.
k. This estimate is based on a requirement of 22 kg of electrodes per every ton of crude steel produced in electric furnaces (0.22 x 2.390) or 53,000 tons. 438/
l. 439/

Table 43

Selected Input Requirements for the Steel Casting Industry (SIC No. 3323) in the USSR a/
1955

Input	Unit	Amount
Pig iron b/	Million metric tons	1.145
Scrap c/	Million metric tons	2.260
Iron ore d/	Million metric tons	0.246
Electric power e/	Million kilowatt-hours	177.0
Limestone f/	Million metric tons	0.183
Manganese ore (40 percent manganese) g/	Million metric tons	0.073
Refractories h/	Million metric tons	0.576
Fuel oil (mazut) i/	Million metric tons	0.049
Coal for gas producers j/	Million metric tons	0.405
Electrodes k/	Thousand metric tons	18.0
Sand l/	Million metric tons	8.85

a. The requirements are based on a steel casting of 1.77 million tons (rough-finished casting). At a yield of 55 percent from the "as-poured" condition to the rough finished casting the metallic "pour" would be 3.22 million tons. It is estimated that in the USSR 60 percent of the steel castings are made in open hearth furnaces, 25 percent in electric furnaces, and 15 percent in converters. Furnace efficiencies are: open hearth, 90 percent; electric, 93 percent; and converter, 90 percent.
b. The percentage of metallics charged as pig iron are: open hearth, 30 percent; electric 3 percent; and converter, 90 percent. Total metallic inputs are 3.54 million tons, of which open hearth requires 2.14 million tons; electric, 0.87 million tons; and converter, 0.53 million tons. Pig iron requirements are, therefore: open hearth, 0.642 million tons; electric, 0.026 million tons; and converter, 0.477 million tons -- a total of 1.145 million tons. 440/
c. The percentage of metallics charged as scrap are: open hearth, 66 percent; electric, 94 percent; and converter, 6 percent. Total scrap inputs are: open hearth, 1.41 million tons; electric, 0.818 million tons; and converter, 0.032 million tons -- a total of 2.26 million tons. 441/

Table 43

Selected Input Requirements for the Steel Casting Industry (SIC No. 3323) in the USSR a/
1955
(Continued)

d. Iron ore concentrates as charged to furnaces are estimated at: open hearth, 4 percent; electric, 3 percent; and converter, 4 percent. Total iron ore inputs (average 54 percent iron) are: open hearth, 0.159 million tons; electric, 0.048 million tons; and converter, 0.039 million tons -- a total of 0.246 million tons. 442/
e. This estimate is based on a requirement of 100 kwh per ton of steel castings. 443/
f. Limestone requirements are equal to 5 percent of the charge of 3.651 million tons. 444/
g. Manganese requirements are equal to 2 percent of the charge. 445/
h. Refractory brick requirements are 10 percent of the charge, and refractory materials are 5.8 percent. 446/
i. This estimate is based on a requirement of 5 million Btu per ton of crude steel. Sixty percent of the crude steel for castings is made in open hearth furnaces, 20 percent of which are oil fired. 447/ There are 39,600 Btu in 1 kg of mazut. Fuel oil requirements are (3.220 x 0.60 x 0.20) (5.0 x 10^6 ÷ 39,600) = 48,700 tons. 448/
j. Btu required for use in open hearth furnaces producing castings with producer gas (3.220 x 10^6 x 0.60 x 5 x 10^6) = 7.74 x 10^{12} Btu. Producer gas contains 4,760 Btu per cubic meter. Therefore, the cubic meters of producer gas required are (7.74 x 10^{12} ÷ 4.760 x 10^3) or 1,620 x 10^6 cubic meters. One pound of dry coal produces 65 cubic feet of gas converted to cubic meters of gas per ton of coal is 4,013 (65 x 2,205 x 0.028). Coal required for gas generators is, therefore, (1,620 x 10^6 ÷ 4.013 x 10^3) or 405,000 tons.
k. This estimate is based on 22 kg per ton of electric furnace steel produced for castings (0.022 x 810 x 10^3) or 18,000 tons. 449/
l. Five tons of sand are required for every ton of rough finished casting: (1.77 x 10^6 x 5.0) = 8.85 million tons. 450/

Table 44

Selected Input Requirements
for the Iron Casting Industry (SIC Nos. 3321 and 3322) in the USSR a/
1955

Input	Unit	Amount
Pig iron b/	Million metric tons	4.570
Scrap c/	Million metric tons	7.780
Electric power d/	Million kilowatt-hours	699.0
Limestone e/	Million metric tons	0.495
Coke f/	Million metric tons	1.730
Refractories g/	Million metric tons	0.827
Sand h/	Million metric tons	35.0
Coal for gas producers i/	Million metric tons	0.350

a. The requirements are based on a total production of iron castings of 6.994 million tons, of which gray cast iron is 6.436 million tons and malleable cast iron is 0.558 million tons. At a yield of 63 percent from the "as-poured" condition to the rough finished casting the metallic "pour" would be 11.1 million tons. Cupola efficiency is 90 percent.
b. Thirty-seven percent of the foundry charge is pig iron. The metallic charge is $11.100 \times 10^6 \div 0.90$ or 12.35 million tons. 451/
c. Sixty-three percent of the foundry charge is scrap. 452/
d. Power requirements are 100 kwh per ton of iron castings. 453/
e. Limestone requirements are equal to 4 percent of the charge of 12.35 million tons. 454/
f. Coke requirements are equal to 14 percent of the charge. 455/
g. Refractory brick requirements are 5.7 percent of the charge, and refractory materials are 1 percent. 456/
h. This estimate is based on 5 tons of sand required for every ton of rough finished casting: $(6.994 \times 10^6 \times 5.0) = 35.0 \times 10^6$. 457/
i. This estimate is based on 0.315 tons of coal required per 1 ton of cast iron obtained from a cupola furnace. 458/

APPENDIX B

METHODOLOGY

1. Section V, B, 5, Vanadium.

For 1 ton of 40 percent ferrovanadium, 840 kg of vanadium pentoxide (V_2O_5) is required. 459/ The production of vanadium pentoxide at Chusovoy is related to the production of pig iron. On the basis of this relationship, production of ferrovanadium was estimated by applying the following factors:

a. The vanadium in the pig iron is "slagged" off in a converter at the rate of 45 kg per 1 ton of pig iron. 460/

b. This slag contains 14.5 percent vanadium pentoxide; 45 kg x 14.5 percent = 6.5 kg of vanadium pentoxide per 1 ton of pig iron. 461/

c. The slag is treated at a chemical plant to release the vanadium pentoxide from the slag. The recovery rate is 80 percent; 6.5 kg x 80 percent = 5.2 kg from 1 ton of pig iron. 462/

d. If each ton of 40 percent ferrovanadium requires 840 kg of vanadium pentoxide, it will take 840 ÷ 5.2, 160 tons, of pig iron for each ton of ferrovanadium. Dividing the pig iron production at Chusovoy by 160 provides a reasonable estimate of ferrovanadium production in the USSR.

2. Section V, B, 8, Ferroalloys.

The derivation of estimated production of electric furnace ferroalloys in the USSR in selected years, 1931-55, is shown in Table 45.*

* Table 45 follows on p. 164.

Table 45

Estimated Production of Electric Furnace Ferroalloys in the USSR
Selected Years, 1931-55

Metric Tons

Year	Production
1931	4,614 a/
1932	15,299 a/
1933	21,000 b/
1935	94,162 a/
1937	172,000 a/
1943	225,000 c/
1945	225,000 d/
1946	258,000 e/
1950	315,000 f/
1955	420,000 g/

a. 463/
b. This estimate is 460 percent of production of 1931. 464/
c. 465/
d. [redacted] the loss of Zaporozh'ye was offset by increased production at Aktyubinsk and Kuznetsk. 466/ 50X1
e. 5,600 percent of 1931. 467/
f. Production was planned to be 80 percent above the 1945 level, but all other evidence points to a lesser figure. One-half, 40 percent, of planned production was used in this table. Also the estimate for 1945 may be high/ [redacted] 50X1
g. This estimate is based on an analysis of estimated requirements, plant capacity figures, miscellaneous production figures, US analogy, and the historical pattern developed to 1950.

a. Ferromanganese.

Total manganese required for steel production in the USSR in 1955 was 351,000 tons. 469/ The amounts of manganese contained in various types of ferromanganese are as follows:

Type	Amount (Metric Tons)
Electric furnace (80 percent manganese)	128,000* 470/
Spiegeleisen (Sp, 17.5 percent manganese)	75,000** 471/
Blast furnace (72.5 percent manganese)	148,000***

The amounts of manganese consumed converted into ferromanganese are as follows:

Type	Amount (Metric Tons)
Electric furnace	160,000 472/
Spiegeleisen	427,000**** 473/
Blast furnace	164,000***** 474/

b. Ferrosilicon.

Consumption of silicon in terms of 45 percent ferrosilicon constitutes on the average 0.3 percent of the total amount of steel produced in the USSR. 475/ The 0.3 percent applied to the 1955 steel production of 45.3 million tons gives 136,000 tons of 45 percent ferrosilicon containing 61,000 tons of silicon.

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* Estimated 1955 production of ferromanganese at Zestafoni and Zaporozh'ye: 160,000 tons x 0.80 average manganese content = 128,000 tons.

** 0.4 kg of spiegeleisen per ton of steel x 45.3 million tons x 175 kg of manganese in 1 ton of spiegeleisen = 75,000 tons.

*** 148,000 tons is a residual figure.

**** 9.4 kg/ton x 45.3 million tons = 427,000 tons.

***** 148,000 tons of manganese + 0.725 average manganese content = 204,000 tons of ferromanganese x 0.80 to compensate for manganese losses in producing ferromanganese = 164,000 tons.

A study of all available data on ferrosilicon production capacity in the USSR indicates a capacity of 125,000 tons capable of producing approximately 100,000 tons of ferrosilicon requiring 45,000 tons of silicon. 476/ The remaining 16,000 tons of silicon is used for making blast furnace ferrosilicon, which is called "silvery pig" and which contains 11 percent silicon on the average. The 16,000 tons of silicon can support a production of 145,000 tons of silvery pig.

3. Section XIII, Employment, Labor Productivity, and Wages.

a. Iron Ore Mining.

In the USSR in 1955, 86.1 million tons of raw iron ore were mined of which 34.4 million tons were mined underground and 51.7 million tons were mined by the open-pit method. At Krivoy Rog, 40,000 workers produced 32.1 million tons in 1955 of which 86.4 percent, 27.7 million tons, were mined underground. Underground mining requires approximately three times the labor force per ton of raw ore mined that open-pit mining requires. Therefore, to obtain production per worker for open-pit and underground mining, the following equation was used:

u = tons per underground worker

x = tons per open-pit worker

$$3u = x \text{ and } \frac{27.7}{u} + \frac{4.4}{x} = 40 \times 10^3$$

$$u = 730 \text{ tons and } x = 2{,}190 \text{ tons}$$

The production per open-pit worker of 2,190 tons compares with a productivity of 2,540 tons per worker at Magnitogorsk and 1,800 tons per worker at the Tagil open-cut mines. For this a figure of 2,220 tons per open-pit worker seems plausible. Based on the estimates given above, all open-pit mining would require 23,500 workers, and underground operations would require 47,200 workers -- a total labor force of 71,000 workers.

b. Manganese Ore Mining.

In the USSR in 1955, 11 million tons of raw manganese ore were mined of which 2.75 million tons were mined by the open-pit method and 8.25 million tons were mined underground. At Chiatura, 10,000 workers mined 6 million tons of raw ore; 15 percent was mined by the open-pit method, and 85 percent was mined underground. Underground mining requires about three times the labor force per ton of raw ore mined that open-pit mining requires. The calculation used is similar to that used for iron ore mining. Therefore, 14,100 underground and 1,570 open-pit workers were required for a total manganese ore mining labor force of 15,670, or approximately 16,000.

c. Limestone Quarrying.

About 20 million tons of limestone were mined in the USSR in 1955 under the jurisdiction of the Ministry of Ferrous Metallurgy for use in iron and steel plants. Limestone is readily won by the open-pit method, so a productivity of 2,200 tons per worker has been assumed. The required labor force would then be 9,100 workers.

d. Ferroalloy Plants at Coke-Chemical Plants.

In the case of Soviet ferroalloy plants, estimates based on documentary sources were made plant by plant. Production per worker for all workers in coke-chemical plants is given in a Soviet journal.

e. Iron and Steel Plants.

At Magnitogorsk in 1955, 26,278 workers were required for the production of 5.8 million tons of crude steel, an average of 220 tons per worker. Production of crude steel per worker at Magnitogorsk is known to have been twice the average for the industry in 1955. The production of 45.2 million tons of crude steel therefore would require (at a rate of 110 tons per worker) 411,000 workers.

f. Administrative.

An estimate of the number of administrative workers required in the Soviet ferrous metallurgical industry was based on the number of main administrations and administrative staffs in the Soviet Ministry of Ferrous Metallurgy and the Ukrainian Ministry of Ferrous Metallurgy.

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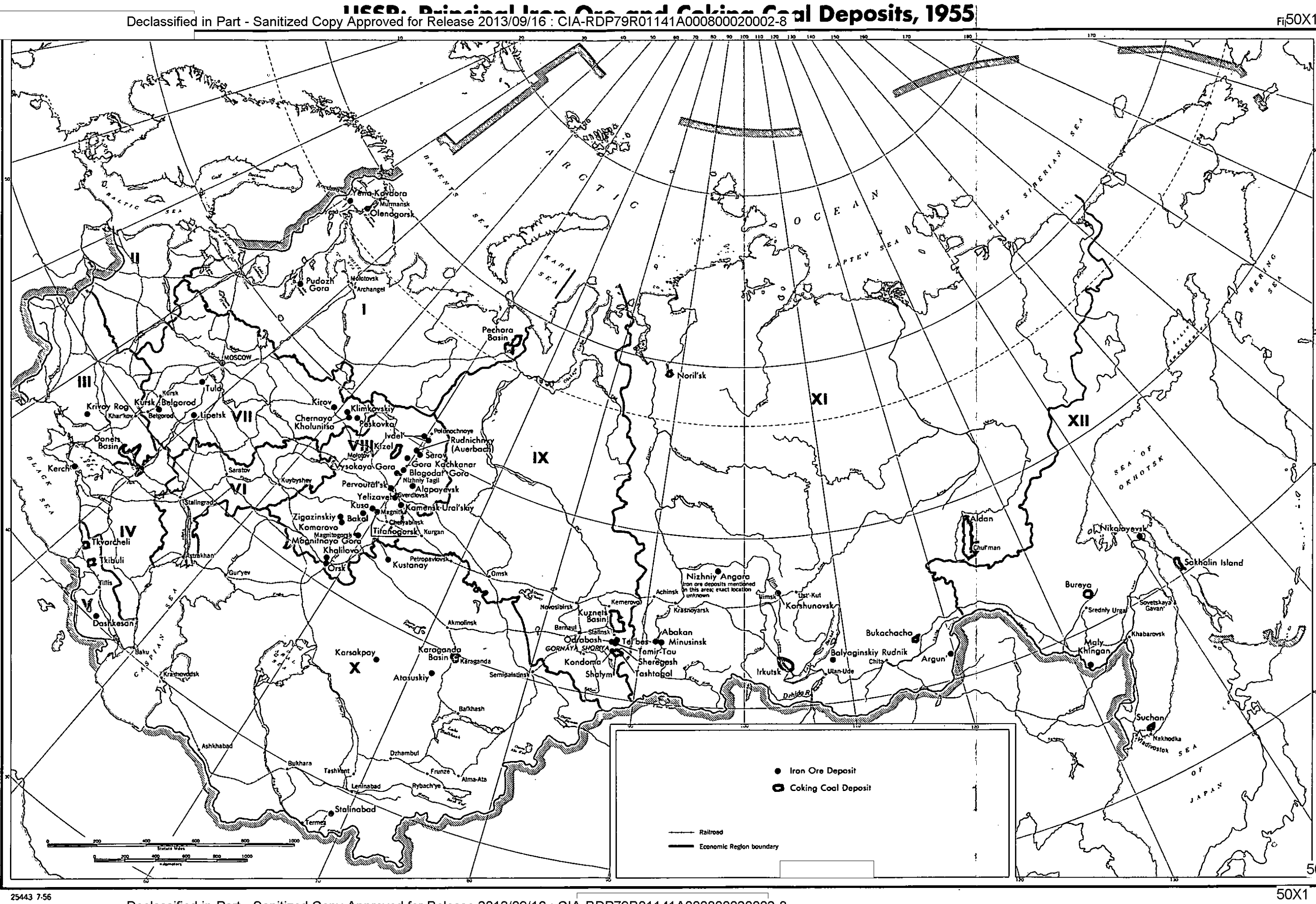
USSR: Principal Iron Ore and Coking Coal Deposits, 1955



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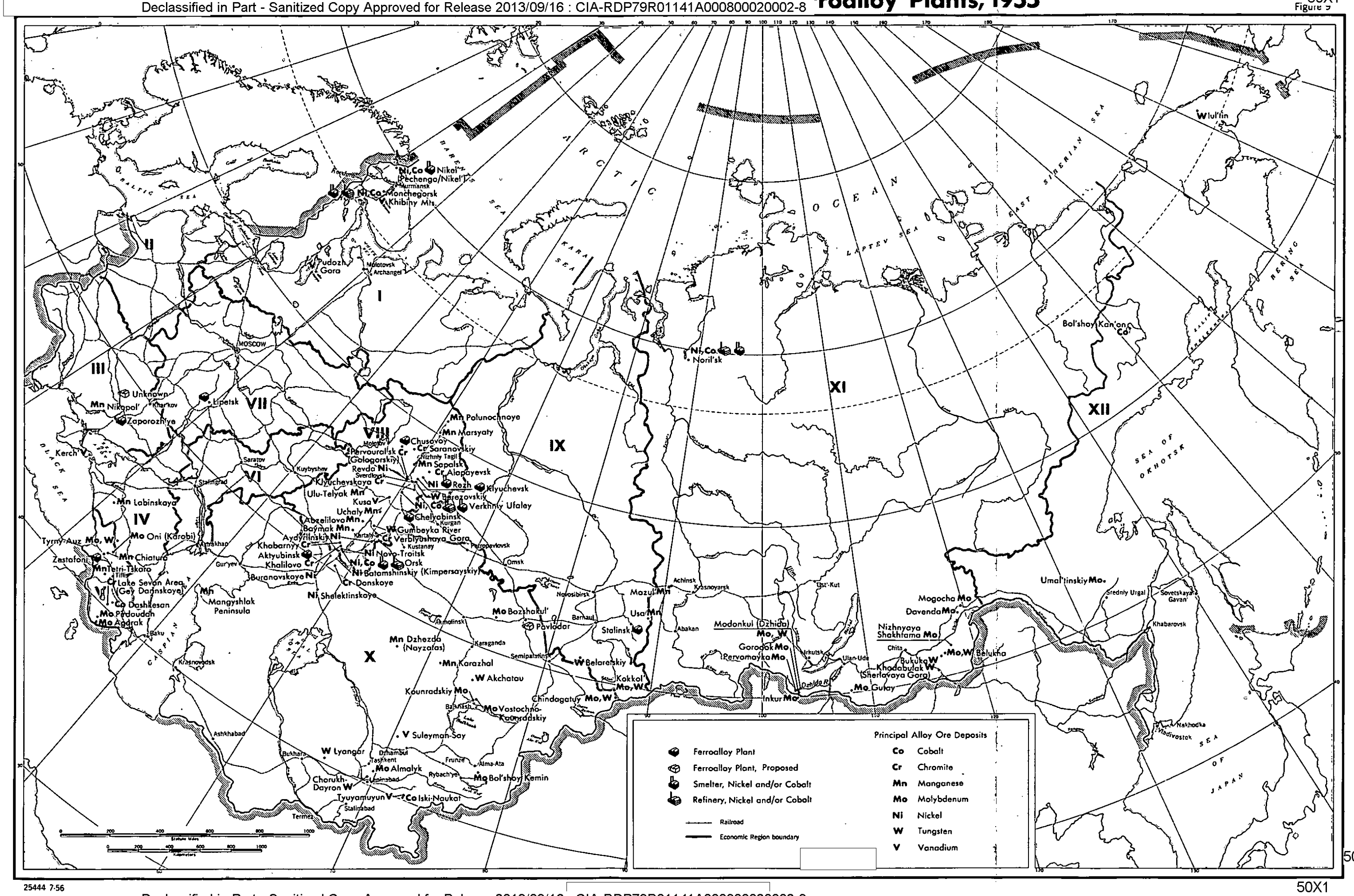
USSR: Principal Alloy Ore Deposits and Ferroalloy Plants, 1955

Figure 5



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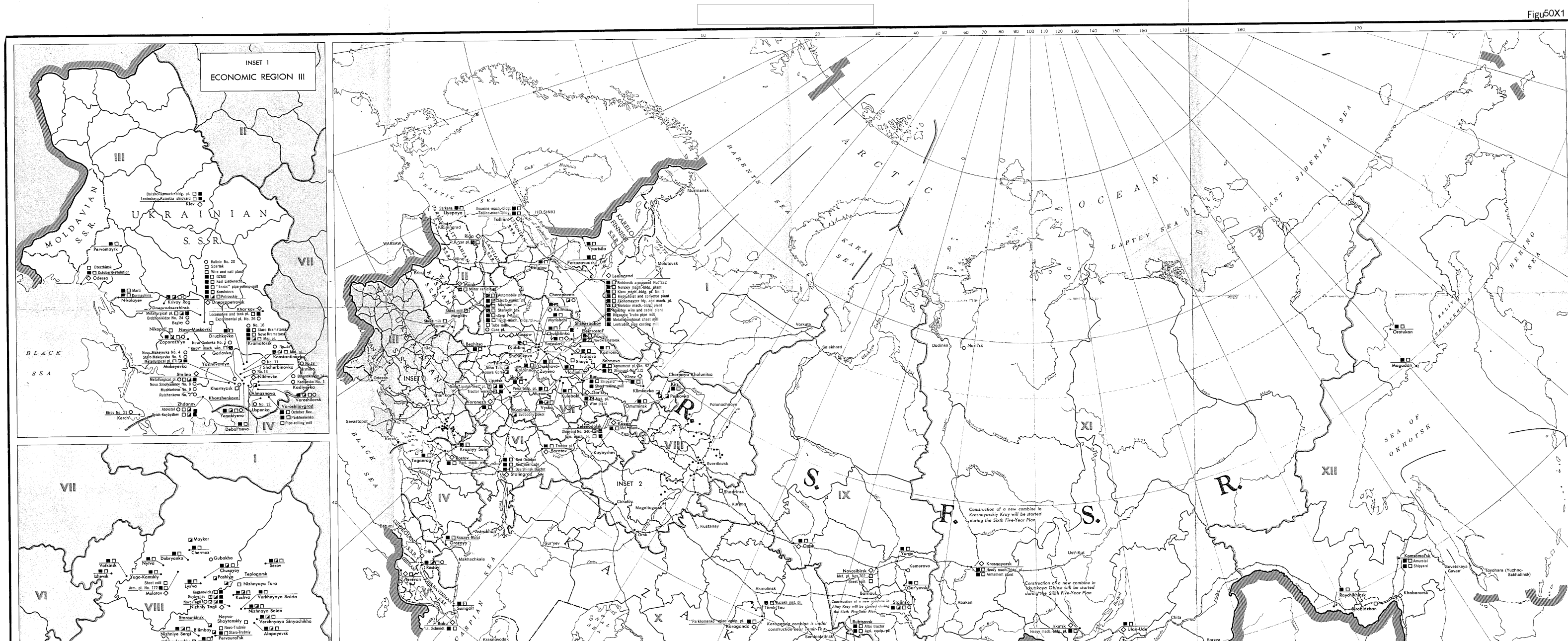

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