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ECONOMIC INTELLIGENCE REPORT

COPPER IN THE USSR 1955



CIA/RR 115

31 December 1957

CENTRAL INTELLIGENCE AGENCY

OFFICE OF RESEARCH AND REPORTS

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COPPER IN THE USSR
1955

CIA/RR 115
(ORR Project 24.869)

CENTRAL INTELLIGENCE AGENCY
Office of Research and Reports

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FOREWORD

Although the USSR has not released any absolute figures on the production, reserves, imports, exports, consumption, or stocks of copper for nearly 20 years, sufficient Soviet data are available on which to base a complete series of estimates on production of refined copper. Such a series is presented in this report and is accompanied by a full description of the underlying methodology and the sources employed. Although the estimates of production of refined copper are believed to be subject to only a small margin of error, those developed for other aspects of copper in the Soviet economy are subject to margins of error that may be of considerable magnitude. Estimates of Soviet trade in copper, for example, although based on an exhaustive analysis of a large quantity of fragmentary information, must be considered incomplete. Estimates of the Soviet stockpile of copper and of the demand for copper in the USSR were derived entirely from secondary material and must be considered preliminary. These limitations reflect the prevailing scarcity of primary information, but the conclusions are believed to be valid.

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COPPER IN THE USSR*
1955

Summary

The USSR is the largest producer of refined copper in the Sino-Soviet Bloc, probably accounting for more than 80 percent of the total production of the Bloc, and also ranks among the leading producers of the world. It is estimated that in 1955 the USSR produced 377,300 metric tons** of refined copper, or about 10 percent of the world production, thus ranking second only to the US, which produced 1,430,000 tons. Soviet production of refined copper in 1960 is scheduled to be about 604,000 tons.

The high position the USSR has attained as a producer of copper is made possible fundamentally by the abundant resources of copper within its borders. Although no data on reserves have been released since the beginning of 1939, Soviet reserves at that time were among the largest in the world. Even if no additional resources had been discovered since 1939, the reserves known to be remaining would be adequate to sustain production at current levels for about 50 years. The new discoveries that have been reported from time to time since 1939 undoubtedly have added significantly to Soviet reserves, but no specific figures have been included in such announcements.

Despite the relatively high domestic production of copper and the large reserves, the USSR has been a net importer of copper for many years. Imports reached their highest level during World War II, when the USSR received nearly 400,000 tons of copper from the US under Lend-Lease agreements. In 1944, for example, shipments from the US totaled 233,400 tons, an amount that exceeded Soviet production by nearly 60 percent.

After World War II the USSR continued to import copper, but until 1953 receipts were fairly small, averaging less than 10,000 tons annually during 1946-52. During 1953-55, imports averaged more than 60,000 tons annually, all of which originated in the Free World.

* The estimates and conclusions contained in this report represent the best judgment of ORR as of 1 October 1957.

** Tonnages are given in metric tons throughout this report unless otherwise indicated.

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Following World War II, most of the exports of copper to the USSR originated in countries which are now members of the Coordinating Committee on International Export Controls (COCOM).^{*} Such exports were placed under quantitative control in August 1950 and under embargo in April 1951. All forms of copper were embargoed until mid-August 1954. At that time the export control lists were revised, and bare copper wire 6 millimeters (mm) and less in diameter was placed under surveillance.^{**} Other forms of copper remain embargoed. Until the removal of the embargo on bare copper wire, most of the copper shipped to the USSR was in unwrought forms. Since August 1954, however, exports have consisted principally of bare copper wire.

Although production of copper in the USSR has nearly tripled since the end of World War II, the demand for copper has nearly quadrupled. Most of the demand stems from the requirements of electrical equipment and machinery and from the manufacture of military end items. To keep pace with these demands, Soviet production of copper has been supplemented by substantial imports from the Free World and by withdrawals from the stockpile of copper, most of which was accumulated during World War II. It is believed that the stockpile was reduced from about 700,000 tons at the end of the war to a little less than 600,000 tons in 1955.

In view of the abundance of Soviet resources of copper and the methods and equipment employed in their exploitation, there is no natural or technological reason for the failure of the USSR to achieve self-sufficiency in copper. To explain this failure, it is necessary to consider the location of Soviet resources of copper and the characteristics of these resources, as well as the supply of needed machinery and manpower. Most of the Soviet resources of copper are located in the eastern part of Region Xa^{***} (Kazakhstan) and in Uzbek SSR in Region Xb (Central Asia), areas that are remote from centers of population and the manufacture of copper products. In addition, the copper ores are relatively low grade, probably averaging about 1 percent copper, and are oxidized. The rapid expansion of production

^{*} The members of COCOM are Belgium, Canada, Denmark, France, Greece, Italy, Japan, Luxembourg, the Netherlands, Norway, Portugal, Turkey, the UK, the US, and West Germany.

^{**} For a discussion of COCOM controls, see IV, A, p. 14, below.

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of copper metal under such conditions requires not only scientific and engineering skill but also a huge investment of capital. The processing of oxidized ores requires changing from flotation processes commonly used with sulfide ores to hydrometallurgical processes for use with oxidized ores. Such a change involves the replacement of considerable quantities of costly equipment. Mining, milling, and beneficiating low-grade copper ores must be largely a mechanized operation, and the current shortage of qualified labor in the USSR makes this requirement difficult to fill. Finally, the problem of assembling adequate supplies of power, labor, food, water, and the equipment for mining, milling, beneficiating, and refining is particularly difficult in view of the present facilities for transportation in the USSR.

Although the Sixth Five Year Plan (1956-60) calls for an increase of 60 percent in production of copper, the proportion of the investment in the nonferrous metals industry that will accrue to the copper industry probably will not be adequate to bring the production abreast of the growing demand. It is anticipated, therefore, that, in order to meet other industrial goals of the Plan, the USSR will continue to import copper from the Free World.

I. Distribution of Resources.*

Most of the resources of copper in the USSR are located in four economic regions -- Region V (Transcaucasus), mainly in the Armenian SSR; Region VIII (Urals); Region Xa (Kazakhstan); and Region Xb (Central Asia), mainly in Uzbek SSR. In 1937 these four regions accounted for nearly 93 percent of all the Soviet resources of copper. The copper content of these resources was estimated by the USSR at 17.1 million tons in 1936, 1/^{**} and 19.5 million tons in 1939. 2/ Although no official estimates of resources have been published by the USSR since 1939, the amount of geological prospecting reported suggests that additional resources of

* For further details on the major deposits of copper in the USSR, see Table 6, Appendix A, p. 30, below. For the location of these deposits, see the map, Figure 3, inside back cover.

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copper have been discovered since that date. The distribution of the resources of copper in the USSR in 1937, by economic region, was as follows 3/:

<u>Economic Region</u>	<u>Percent of Total</u>
V (Transcaucasus)	9.20
VIII (Urals)	15.97
Xa (Kazakhstan)	52.34
Xb (Central Asia)	15.04
Others	7.45
Total	<u>100.00</u>

Other resources of copper include the ores from Noril'sk, which contain a small percentage of copper in addition to nickel, cobalt, and metals of the platinum group, and the nickel-copper ores of the Kola Peninsula. Copper is produced in these two areas as a byproduct of the nickel-mining industry.

The oldest copper-producing region in the country is Region VIII. During the middle of the 18th Century, it was the leading copper-producing region of the world. The main copper belt extends southward along the eastern range of the mountains from Krasnoural'sk in Sverdlovskaya Oblast to Zlatoust in Chelyabinskaya Oblast. These deposits always have been of primary importance in the various attempts of the USSR to increase production of copper. Although deposits in some of the older producing areas are approaching exhaustion, additional discoveries resulting from more intensive exploration may be expected because of the size of the area.

Copper has also been produced for many years in Region V. In the 1890's the deposits at Zangezur (Kafan) and Shamlug (Alaverdi) were discovered and production was developed rapidly by foreign capital. Since that time, other deposits have been discovered, but most of them contain very low-grade ore. Inasmuch as Region V has been thoroughly explored geologically, the discovery of large new deposits containing high-grade ore is improbable.

The largest deposits of copper in the USSR have been found in Region Xa. These deposits form the basis of the Soviet copper industry and will become progressively more important. Although these deposits were discovered many years ago, they have become especially significant only since World War II. The deposit at Dzhezkazgan, probably the largest

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in the USSR, was discovered in 1771, but mining actually was not under way until 1906. The deposit at Kounrad was discovered in 1928. A third deposit, at Boshchekul, the existence of which also has been known for some time, is expected to be developed under the Sixth Five Year Plan. The lack of facilities for transportation probably explains the delay in developing this deposit.

A large deposit of copper, similar in both size and quality to the deposit at Kounrad, has been located at Almalyk in eastern Uzbek SSR, about 75 kilometers (km) southeast of Tashkent. The development of this deposit, interrupted by World War II, was resumed in 1946, 4/ but production had not started by 1949. No further mention of progress in exploiting this deposit was made until March 1956, when Pravda stated that the first section of the copper mine will begin operations in 1957 and that the first section of a copper smelter will be completed under the Sixth Five Year Plan. 5/

II. Remaining Reserves.

The Soviet press has provided little concrete information on results of exploratory work in the field of nonferrous metals in general and of copper in particular. Numerous statements of a general nature have been released indicating that exploratory activity has taken place. The geological organizations of the Ministry of Nonferrous Metallurgy did considerable work under the Fifth Five Year Plan and succeeded in expanding the reserves of nonferrous metallic ore. 6/ To what extent these efforts apply to reserves of copper, however, is not specified.

That the Soviet press has published few statements on copper should not be taken as indicating a lack of interest in developing new resources of copper. Bulganin has stated:

In the Sixth Five Year Plan, serious attention must be paid to the development of nonferrous metallurgy. A large quantity of copper, lead, and aluminum will be required for the new electric power stations and electric power network, for cable communication lines, accumulators, electrification of railways, and other needs of the national economy. In order to increase the production of nonferrous and rare metals, it is necessary to develop the ore base, improve the complex utilization of raw materials, and insure a fuller extraction of ores. 7/

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To accomplish these objectives, investment in the development of nonferrous metals is to increase sharply. In Region Xa, for example, the amount to be spent on expanding the nonferrous metallurgical industry under the Sixth Five Year Plan is more than 10 billion rubles,* or somewhat more than twice the amount spent under the Fifth Five Year Plan. 8/ Inasmuch as Region Xa is the leading copper-producing region and has the largest resources of copper in the USSR, it is probable that a sizable share of this investment will be spent in exploration and the development of new reserves of copper.

In view of various uncertainties, an estimate of the exact size of the total reserves of copper in the USSR is not warranted. It is possible, however, to estimate the minimum reserves of the USSR, which at the end of 1955 amounted to at least 16 million tons (reserves in 1939 less cumulative production through 1955). Even on this basis, which is conservative in the extreme, the reserves of copper in the USSR at the end of 1955 were exceeded only by those of the following countries: the Belgian Congo, Chile, Northern Rhodesia, and the US. It can be stated with assurance, therefore, that the reserves of copper in the USSR are among the largest in the world.

III. Production.

A. Metal.

The USSR is the largest producer of refined copper in the Sino-Soviet Bloc, probably accounting for more than 80 percent of the total production by the Bloc, and also ranks among the leading producers of the world. It is estimated that in 1955 the USSR produced 377,300 tons of refined copper, or about 10 percent of the world production, 9/ thus ranking second only to the US, which produced 1,430,000 tons. 10/

The USSR has been especially reticent about production of copper metal since the beginning of World War II. No tonnage figure for production of copper in the USSR as a whole or in any of its producing regions has been released since 1938, when production was said to have amounted to 103,200 tons, of which 83,700 tons were from ore. Other statements in the Soviet press made it possible to arrive at firm figures for production in

* The official rate of exchange, 4 rubles to US \$1, is not necessarily an accurate reflection of the dollar value.

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1939 and 1940. Although annual percentage increases have been published for most of the years since World War II, such percentages must be applied to a base figure. Uncertainty as to this base figure, usually taken to represent production in 1945, has given rise to divergent estimates, both here and abroad, of production of copper in the USSR since the war.

Three facts concerning achievements during the Fifth Five Year Plan were recently published, as follows 11/:

1. Production of blister copper in Region Xa in 1955 was 79 percent greater than in 1950.
2. In 1955, Region Xa produced 44 percent of all the copper produced in the USSR.
3. The total production of copper in the USSR in 1955 was 53 percent greater than in 1950.

These three statements, which are believed to relate to refined copper produced from both ores and scrap, can be related to other data published previously to derive a complete series of figures on production based entirely on information released by the USSR. The estimated production of copper in the USSR in 1913, 1937-55, and 1960 is shown in Table 1.* The estimated production of copper in the USSR, by economic region, in 1950-55 and 1960, is shown in Table 2.**

As indicated in Table 2, production of copper reached 377,300 tons in 1955, and Region Xa showed the greatest increase. In 1954, for the first time, more copper was produced in Region Xa than in Region VIII. In 1960, Region Xa is scheduled to produce more than one-half of the national total, with Region VIII contributing a little less than 30 percent. This trend results directly from the distribution of the resources of copper. Region Xa was reported to possess more than one-half of the resources of copper in the USSR in 1937. In view of the large size of Region Xa -- a little more than one-third as large as the US -- additional exploration may have disclosed new deposits of copper since that time. It is conceivable, therefore, that the reserves of copper in Region Xa are considerably larger than they were in 1937. In any case, Region Xa is expected to continue as the largest copper-producing region in the USSR for many years.***

* Table 1 follows on p. 8.

** Table 2 follows on p. 10.

*** Continued on p. 11.

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Table 1

Estimated Production of Copper in the USSR
1913, 1937-55, and 1960

Thousand Metric Tons					
Year	Region Xa <u>a/</u> (Kazakhstan)	Total	Year	Region Xa <u>a/</u> (Kazakhstan)	Total
1913	5.1 <u>b/</u>	31.0 <u>c/</u>	1947	57.7 <u>m/</u>	155.7 <u>n/</u>
1937	N.A.	97.6 <u>d/</u>	1948	63.9 <u>o/</u>	186.8 <u>p/</u>
1938	N.A.	103.2 <u>e/</u>	1949	77.9 <u>q/</u>	224.2 <u>r/</u>
1939	N.A.	142.5 <u>f/</u>	1950	92.7 <u>s/</u>	246.6 <u>t/</u>
1940	35.5 <u>g/</u>	161.0 <u>h/</u>	1951	98.3 <u>u/</u>	281.1 <u>v/</u>
1941	41.7 <u>i/</u>	186.8 <u>i/</u>	1952	109.4 <u>w/</u>	323.3 <u>x/</u>
1942	43.1 <u>i/</u>	164.0 <u>i/</u>	1953	120.6 <u>y/</u>	320.8 <u>z/</u>
1943	44.6 <u>i/</u>	141.2 <u>i/</u>	1954	143.3 <u>w/</u>	336.8 <u>aa/</u>
1944	52.6 <u>i/</u>	147.4 <u>i/</u>	1955	166.0 <u>bb/</u>	377.3 <u>cc/</u>
1945	55.0 <u>i/</u>	134.7 <u>j/</u>	1960	315.4 <u>dd/</u>	603.7 <u>ee/</u>
1946	55.0 <u>k/</u>	142.8 <u>l/</u>			

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- b. In 1913, Region Xa produced 5,070 tons of copper. 12/
c. 13/
d. In 1938, 5.7 percent more copper was smelted than in 1937. 14/
Production in 1938 is known, and production in 1937 was derived.
e. 15/
f. Production of copper in 1939 was 46 percent greater than that
in 1937. 16/
g. In 1940, smelting of black copper in Region Xa was seven times
greater than that in 1913. 17/
h. In 1940, production of copper was 65 percent greater than that
in 1937. 18/
i. For methodology, see Appendix B.
j. Derived from production in 1946, which was 6 percent greater
than that in 1945. 19/
k. Derived from production in 1947, which was 5 percent greater
than that in 1946. 20/
l. Derived from production in 1947, which was 9 percent greater
than that in 1946. 21/

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Table 1

Estimated Production of Copper in the USSR
1913, 1937-55, and 1960
(Continued)

- m. Derived from production in 1948, which was 10.7 percent greater than that in 1947. 22/
- n. Derived from production in 1948, which was 20 percent greater than that in 1947. 23/
- o. Derived from production in 1949, which was 22 percent greater than that in 1948. 24/
- p. Derived from production in 1949, which was 20 percent greater than that in 1948. 25/
- q. Derived from production in 1950, which was 19 percent greater than that in 1949. 26/
- r. Derived from production in 1950, which was 10 percent greater than that in 1949. 27/
- s. The planned production of copper in Region Xa in 1950 was to be 260 percent of production in 1940, 28/ or 92,274 tons. The Fourth Five Year Plan (1946-50) for production of copper in Region Xa was fulfilled by 100.5 percent. 29/
- t. Derived from production in 1955, which was 53 percent greater than that in 1950. 30/
- u. In 1951, production of copper in Region Xa was 6 percent greater than that in 1950. 31/
- v. In 1951, production of copper in the USSR was 14 percent greater than that in 1950. 32/
- w. Interpolated.
- x. In 1952, production of copper in the USSR was 15 percent greater than that in 1951. 33/
- y. In 1953, production of copper in Region Xa was 30 percent greater than that in 1950. 34/
- z. Derived from production in 1954, which was 5 percent greater than that in 1953. 35/
- aa. Derived from production in 1955, which was 12 percent greater than that in 1954. 36/
- bb. In 1955, production of blister copper in Region Xa was 79 percent greater than that in 1950. 37/
- cc. In 1955, Region Xa produced 44 percent of the copper produced in the USSR. 38/ Production of copper in the USSR has been computed from this fact.
- dd. The planned production of blister copper in Region Xa in 1960 is 190 percent of that in 1955. 39/
- ee. The planned production of copper in the USSR in 1960 is 160 percent of that in 1955. 40/

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Table 2

Estimated Production of Copper in the USSR, by Economic Region a/
1950-55 and 1960

Thousand Metric Tons							
Year	Region Ia (Northwest)	Region V (Transcaucasus)	Region VII (Central)	Region VIII <u>b/</u> (Urals)	Region Xa <u>c/</u> (Kazakhstan)	Region XI (East Siberia)	Total <u>c/</u>
1950	6.0 <u>d/</u>	13.0	50.0 <u>e/</u>	82.9	92.7	2.0 <u>f/</u>	246.6
1951	7.0	14.0	50.0	108.8	98.3	3.0	281.1
1952	8.0 <u>d/</u>	16.0	50.0	135.9	109.4	4.0 <u>f/</u>	323.3
1953	8.0	17.0	50.0	120.2	120.6	5.0	320.8
1954	8.0	19.0	50.0	110.5	143.3	6.0	336.8
1955	8.0	20.0 <u>g/</u>	50.0	126.3	166.0	7.0	377.3
1960	15.0	25.0	60.0	178.3	315.4 <u>h/</u>	10.0	603.7 <u>h/</u>

b. Difference between the total production in the USSR and the sum of production in the other regions.

c. Figures are taken from Table 1, p. 8, above.

d. 41/

e. 42/

f. 43/

g. 44/

h. Plan figure.

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Under the Sixth Five Year Plan, production of copper in the USSR is scheduled to increase 60 percent over that in 1955. Attainment of this goal will result in production in 1960 of a little more than 600,000 tons, an increase of 226,000 tons over that in 1955. Two-thirds of the increase is to come from Region Xa, where production is scheduled to increase from 166,000 tons in 1955 to slightly more than 315,000 tons in 1960, a gain of nearly 150,000 tons. In 1960 the share of Region Xa in the total production of copper in the USSR will be more than 50 percent. Reliable data on the plans for production of copper in other regions are not available. It is anticipated, however, that the producers of copper in Region VIII also will be called upon to increase their production. Except for Region Xa, the estimates of production in 1960 shown in Table 2 represent an attempt to apportion the planned production of copper in 1960 among the producing regions on the basis of fragmentary qualitative information.

B. Mines and Mining Areas.*

The three principal mining areas in Region V are at Zangezour, Kadzharan, and Shamlug. Most of the resources of copper are centered in the Zangezour district, where lode deposits containing 2 to 5 percent copper have been reported. The ore is chiefly chalcopyrite, occurring in irregular veins in andesite. At Kadzharan the deposit is porphyritic, containing about 0.6 percent copper. At Shamlug the grade of the ores available for exploitation is becoming progressively lower.

Of the principal copper mines in Region VIII, those at Degtyarka, Krasnoural'sk, and Blyava are reported to be among the most important. Copper is mined in the Degtyarka district from a deposit 5 km long. Three shafts are operating, and all are equipped with modern machinery. ^{45/} The ore is reported to contain about 1.4 percent copper. ^{46/} Copper-bearing pyrites, averaging about 2.2 percent copper ^{47/} with small percentages of tin and zinc, are mined at Krasnoural'sk. At Blyava, all mined ore is chuted to the main level, where it is transported by a system of electric haulage to the hoisting shaft and thence to the surface for processing. The mine has up-to-date equipment, and mechanization has played an important role in maintaining the level of production. ^{48/}

* For further details on the major deposits of copper in the USSR, see Table 6, Appendix A, p. 30, below. For the location of these deposits, see the map, Figure 3, inside back cover.

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The future of the copper industry in the USSR depends on the exploitation of large, low-grade deposits in Region Xa. The Kounrad open-pit mine in Region Xa is the largest copper-mining operation in the USSR 49/ and compares favorably in size with some of the open-pit mines in the US. After about a decade of development, this mine began operating in 1939. 50/ Production of ore in 1940 amounted to only 7,500 tons, but the Fourth Five Year Plan (1946-50) called for production of 22,500 tons per day in 1950. 51/ It is estimated that in 1955 the daily production amounted to about 27,000 tons. The ore, containing about 1.1 percent copper, is mined with power shovels and transported about 20 km over an electrified railroad to the concentrator at Balkhash. 52/

The reserves of copper-impregnated sandstone in the deposit at Dzhezkazgan are spread over a large area. Mining operations are conducted from at least 50 shafts which have been sunk in all parts of Dzhezkazgan. 53/ There may be some open-pit mining where the ore outcrops or is near the surface. The mines are located in a semidesert where the supply of water is dependent on the spring run-off from melting snow. To eliminate fluctuations in the water supply, a dam to impound the seasonal water run-off for use in the Kingir concentrator during the long, dry summer has been constructed on the Karakingir River. The planned capacity of the dam is 125 million cubic meters. 54/

C. Beneficiation.

Most of the copper ores in the USSR must be beneficiated before they can be smelted. At the time when most of the concentrating plants were built, selective flotation was well advanced in the US, and much of the technical aid needed by the USSR to establish and operate such plants was furnished by the US.

Little information has been released by the USSR in the last 20 years regarding the beneficiation of copper ores. Considerable data have been gleaned, however, from reports describing operations on the ores from Region VIII during 1935. For example, the copper content of the ores from this region ranged from 1.73 to 4.07 percent, with an average of 2.57 percent. The copper content of the concentrates averaged 12.0 percent, but only 80.1 percent recovery in the concentrates was achieved. These data indicate that the process of selective flotation had not been mastered. With a relatively high-grade ore the concentrate was low-grade, and the recovery of copper in the concentrator ranged from poor to fair. The Plan for 1941, however,

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indicated some improvement, and a higher recovery in the concentrators was expected from a lower grade of ore. ^{55/} It is also noteworthy that the average grade of ore in Region VIII had dropped from 2.57 percent copper in 1935 to 1.95 percent under the Plan for 1941. Inasmuch as substantially greater recoveries are achieved in the US from similar grades of ore, it is possible that recoveries have increased measurably in the USSR since that time.

D. Smelters.*

The USSR has at least 12 smelters for smelting ores and concentrates, and 1 utilizing copper scrap as the primary charge. The total smelting capacity is believed to range between 477,000 and 481,000 tons, about 30 percent of which is represented by the plant at Balkhash. Other smelters are situated at Revda (estimated capacity, 50,000 tons) and Krasnoural'sk (estimated capacity, 40,000 tons) in Region VIII, and the scrap smelter (estimated capacity, 55,000 to 60,000 tons) is located at Moscow. These smelters constitute about 30 percent of the total estimated capacity. Of the remaining capacity, about one-half is located in Region VIII. As early as 1941 a copper-smelting plant with a capacity of about 150,000 tons had been planned for Almalyk in Uzbek SSR, but little progress was made because the ores are badly oxidized and difficult to process. Methods of enrichment used elsewhere in the USSR were not adaptable to these oxidized ores, and a new technique had to be developed before production of copper could be achieved. Inasmuch as the work of preparing deposits for mining has been resumed at Almalyk, it is probable that a suitable technique has been developed. US mining journals have contained enough information on the treatment of oxidized ores to give the USSR all the technical information needed.

E. Electrolytic Refineries.**

In 1941 there were only three refineries in the USSR for producing electrolytic copper, located at Pyshma, Kyshtym, and Moscow. The refinery at Moscow utilizes scrap as raw material. Since 1941,

* For further details on copper smelters in the USSR, see Table 7, Appendix A, p. 33, below. For the location of these smelters, see the map, Figure 3, inside back cover.

** For further details on electrolytic refineries in the USSR, see Table 8, Appendix A, p. 35, below. For the location of these refineries, see the map, Figure 3, inside back cover.

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four additional electrolytic refineries have been placed in operation, and the current refining capacity in the USSR is estimated to range between 430,000 and 470,000 tons, of which the plant at Balkhash in Region Xa accounts for a little more than 35 percent. Originally, the plant at Balkhash fire-refined copper, but since about 1952 the electrolytic process has been installed, making it one of the largest electrolytic copper refineries in the country and an important factor in the development of the resources of copper in Region Xa. Provisions are reported to have been made to install a second section in the electrolytic plant, increasing the annual capacity of the plant to about 175,000 tons.

IV. Trade.

A. East-West.

The USSR has been a net importer of copper for many years. Just before World War II, imports of copper by the USSR are believed to have been nearly equal to the Soviet domestic production. Imports of copper by the USSR from the US alone in 1940 amounted to more than 50,000 tons. 56/ From mid-1941 through mid-1945 the USSR imported about 400,000 tons of electrolytic copper, tubes, sheets, copper-base alloys, and copper wire and cable from the US under Lend-Lease agreements. 57/ Before 1939 and after 1945 the USSR obtained only minor amounts of copper from the US. Information on Soviet imports of copper from the rest of the world during World War II is not available.

In 1948, as a result of a decision of the National Security Council, the US instituted controls over exports of strategic materials to the Soviet Bloc. 58/ The US also urged other countries to follow suit, and in the latter half of 1949 a Consultative Group (CG) was formed, with representation from the US and several Western European countries. In 1950 the CG established COCOM in Paris as the working group of the CG.*

In April 1951, copper in the form of ores, concentrates, scrap and old metal, and in primary forms was placed under international control for the first time. 61/ Semifinished forms such as



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plates, sheets, and bare wire were placed under control in October 1951. All such forms of copper remained embargoed to the Sino-Soviet Bloc until mid-August 1954, at which time bare copper wire, 6 mm or less in diameter, was removed from the list of items embargoed (IL-I)* to the Soviet Bloc and placed under surveillance (IL-III).* The controls on the other forms of copper remained unchanged through the end of 1955, and all forms of copper remained embargoed to Communist China.

The USSR imported only very small quantities of copper from the Free World in the years immediately following World War II, but such quantities increased very rapidly after 1950. During the period from 1951 to 1954, when all exports of copper to the USSR from the major producers of the Free World were embargoed, a lively illegal trade in copper developed. [REDACTED]

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[REDACTED] After mid-August 1954, most of the trade in copper consisted of legal shipments of copper wire. Because these shipments are reported in the official trade statistics of the exporting countries, the estimate for 1955, which is based on these data, is believed to be much more accurate than estimates for earlier years. Estimated imports of copper by the USSR, 1946-55, are shown in Table 3.**

With the removal of copper wire from IL-I in 1954, imports of wire by the USSR increased significantly, although total Soviet imports of copper declined slightly. The relaxation of the embargo on copper wire enabled the USSR to enter the world market and purchase wire at competitive prices. Thus, copper wire of 6 mm or less in diameter constituted more than 90 percent of all the copper imported by the USSR in 1955 except for covered wire and cable. Slightly more than one-half of this quantity was obtained from the UK, with most of the balance coming from other members of COCOM.

* Items which are embargoed to the Soviet Bloc are on International List I (IL-I); those subject to quantitative control, on International List II (IL-II); and those subject to surveillance, on International List III (IL-III). 62/

** Table 3 follows on p. 17. [REDACTED]

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B. Intra-Bloc.

The trade in copper between the USSR and the Free World is difficult to gauge, but the trade between the USSR and the Satellites is less elusive. The available evidence indicates that Soviet imports of copper from the Satellites are about equal to Soviet exports of copper to the Satellites.

Before 1952, all of the copper produced in Bulgaria was shipped to the USSR for refining. Since 1952, when a refinery with a capacity of 5,000 tons was installed at Eliseyna in Bulgaria, only the copper produced in excess of the refining capacity has been shipped to the USSR. 64/ Estimates of Soviet imports of copper from Bulgaria during 1950-55 are as follows:

<u>Year</u>	<u>Amount</u> <u>(Thousand Metric Tons)</u>
1950	2.4
1951	3.0
1952	0
1953	1.8
1954	3.0
1955	5.5

In return the USSR exports refined metal to Bulgaria, probably in amounts equivalent to imports of ore and concentrates.

Somewhat similar is the arrangement between the USSR and East Germany. In this case the USSR exports unwrought copper, perhaps as much as 10,000 tons annually, to East Germany, which fabricates this copper and returns the products to the USSR.

Relatively small amounts of refined copper and copper alloys, probably not exceeding 5,000 tons in any recent year, are shipped to Rumania and to Communist China. Whereas most of the shipments to Rumania are believed to be exported in return for imports of copper ore and perhaps for concentrates as well, those to Communist China may actually constitute exports in the true sense of the word.

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Table 3

Estimated Imports of Copper by the USSR
1946-55

Thousand Metric Tons				
<u>Year</u>	<u>Amount</u>		<u>Year</u>	<u>Amount</u>
1946	0.3 <u>a/</u>		1951	21.0 <u>f/</u>
1947	0.1 <u>b/</u>		1952	18.0 <u>f/</u>
1948	4.7 <u>c/</u>		1953	61.0
1949	14.2 <u>d/</u>		1954	73.0
1950	6.0 <u>e/</u>		1955	49.2

a. 65/

b. 66/

c. Including about 4,000 tons of copper and copper wire 67/ and about 700 tons of covered wire and cable. 68/

d. Including about 9,000 tons of copper and copper wire 69/ and about 5,200 tons of covered wire and cable. 70/

e. 71/



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V. Demand.

The USSR has released no substantive information on the use of copper for more than 20 years. Soviet statements have consisted only of general allusions to the importance of the metal in its program of expanding heavy industry. In order to estimate the demand for copper in the USSR, therefore, an indirect methodology must be employed. In the US, a direct relationship exists between production of crude steel* and consumption of unwrought copper (copper

* For methodology and for data on production of crude steel and consumption of refined copper in the US, 1930-55, see Table 9, Appendix B, p. 39, below.

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metal produced from ores, concentrates, and scrap). The relationship is believed to be causal: the specific properties of copper make it complementary to steel rather than competitive, as is the case with aluminum, titanium, and magnesium.

Accurate data on production of crude steel in the USSR are available for the years 1929-55 except for 2 or 3 years during World War II, when there are uncertainties as to the dates that production ceased at some of the plants overrun by the invading Germans. Firm data also are available on the production, importation, and exportation of copper in the years 1929-33. Although the changes in the level of the stocks of copper are unknown, it is believed that the annual production plus imports minus exports (which were zero), averaged for the years 1929-33, will cancel any changes in stocks that may have occurred and will, therefore, indicate within reasonable limits the level of the demand for copper. The demand for copper in the years 1934-55 was estimated on the basis of the increase in production of steel, using the average annual production of steel in 1929-33 as a base. The estimated demand for copper in the USSR, 1929-55, is shown in Table 4.* The demand for copper can be estimated within reasonable limits on the basis of its relationship to production of steel for past years, and the same technique probably can be used to forecast its future growth. The Sixth Five Year Plan calls for an increase of 50 percent in production of steel. Accordingly, the demand for copper also is expected to increase 50 percent over that in 1955. On this basis the demand for copper in 1960 can be estimated at about 671,000 tons. Available data are too fragmentary to apportion this total among the chief consumers, except for electrical machinery, which is expected to consume about 390,000 tons of copper in 1960. 72/

An exhaustive analysis has been made of the electrical machinery industry of the USSR. 73/ This analysis concluded that about 240,000 tons of refined copper were consumed in the USSR during 1955 in the production of motors, generators, power and distribution transformers, switchgear equipment, electric wire and cable, and communications equipment.

Information on the quantities of copper for uses other than electrical machinery in the USSR is very sparse and fragmentary, but intelligence studies based on interpretations of such data make possible

* Table 4 follows on p. 19.

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Table 4
Estimated Demand for Copper in the USSR
1929-55

Year	Production of Steel a/ (Million Metric Tons)	Index of Production (1929-33 Average = 100)	Estimated Demand for Copper b/ (Thousand Metric Tons)	Year	Production of Steel a/ (Million Metric Tons)	Index of Production (1929-33 Average = 100)	Estimated Demand for Copper b/ (Thousand Metric Tons)
1929	4.9			1943	7.5	129	106.2 d/
1930	5.8			1944	10.7	184	151.5 d/
1931	5.6	100	60.9 e/	1945	12.3	212	174.5 d/
1932	5.9			1946	13.3	229	139.5
1933	6.9			1947	14.5	250	152.3
1934	9.7	167	101.7	1948	18.6	321	195.5
1935	12.6	217	132.2	1949	23.3	402	244.8
1936	16.4	283	172.3	1950	27.3	471	286.8
1937	17.7	305	185.7	1951	31.4	541	329.5
1938	18.1	312	190.0	1952	34.5	595	362.4
1939	17.6	303	184.5	1953	38.1	657	376.1 e/
1940	18.3	316	192.4	1954	41.4	714	408.7 e/
1941	16.7	288	237.0 d/	1955	45.3	781	447.1 e/
1942	6.5	112	92.2 d/				

a. 1929, 74/; 1930-40 and 1945-55, 75/; 1941-44, 76/.

b. The coefficient of correlation between the demand for copper and the production of steel in the USSR was assumed to be 1. Although this degree of correlation is known to be too high statistically, it is assumed to be reasonable in the case of the USSR because the emphasis on heavy industry reflects a different pattern of consumption and creates a higher correlation between the demand for copper and the production of steel than would occur in countries where production is more evenly balanced between light and heavy industry. For methodology, see Appendix B.

c. It has been assumed that for the years 1929-33 the supply of copper and the demand for copper were in balance. The average annual supply of copper during this period has been estimated at 60,900 tons. (See Table 5, p. 22, below).

d. Increased by a factor of 1.35 to reflect the greater consumption of copper per ton of steel resulting from production of ammunition during World War II.

e. Reduced by a factor of 0.06 to adjust for the substitution of copper by aluminum, allowing a 2-year technological lag behind the US.

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some estimates of other specific uses. For example, the shipbuilding industry of the USSR is estimated to have consumed about 20,000 tons of copper for all types of vessels, naval and commercial, in 1955. Similar estimates have been made of consumption of copper (excluding wire and cable) in the manufacture of automobiles; tractors; locomotives and rolling stock; agricultural machinery, machine tools, and metal-forming machinery; and aircraft. The difference between the sum of these uses and the estimated total consumption of copper must be consigned to other manufacturing uses that cannot be identified separately and to direct military consumption, including ammunition. The estimates of consumption of copper in the USSR for these various uses in 1955 are as follows:

<u>Use</u>	<u>Amount</u> <u>(Thousand Metric Tons)</u>
Electrical machinery	240
Automobiles	20
Ships	20
Tractors	5
Locomotives and rolling stock	4
Agricultural machinery, machine tools, and metal-forming machinery	4
Aircraft	1
Direct military and miscellaneous manufacturing equipment	153
Total	<u>447</u>

The methodology employed in estimating consumption of copper in the USSR has taken into consideration an intensive program for production of ammunition during World War II. The methodology also provides for a fairly substantial program for production of ammunition in peacetime comparable to that of the US and allows for considerable substitution of aluminum for copper. It is known that the USSR has significant substitution in the electric wire and cable industry, in the automotive industry, and to some extent in the transformer industry. 77/ These data suggest that the USSR probably has carried the substitution of aluminum for copper about as far as has the US.

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VI. Supply and Demand Balance.

The available supply of copper in the USSR, shown in Figure 1,* is made up essentially of domestic production and importation from the Free World (net exports being negligible). The supply and demand balance of copper in the USSR for the years 1929-55 is shown in Table 5.** The annual differences between supply and demand are shown as stock changes. The data in this table indicate that during the 1930's the demand for copper increased faster than domestic production. Only part of the deficit was met by imports and the remainder apparently was met by withdrawals from stocks. A critical shortage of foreign exchange probably explains the failure to import larger quantities.

Later in the 1930's and throughout World War II the USSR imported sizable quantities of copper. These imports, added to domestic production, gave the USSR a supply of copper in excess of demand each year during 1937-47. The only exception was the year 1941, when the nonaggression pact between the USSR and Germany had its maximum effect on the world copper market, which was controlled mainly by the Allies.

During 1948-55, withdrawals from stocks of copper are believed to have been resumed, except in 1953 and 1954, when supply and demand were very nearly in balance. Although positive information that stocks of copper were reduced during this period is not available, there is ample evidence that a shortage of copper has existed in the USSR since 1950. Three factors are believed to account for this shortage, as follows: the failure of the copper industry to meet the goal for production of the Fifth Five Year Plan, the high price of copper on the world market, and the restrictions on exports of copper imposed by members of COCOM. In any event, it is highly unlikely that stocks of copper in the USSR were augmented during this period.

A comparison of the planned production of copper in the USSR of 604,000 tons in 1960 with the estimated demand for copper of nearly 671,000 tons indicates that there will be a deficit of copper of approximately 67,000 tons. This deficit is about equal to that of 1955, which was met by imports from the Free World and by withdrawals from the stockpile. Inasmuch as the Satellites are also

* Following p. 22.

** Table 5 follows on p. 22.

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Table 5
Supply and Demand Balance of Copper in the USSR
1929-55

Thousand Metric Tons						
Year	Production ^{a/}	Imports ^{b/}	Total Supply ^{c/}	Estimated Demand ^{d/}	Indicated Changes in Stocks ^{e/}	Minimum Stocks on Hand ^{f/}
1929	35.5	25.1	60.6	60.9 ^{g/}	0	88.9 ^{h/}
1930	44.5	20.6	65.1			
1931	44.3	25.1	69.4			
1932	45.0	12.0	57.0			
1933	44.3	7.9	52.2	101.7	-36.9	52.0
1934	53.3	11.5	64.8			
1935	76.0	29.6	105.6	132.2	-26.6	25.4
1936	100.7	46.2	146.9	172.3	-25.4	0
1937	97.6	103.1	200.7	185.7	15.0	15.0
1938	103.2	125.4	228.6	190.0	38.6	53.6
1939	142.5	72.8	215.3	184.5	30.8	84.4
1940	161.0	84.0	245.0	192.4	52.6	137.0
1941	186.8	11.2	198.0	237.0	-39.0	98.0
1942	164.0	94.7	258.7	92.2	166.5	264.5
1943	141.2	135.0	276.2	106.2	170.0	434.5
1944	147.4	233.4	380.8	151.5	229.3	663.8
1945	134.7	63.0	197.7	174.5	23.2	687.0
1946	142.8	0.3	143.1	139.5	3.6	690.6
1947	155.7	0.1	155.8	152.3	3.5	694.1
1948	186.8	4.7	191.5	195.5	-4.0	690.1
1949	224.2	14.2	238.4	244.8	-6.4	683.7
1950	246.6	6.0	252.6	286.8	-34.2	649.5
1951	281.1	21.0	302.1	329.5	-27.4	622.1
1952	323.3	18.0	341.3	362.4	-21.1	601.0
1953	320.8	61.0	381.8	376.1	5.7	606.7
1954	336.8	73.0	409.8	408.7	1.1	607.8
1955	377.3	49.2	426.5	447.1	-20.6	587.2

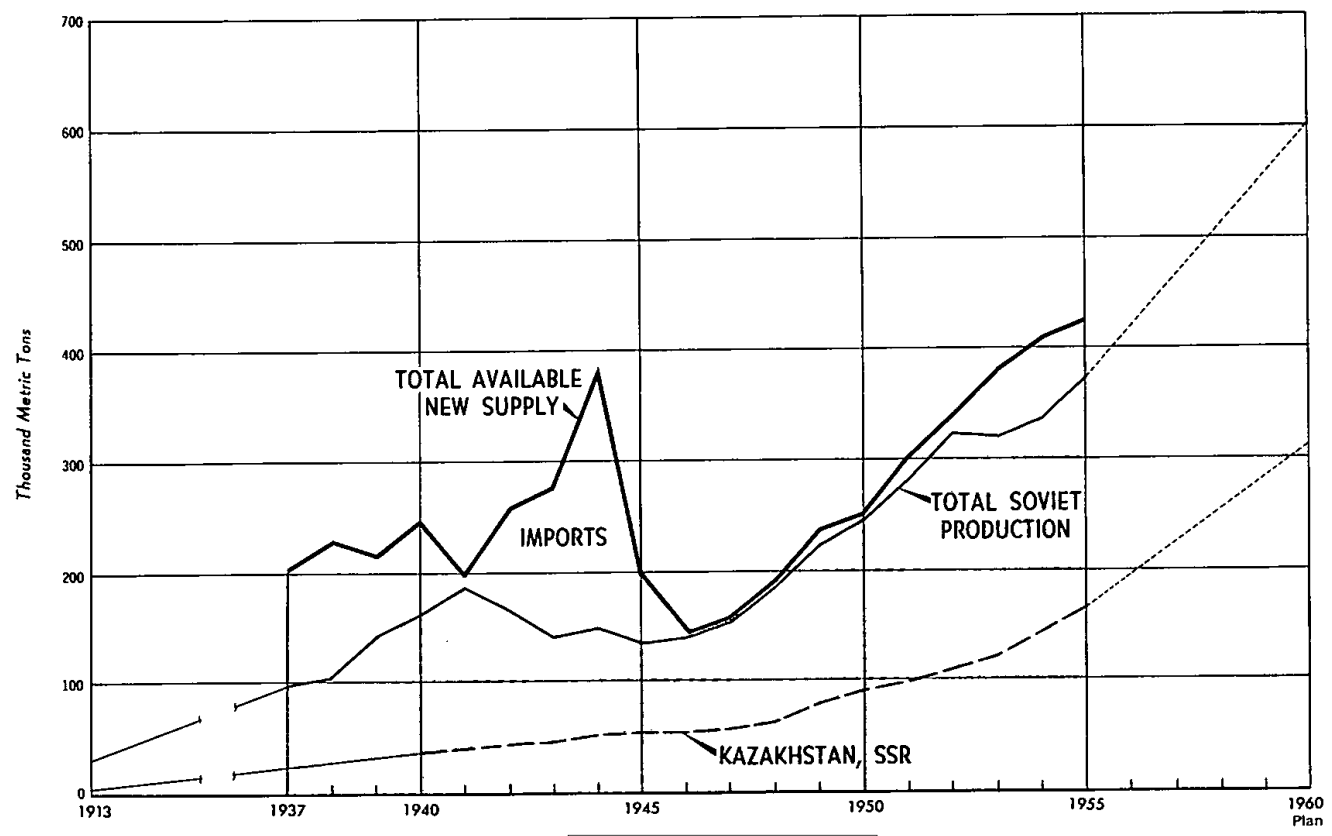
a. 1929-35, ^{78/}; 1936, ^{79/}; 1937-55, from Table 1, p. 8, above.
 b. 1929-37, ^{80/}; 1938, ^{81/}; 1939-45, ^{82/}; 1946-55, from Table 3, p. 17, above.
 c. Sum of production and imports.
 d. From Table 4, p. 19, above.
 e. Difference between supply and demand.
 f. Accumulated stock changes.
 g. Average.
 h. At least this quantity must have been available because stocks at the close of 1936 could not have been less than zero.

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Figure 1

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USSR PRODUCTION AND IMPORTS OF COPPER 1913, 1937-55, and 1960 PLAN



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deficient in resources of copper, and in view of the growing domestic demands, it appears that the USSR will continue to rely on the Free World for supplies of copper throughout the Sixth Five Year Plan. Probably the only feasible alternative is for the USSR to engage in an even more rigorous and stringent program to conserve copper through the intensive substitution of aluminum and plastics.

Dependence on imports of copper is not believed to have resulted from any technological deficiency on the part of the USSR. Abundant evidence is available that indicates that the USSR has an adequate working knowledge of all phases of copper operations, from exploratory drilling to electrolytic refining. The USSR also is capable of producing equipment for mining, milling, and handling materials which compares favorably in both size and quality with that of the US.

There are two main reasons why the copper industry has lagged in the industrial development of the USSR. One is the remoteness of the areas in which most of the Soviet resources of copper are located, and the other is the general Soviet policy of emphasizing immediate gains in production at the expense of long-range developments.

As previously indicated, more than one-half of the resources of copper in the USSR are located in the eastern part of Region Xa. In 1955, nearly one-half of the Soviet production of refined copper was produced in Region Xa. On the other hand, most of the copper produced is consumed in other parts of the country.

The principal consumer of copper in the USSR is the electric wire and cable industry. None of the known plants manufacturing electric wire and cable is located in Region Xa, and only one -- the Salar Electric Cable Plant at Tashkent -- is located in Region Xb (Central Asia). In 1955 the plant at Tashkent accounted for only 6 percent of the national production of electric wire and cable. On the other hand, production of electric wire and cable in regions west of the Urals* accounted for about 68 percent of the total production of electric wire and cable, whereas these regions accounted for only about 21 percent of the national production of refined copper. 83/

* Economic Regions Ia (Northwest), Ib (North), IIa (Baltic), IIb (Belorussia), III (South), IV (Southeast), V (Transcaucasus), and VII (Central).

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Of perhaps even greater significance, however, is the logistic burden resulting from the remote location of Soviet resources of copper with respect to the sources of supply of equipment, materials, and labor. As the trend toward exploiting leaner ores in open-pit mines in Region Xa and probably also in Uzbek SSR continues, the need for more equipment and materials will intensify. The mining and efficient processing of the lean ore of the type most common in these regions require large quantities of heavy, power-driven, earthmoving equipment; large milling and concentrating plants; plentiful supplies of fuel, power, and water; sizable inventories of spare parts; and an abundance of skilled labor. The necessity of hauling machinery, equipment, and other essential supplies over long distances will continue to place a heavy burden on the transportation system. Although the USSR has proved capable of manufacturing the required machinery and equipment and probably has available adequate supplies of power, water, labor, and food, it is by no means certain that the present facilities for transportation can bring all these factors together simultaneously in Region Xa and Uzbek SSR in sufficient quantity to expand production to the desired levels and meet other planned objectives as well.

The national and the regional press have emphasized repeatedly that the USSR has not been devoting the necessary attention and funds to developmental work in various phases of the copper industry. For example, the lag in developing the ore base is claimed to have retarded the expansion of the copper industry. 84/ The use by many plants of outmoded, unimproved machinery and equipment for enriching ore and for smelting and refining is said to have resulted in extremely high losses of metal. In mid-1956 it was announced that cumulative losses of copper throughout the nation amounted to 21 percent of the metal contained in the ore. 85/ In comparison with the US, where losses probably average not more than 10 percent, the losses in the USSR must be considered excessive. Although one regional newspaper has pointed out that a good technological method for processing the complex ores found in Region Xa has not been developed, 86/ other criticism contends that satisfactory technological processes for ore concentration have been developed but that they have not been put into practice. 87/ In view of the fact that US technical journals on mining and metallurgy have published many articles on all aspects of copper technology, the failure of the USSR to reduce metal losses and to install and utilize modern methods and equipment must be attributed to lack of investment in these phases of the industry rather than to

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lack of knowledge or ineptitude. Such investment presumably was not made because the results would not have been as immediate as investment elsewhere, such as in equipment for excavating, hauling, and handling materials.

VII. Stockpile.

The USSR is known to have been engaged in an extensive stockpiling program for many years, but its exact magnitude is unknown. [REDACTED]

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[REDACTED] it is certain that the USSR emerged from the war with a sizable stockpile of copper metal. On the basis of available data on production, importation, exportation, and consumption, this reserve is calculated to have amounted to approximately 700,000 tons in 1946.*

Since the war the Soviet demands for copper have expanded more rapidly than has the domestic production. To meet the increased needs for copper the USSR has increased the domestic production, but the rate of increase has not been great enough to keep abreast of the demand. As a result, additional supplies were imported from the Free World to the extent possible, with the remaining deficit being met by withdrawals from the stockpile. Although estimates of withdrawals from stockpiles in any 1 year are necessarily tenuous, there is little doubt that significant withdrawals from stocks have been made during the past 6 years. Such withdrawals are estimated to have reduced the stockpile of copper by a little more than 100,000 tons since World War II. The evolution of the stockpile of copper in the USSR during 1937-55 is shown in Figure 2.**

VIII. Capabilities, Vulnerabilities, and Intentions.

Because copper is essential in many phases of Soviet industry, inadequate supplies of copper have a retarding effect on the over-all development and expansion of industry generally. Although the USSR has evaded stating directly whether the goal of the Fourth Year Plan for production of copper was fulfilled, there is no doubt that the goal of the Fifth Five Year Plan for production of copper was not. Meanwhile, the demands for copper in the USSR have been rising steadily. Consequently, the USSR had to supplement production of copper and

* See Table 5, p. 22, above.

** Following p. 26.

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withdraw significant quantities from the stockpile of copper. The only alternative was to retard the over-all growth of industry generally by allocating smaller supplies of copper to consumers. Inasmuch as there are no countries in the Sino-Soviet Bloc which produce a surplus of copper, the USSR imported supplies from the Free World. In view of the failure to mine and process sufficient copper to meet the goals of the Fifth Five Year Plan, the failure to make adequate investment in the long-range development of the industry, and the tremendous logistics problem facing the industry, it is anticipated that the USSR will have to rely on the Free World for a significant portion of its new supplies of copper, at least through 1960. Such imports would, of course, be cut off with the outbreak of hostilities. In this event, unless the USSR had been able to accumulate, through more sizable imports, a much larger stockpile than it now has, the country would be in a vulnerable position.

Under the Sixth Five Year Plan the USSR proposes to increase production of copper by 60 percent, or by about 225,000 tons. This plan may be compared with the achievements in the course of the Fifth Five Year Plan, when production increased by 53 percent (the plan called for 90 percent), or about 131,000 tons. The amount of capital invested in the entire nonferrous metallurgical industry under the Sixth Five Year Plan is to be 2.3 times greater than was invested under the Fifth. 88/ Because of the importance of copper to the Soviet economy, it is assumed that a considerable share of this increase will accrue to the copper industry.

If the Sixth Five Year Plan for production of copper is achieved, production in 1960 will be about 604,000 tons. Under the same plan the USSR intends to increase production of crude steel by about 50 percent, which will bring production in 1960 to about 68 million tons. On the basis of the copper-to-steel ratio that is believed to have prevailed during the latter part of the Fifth Five Year Plan -- that is, nearly 1 ton of copper consumed for each 100 tons of crude steel consumed -- the demand for copper in 1960 may exceed the domestic production by about 67,000 tons if all other conditions remain approximately equal. Even if further steps are taken to substitute other materials for copper and allocations to consumers are controlled more rigidly than was the case under the Fifth Five Year Plan, continued dependence on imported supplies and withdrawals from stocks may be anticipated.

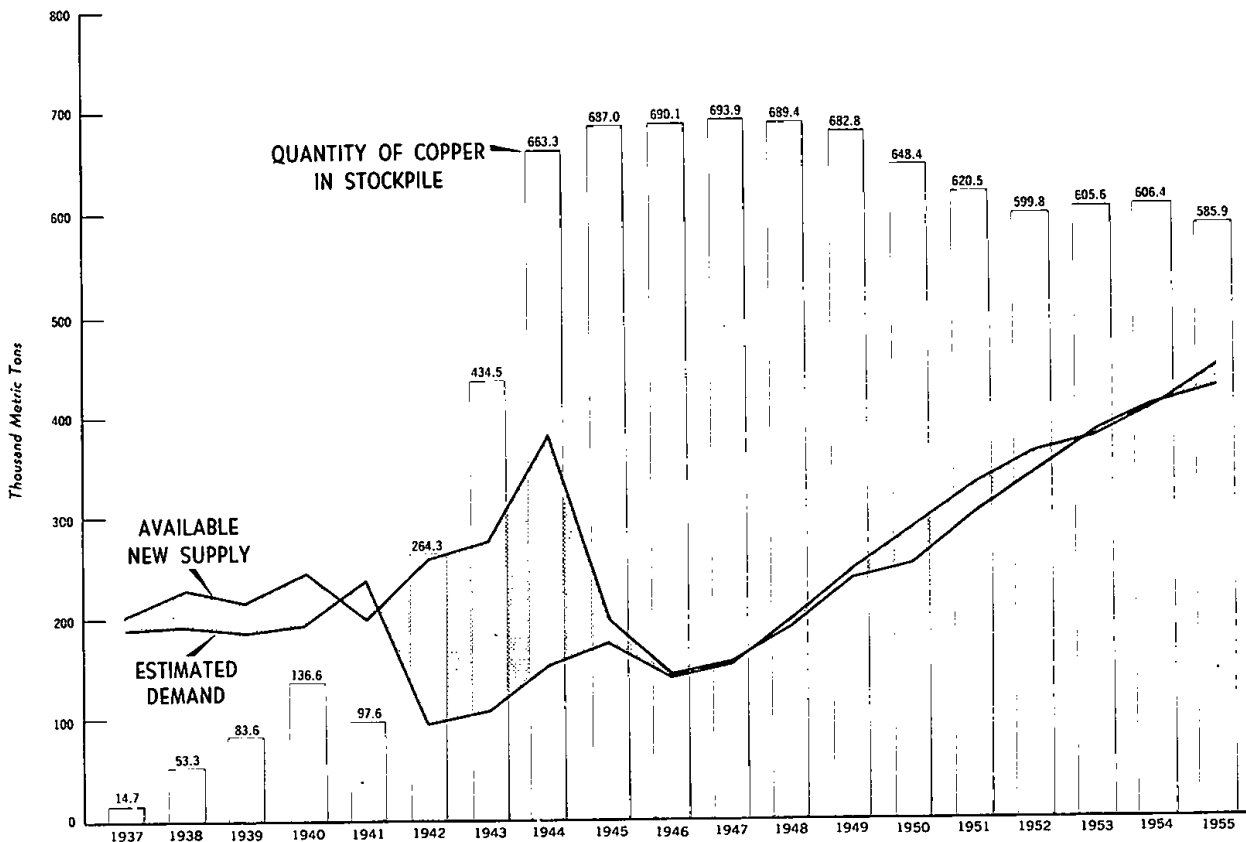


USSR

Figure 2

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EVOLUTION OF THE COPPER STOCKPILE, 1937-55



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Although no direct evidence can be cited to support this contention, indirect evidence exists in the magnitude of the imports of copper from the Free World. During 1953-55, imports ranged from a low of 49,000 tons to a high of 73,000 tons.* In 1956, imports amounted to nearly 60,000 tons, suggesting that no significant progress has been made toward overcoming the deficit between domestic production and demand. It appears, therefore, that the USSR does not expect to become self-sufficient in copper by the end of the Sixth Five Year Plan in 1960. Although investment in the copper industry probably is much higher than in any previous plan, the size of the investment required to expand the domestic production to the point of self-sufficiency may have been considered too great. Continued reliance on supplies of copper from the Free World may, therefore, have been judged to be the more prudent course.

* See Table 3, p. 17, above.

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APPENDIX A

DEPOSITS OF COPPER AND PROCESSING FACILITIES IN THE USSR

Available information on the major deposits of copper and processing facilities in the USSR is shown in the tables which follow. Major deposits of copper in the USSR in 1955 are shown in Table 6.* Copper smelters in the USSR in 1955 are shown in Table 7.** Electrolytic copper refineries in the USSR in 1955 are shown in Table 8.***

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- * Table 6 follows on p. 30.
 - ** Table 7 follows on p. 33.
 - *** Table 8 follows on p. 35.

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Table 6
Major Deposits of Copper in the USSR
1955

Location	Economic Region 5*	Description of Deposits	Mining and Beneficiating Methods	Estimated Production, 1955 b/ (Metric Tons)	Disposition of Ores and Concentrates	Estimated Reserves (Metric Tons)
Almalyk, Tashkent Oblast, Uzbek SSR	Xb	A large porphyry deposit with a thickness of more than 200 meters and a horizontal area of approximately 0.37 square kilometers (sq.). The average copper content of the ore is about 0.9 percent. 29/ Because of the oxidized nature of the ores, exploitation was delayed until a suitable ore-treating process had been developed. 30/ The structure of the deposit is similar to that at Kounrad. 21/	Preparations for open-pit mining were started in 1955. 32/ A concentrating plant was under construction in 1956. 33/	This deposit was not being worked in 1955.	A copper smelter was under construction in 1956. 24/	This deposit has been known for a long time. In 1934, reserves were estimated at 2,213,000 tons of copper. 32/
Baymak, Bashkirskaya ASSR, RSFSR	VIII	Sulfurous ores containing both copper and zinc occur in Devonian schist. 35/	Both open-pit and underground methods are used. The ore is beneficiated by selective flotation.	Production is estimated at 1.5 million to 2 million tons of ore containing about 2 percent copper, or 30,000 to 40,000 tons of copper.	Ores and concentrates produced in excess of the capacity of this smelter are shipped to other plants in Region VIII.	In 1934, reserves were estimated at 352,700 tons of copper in 16.5 million tons of ore. 37/ It is believed that additional reserves have been developed since then.
Elyava, Chkalovskaya Oblast, NEFSR	VIII	Ore bodies consist of lenses of copper pyrite ranging from 0.5 to 7 percent copper. The average grade is less than 3 percent. 38/ The largest lens being worked in 1950 was 500 meters long along the strike. Its average thickness was 60 to 65 meters. 22/	For many years the deposit was worked by underground methods. Open-pit mining was started in 1952. In 1954 the underground operations were being curtailed. 100/	Assuming the smelter at Mednogorsk was operating at or near capacity in 1955, the production of ore at Elyava was about 850,000 tons of ore containing 20,000 to 25,000 tons of copper.	The ore is shipped to the plant at Mednogorsk for processing and smelting. 101/	In 1934 reserves were estimated at about 550,000 tons of copper in about 22 million tons of ore. 102/
Bozhchekul, Pavlodarskaya Oblast, Kazakh SSR	Xa	A large porphyry deposit containing copper, gold, and molybdenum. 103/ The average copper content of the ore is about 0.8 percent.	Open-pit mining and concentrating methods will be similar to those at Balkhash. 104/	Development of this deposit was delayed because of lack of transportation. The completion of the railroad line between Akmalinsk and Pavlodar provides access to the area. Production is to begin during the course of the Sixth Five Year Plan (1956-60).	Ores will be treated at Bozhchekul, and the concentrates probably will be shipped to Balkhash for smelting and refining.	In 1935 the reserves were estimated at 2,546,000 tons of copper. 105/
Degtjarkh, Sverdlovskaya Oblast, RSFSR	VIII	A narrow deposit approximately 5 km long. In the central part of the deposit, which is about 130 meters wide, the deposit is known to extend to a depth of 130 meters. The main ore minerals are pyrite, sphalerite, chalcocite, arsenopyrite, and covellite. The average copper content of the ore is about 1.4 percent. 106/	Mining is done underground, with three main levels at 130 meters, 190 meters, and 290 meters. 107/	Daily production of ore in 1955 was 8,000 tons. 108/ On an annual basis, this rate would amount to nearly 3 million tons of ore or 40,000 to 45,000 tons of copper.	The ore is shipped to the nearby concentrator at Revda. Copper concentrates are smelted at Revda, and pyrite concentrates are shipped to sulfuric acid plants.	In 1955 a geological delegation from the Free World reported that the reserves of ore were claimed to be about 60 million tons. 109/

* Footnotes for Table 6 follow on p.32.

S-E-C-R-E-T

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S-E-C-R-E-T

Table 6
Major Deposits of Copper in the USSR
1955
(Continued)

Location	Economic Region #	Description of Deposits	Mining and Beneficiating Methods	Estimated Production, 1955 b/ (Metric Tons)	Disposition of Ore and Concentrate	Estimated Reserves (Metric Tons)
Dzhetskasgan, Karagandinskaya Oblast, Kazakh SSR	Xa	This deposit consists of copper-impregnated sandstones spread over a large area, with numerous ore bodies occurring in scattered, irregular lenses. By 1935, 37 distinct ore bodies had been discovered. ^{110/} The copper-bearing formations are flat, dipping, and comparatively shallow. The ore averages about 1.6 percent copper. ^{111/}	In 1954 there were 20 underground mines and 1 open-pit mine in the area. ^{112/} In 1955, another open-pit mine (Glasnost-Belovskiy) was started, which was to become the largest in the area. ^{113/}	Production is estimated at 5,000 to 10,000 tons of ore per day, ^{114/} or 30,000 to 60,000 tons of copper per year.	The high-grade ore is shipped to the concentrator at Karakpай. The low-grade ore is shipped to a concentrator at Kirgiz or to Balkhash. All of the concentrates are believed to be smelted and refined at Balkhash.	In 1937, reserves were reported to be 3.7 million tons of copper. ^{115/} More recent discoveries probably have been made.
Kadsharan, Armyskaya SSR	V	This porphyry deposit, also known as the Agark deposit, has disseminations of chalcopyrite, pyrite, and molybdenite in altered tertiary granite rock. The average copper content is 0.6 percent. ^{116/} The mines are at an elevation of 2,500 meters. ^{117/}	Underground methods have been used exclusively. The Sixth Five Year Plan calls for extensive use of open-pit methods. ^{118/}	The capacity of the concentrator is 3,000 tons of ore per day. ^{119/} On an annual basis, this would amount to 1,095,000 tons of ore containing about 6,500 tons of copper.	Ore is delivered to a concentrator at Kadsharan via an aerial tramway. ^{120/} The copper concentrates probably are sent to Alaverdi for smelting.	In 1935, reserves were estimated at 523,000 tons of copper. ^{121/}
Karabash, Chelyabinskaya Oblast, RSFSR	VIII	This deposit consists of 7 ore bodies concentrated in a narrow schist north-south belt 12 km long. The average grade of the ore is about 2.3 percent copper, with high zinc values in some of the bodies. ^{122/}	Four mines, all interconnected underground, are in operation. Ore is treated by selective flotation.	The annual capacity of the smelter at Karabash is estimated to have been increased to 25,000 tons in 1940. ^{123/} If the smelter has been operating at capacity since that time on concentrates from Karabash and if no additional discoveries have been made, deposits at Karabash may be approaching exhaustion. Current annual production is estimated at 10,000 to 25,000 tons.	The copper concentrates are smelted at Karabash, ^{124/} but the zinc concentrates probably are shipped to Chelyabinsk.	In 1934, reserves were estimated at 391,000 tons of copper. ^{125/}
Kirovgrad, Sverdlovskaya Oblast, RSFSR	VIII	This deposit was mined as early as 1813. Copper occurs as irregular bodies in schist. Some of the ore bodies in the Levitsa group have a high zinc content. ^{126/}	Underground methods are used, with selective flotation being used to produce copper and zinc concentrates. ^{127/}	The annual capacity of the smelter at Kirovgrad, which processes mainly local ore, is estimated at about 30,000 tons.	Ore is concentrated and the copper ore is smelted at Kirovgrad. Zinc concentrates probably are shipped to Chelyabinsk, and the pyrites probably are shipped to sulfuric acid plants.	In 1934, reserves were estimated at 471,500 tons of copper in 31.4 million tons of ore. ^{128/}
Koumred, Karagandinskaya Oblast, Kazakh SSR	Xa	This is a large, low-grade porphyry deposit located about 20 miles north of Balkhash. The deposit is basin-shaped and consists of an oxidized upper zone about 21 meters thick, followed by a leached zone 20 to 25 meters thick, and finally a sulfide zone about 110 meters thick. The average copper content of the deposit is about 1.1 percent. ^{129/}	The mine is a large open-pit operation, well equipped with modern machinery. The ore is treated by fine grinding and flotation. ^{130/}	Recent photographs of the concentrator show 20 to 24 large ball mills. It is estimated that this equipment could process 30,000 to 35,000 tons of ore daily. Production is estimated, therefore, at 120,000 to 140,000 tons of copper per year.	Ore is shipped to Balkhash for both concentrating and refining. ^{131/}	As of 1 January 1936, reserves were estimated at 2,843,000 tons of copper. ^{132/}

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Table 6
Major Deposits of Copper in the USSR
1955
(Continued)

Location	Economic Region ^{a/}	Description of Deposits	Mining and Beneficiating Methods	Estimated Production, 1955 ^{b/} (Metric Tons)	Disposition of Ores and Concentrates	Estimated Reserves (Metric Tons)
Krasnoural'sk, Sverdlovskaya Oblast, RSFSR	VIII	The principal ore bodies in this deposit occur in a mineralized schist zone, which can be considered a continuation of that in the Karabash district. The two most important mines are in copper-bearing pyrite that occurs in the form of lenses. The copper content of the ore averages about 2.2 percent. ^{133/}	The ore is mined by underground methods and is treated in a fine-grinding, selective flotation plant where a copper concentrate and a pyrite concentrate are produced.	The capacity of the smelter at Krasnoural'sk is not less than 20,000 tons per year, but may be twice as large. Production is, therefore, probably at least 20,000 tons of copper annually. ^{134/}	The ores are concentrated and the copper concentrates are smelted at Krasnoural'sk. The pyrite concentrates are shipped to sulfuric acid plants.	In 1954, reserves were estimated at only 313,600 tons of copper in 14.3 million tons of ore. ^{135/}
Shanlug, Armyanskaya SSR	V	Copper ore with an average metal content of about 3.7 percent occurs in irregular masses in a rock formation. Formerly there were several mines operating in this district, but they have been abandoned because of the exhaustion of ore resources. ^{136/}	Underground mining methods are used. The first concentrating plant in the district is to be built at this mine under the Sixth Five Year Plan. ^{137/}	Production exceeds that of 1950 by approximately 30 percent, ^{138/} amounting to about 50,000 tons of ore containing 3,000 tons of copper.	Ore probably is shipped to Zangezur for concentrating and then on to Alaverdi for smelting and refining.	Although large ore bodies are reported to have been discovered, ^{139/} reserves probably are small compared to those of Region Xa.
Zangezur, Armyanskaya SSR	V	Copper occurs in irregular veins in andesite, some of which are polymetallic. The copper ore, chiefly chalcopyrite, averages 4 percent copper. ^{140/}	The ore is mined by underground methods and is concentrated by fine grinding and flotation at the Zangezur plant.	This is a small operation, probably not exceeding 1,000 tons of ore per day, or 14,500 tons of copper per year.	Concentrates are shipped to the smelter at Alaverdi.	In 1935, reserves were estimated at 183,000 tons of copper. ^{141/}

b. The total production in 1955 was 324,000 to 409,000 tons.

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Table 7
Copper Smelters in the USSR
1955

Location	Economic Region #/1	Description of Plant	Source of Raw Material	Disposition of Product	Estimated Capacity, 1955 2/ (Metric Tons)	Estimated Production of Blister Copper, 1955 3/ (Metric Tons)
Alaverdi, Arzyaszkaya SSR	V	This is the only copper smelting plant in Region V. Before World War I a French company operated this smelter. Additions to the old plant were made in 1936, bringing capacity to 10,000 tons per year. 142/	Copper concentrates from Zangzur and Fadzharan	Blister copper is refined at the local electrolytic refinery.	Completion of the concentrator at Fadzharan was to have resulted in a doubling of the capacity of this smelter. Therefore, 1955 capacity was estimated at 25,000 tons.	21,000
Balkhash, Karagandinskaya Oblast, Kazakh SSR	Xa	This is a modern smelter with 3 reverberatory furnaces and 3 converters, the largest nonferrous installation in the USSR. Under the Sixth Five Year Plan, (1956-60) a new reverberatory furnace is to be constructed, and it is planned to automate the control and checking of all furnaces. Such improvements are to result in an increase of 31.4 percent in production of blister copper by 1960. 143/	Copper concentrates provided by the local concentrator	Blister copper is refined at the local electrolytic refinery.	Capacity must be adequate not only to handle local concentrates of 120,000 to 140,000 tons annually but also to smelt Kirgiz concentrates made from Dzhetsayagan ores which may amount to 25,000 tons annually. Therefore, capacity is estimated at 165,000 tons annually.	140,000
Baymak, Bashkirskaya ASSR, RSFSR	VIII	This is a small smelter treating concentrates made locally. In view of fairly large reserves, expansion of the smelter can be anticipated.	Local concentrates	Blister copper is shipped to Pyshma and Khabysk for refining by electrolysis.	5,000 144/	4,000
Glubokoye, Vostochno-Kazakhstanskaya Oblast, Kazakh SSR	Xa	Also known as the Irtysh plant, this smelter was built by an English company in the early 1920's. The smelter was renovated in 1936 and was scheduled for expansion under the Third Five Year Plan (1928-32). 145/	Concentrates from locally mined copper and copper-lead-zinc ores	Blister copper is shipped to Balkhash for refining.	18,000	15,000
Karabash, Chelyabinskaya Oblast, RSFSR	VIII	This plant had 3 blast furnaces, 1 reverberatory furnace, and 4 converters in 1948. 146/	Local concentrates	Blister copper is shipped to the electrolytic refinery at Khabysk. 147/	Probably not more than 25,000 tons	10,000 to 20,000
Karashayev, Karagandinskaya Oblast, Kazakh SSR	Xa	Construction of this plant was started in 1921. By 1939, capacity was at least 8,000 tons. Capacity was to reach 15,000 to 20,000 tons by 1950. 148/	High-grade Dzhetsayagan ores	Blister copper is shipped to Balkhash for refining.	25,000	21,000
Mirovograd, Sverdlovskaya Oblast, RSFSR	VIII	This plant is equipped with reverberatory furnaces and converters. At least part of the fuel used in the smelter consisted of hard coal and peat. 149/	Local concentrates	Blister copper is shipped to Pyshma for refining by electrolysis.	30,000	25,000

50X1

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Table 7
Copper Smelters in the USSR
1955
(Continued)

Location	Economic Region a/	Description of Plant	Source of Raw Material	Disposition of Product	Estimated Capacity, 1955 b/ (Metric Tons)	Estimated Production of Blister Copper, 1955 c/ (Metric Tons)
Krasnoural'sk, Sverdlovskaya Oblast, RSFSR	VIII	This plant is believed to be equipped with reverberatory furnaces and converters. <u>150/</u>	Concentrates from the plant and probably some from Baymak	Blister copper is shipped to Pyshma for refining by electrolysis.	40,000 <u>151/</u>	34,000
Mednogorsk, Chkalovskaya Oblast, RSFSR	VIII	At this site is a concentrating plant with 2 sections, a smelter with 2 blast furnaces and 2 converters, a copper sulfide plant for smelting sulfurous copper ore, and a sulfuric acid plant. <u>152/</u>	Concentrates produced locally with ores from Blyava	Blister copper is shipped to the electrolytic refinery at Kyshtym.	25,000 Expansion is reported to be under way. <u>153/</u>	21,000
Monchegorsk, Murmanskaya Oblast, RSFSR	IX	This is primarily a nickel smelter where a nickel-copper matte is produced by electric furnaces. <u>154/</u>	Nickel-copper concentrates and high-grade ores, also nickel-copper matte from the smelter at Pechenga.	Copper in the nickel-copper matte is recovered locally by electrolysis.	7,000 <u>155/</u>	7,000
Moscow, Moskovskaya Oblast, RSFSR	VII	A copper smelter has been operating at this site at least since 1913. The plant was dismantled and moved to Kyshtym in October 1941 and was back in operation probably before the end of 1955. <u>156/</u>	Copper scrap collected from all parts of the USSR <u>157/</u>	Blister copper is refined by electrolysis. <u>158/</u>	55,000 to 60,000 <u>159/</u>	50,000
Noril'sk, Taymyrskiy Natsional'nyy Okrug, RSFSR	XI	Construction began in April 1948 and the plant was in operation by mid-1949. Equipment consists of 2 reverberatory furnaces, horizontal converters, and 2 anode furnaces. <u>160/</u>	Concentrates from local ores containing nickel, platinum, and copper <u>161/</u>	Blister copper is refined locally by electrolysis.	7,000	6,000
Revd, Sverdlovskaya Oblast, RSFSR	VIII	This plant was completed in 1948 and is connected by rail with the copper mines at Degtyarka. Equipment consists of coarse and fine crushing plants, a selective flotation plant, 2 converters, and 2 large reverberatory furnaces. <u>162/</u>	Copper mines at Degtyarka and Baymak	Blister copper is shipped to Pyshma for refining by electrolysis.	50,000 <u>163/</u>	40,000 to 50,000

b. The total capacity in 1955 was 477,000 to 481,000 tons.
c. The total production in 1955 was 394,000 to 414,000 tons.

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Table 8
Electrolytic Copper Refineries in the USSR
1955

Location	Economic Region #/*	Description	Source of Blister Copper	Estimated Capacity, 1955 b/ (Metric Tons)	Estimated Production, 1955 c/ (Metric Tons)
Alaverdi, Arzyanskaya SSR	V	This plant was constructed in 1944-46. In 1955 the production of refined copper was reported to have increased 32 percent over that of 1950. <u>164/</u>	Local smelters	Inasmuch as this is the only electrolytic refinery in Region V, its capacity must be roughly equivalent to the capacity of the smelter, or 25,000 tons annually.	20,000
Balkhash, Karagandinskaya Oblast, Kazakh SSR	Xa	Until 1952, when the first section of its electrolytic unit was completed, this refinery either fire-refined its blister copper or shipped it to Region VIII for electrolytic refining. A second section was scheduled for operation in 1954. <u>165/</u>	The smelters at Balkhash, Glubokoye, and Karakapay	Inasmuch as this is the only electrolytic refinery in Region X and Region X produced 166,000 tons of refined copper in 1955, it is estimated that the capacity of the refinery must be about 175,000 tons annually to produce this amount of refined copper.	166,000
Kyshtym, Chelyabinskaya Oblast, RSFSR	VIII	The plant is equipped with anode and cathode furnaces, casting wheels, and electrolytic cells. Two of the anode and two of the cathode furnaces use fuel oil for smelting. <u>166/</u>	The smelters at Karabash, Baymak, and Mednogorsk	Approximately 50,000 tons annually <u>167/</u>	35,000 to 45,000
Monchegorsk, Murmanskaya Oblast, RSFSR	Ia	Produces copper as a byproduct by electrolysis. Plant was badly damaged during World War II. <u>168/</u>	Nickel-copper matte from the the smelter at Monchegorsk	8,000 <u>169/</u>	7,000
Moscow, Moskovskaya Oblast, RSFSR	VII	No details are available.	The secondary copper smelter at Moscow	55,000	50,000
Koril'sk, Taymyrskiy Natsional'nyy Okrug, RSFSR	XI	The refinery has 6 cells. The average weight of the anodes is 270 kilograms. <u>170/</u>	The local smelter	7,000	6,000

* Footnotes for Table 8 follow on p. 36.

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Table 8
Electrolytic Copper Refineries in the USSR
1955
(Continued)

Location	Economic Region ^{a/}	Description	Source of Blister Copper	Estimated Capacity, 1955 ^{b/} (Metric Tons)	Estimated Production, 1955 ^{c/} (Metric Tons)
Pyshma, Sverdlovskaya Oblast, RSFSR	VIII	Construction began in 1929 or 1930 along a US design. The five reverberatory furnaces are oil fired. ^{171/} For many years the largest electrolytic refinery in the USSR, this refinery was surpassed in size by the one at Balkhash in 1954.	The smelters at Baymak, Kirovgrad, Krasnoural'sk, and Revda	110,000 to 150,000 ^{172/}	85,000 to 100,000

b. The total estimated capacity in 1955 was 430,000 to 470,000 tons.
c. The total estimated production in 1955 was 377,300 tons.

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APPENDIX B

METHODOLOGY

1. Estimates of Production, 1941-44.

a. 1941.

During the first 7 months of 1944, production of copper in Region Xa was 69.4 percent above that of the corresponding period of 1940, 26.3 percent above the level of 1941, and 18 percent above the level of 1943. 173/ On the basis of this statement an index of production of copper in Region Xa was derived, as follows (1940=100):

<u>Year</u>	<u>Index</u>
1940	100
1941	134.0
1943	143.6
1944	169.4

This index applies only to the first 7 months of each year. New capacity was being installed at the Balkhash plant in 1940 which resulted in a concentration of an unusually large proportion of production during the latter months. It is probable, therefore, that the monthly production during the last 5 months of 1940 approximated that during 1941: that is, an increase of 34 percent. The average monthly production in 1940 was, therefore, as follows:

X = average monthly rate in each of the first 7 months
1.34 X = average monthly rate in each of the last 5 months
 $7X + 5(1.34)X = 35,490$
 $7X + 6.7X = 35,490$
X = 2,590, average during the first 7 months
 $2,590 \times 1.34 = 3,471$, average during the last 5 months

Production in Region Xa in 1941 is estimated, therefore, at $3,471 \times 12$, or 41,652 tons, which was 22.3 percent of the total production of copper in the USSR in that year. 174/ The total production of copper in 1941 was, therefore, about 186,800 tons.

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b. 1942.

Production of copper in 1942 was estimated at 164,000 tons by interpolating between 1941 and 1943.

c. 1943.

Production of about 44,600 tons of copper in Region Xa was estimated by increasing the average monthly production during the first 7 months of 1940 (2,590 tons) by the factor 1.436 and multiplying this product by 12. The total production of copper in the USSR in 1943 is estimated at 141,200 tons, inasmuch as production in Region Xa accounted for 31.6 percent of the total. 175/

d. 1944.

Production of 52,600 tons of copper in Region Xa was estimated by increasing the average monthly production during the first 7 months of 1940 (2,590 tons) by the factor 1.694 and multiplying this product by 12. The total production in the USSR, 147,400 tons, was derived from the statement that Region Xa produced 35.7 percent of the total production of copper in the USSR in 1944. 176/

2. Estimates of Demand.

Production of crude steel* and consumption of refined copper in the US, 1930-55, are shown in Table 9.** These two series of data were correlated, and a coefficient of correlation of 0.91 was found to exist between the two variables. A significantly higher coefficient of correlation exists if two groups of years are eliminated from the series. These are the war years, 1941-46, and the last 5 years, 1951-55. In 1941-46 the steel-to-copper ratio decreased because of the large quantities of copper used in production of ammunition. In 1951-55 the steel-to-copper ratio increased because aluminum has captured part of the market traditionally served by copper. If these two groups of years are eliminated, a coefficient of correlation of 0.98 exists between consumption of copper and production of crude steel.

* Production of crude steel is virtually equivalent to consumption of crude steel, inasmuch as crude steel in unfabricated forms normally is not exported or imported in significant quantities.

** Table 9 follows on p. 39.

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Table 9
 Production of Crude Steel
 and Consumption of Refined Copper in the US ^{a/}
 1930-55

Year	Production of Crude Steel (Million Short Tons)	Consumption of Refined Copper (Thousand Short Tons)	Year	Production of Crude Steel (Million Short Tons)	Consumption of Refined Copper (Thousand Short Tons)
1930	45.6	632.5	1943	88.8	1,502.0
1931	29.1	451.0	1944	89.6	1,504.0
1932	15.3	259.6	1945	79.7	1,415.0
1933	26.0	339.4	1946	66.6	1,391.0
1934	29.2	322.6	1947	84.9	1,286.0
1935	38.2	441.4	1948	88.6	1,214.0
1936	53.5	656.1	1949	78.0	1,072.0
1937	56.6	694.9	1950	96.8	1,447.0
1938	31.8	407.0	1951	105.2	1,304.0
1939	52.8	714.9	1952	93.2	1,360.0
1940	67.0	1,008.8	1953	111.6	1,435.0
1941	82.8	1,641.6	1954	88.3	1,235.0
1942	86.0	1,608.0	1955	117.0	1,412.0

a. 177/

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S-E-C-R-E-T

High positive correlations between production of crude steel and consumption of copper were found to exist also in other industrialized countries. For example, the coefficient of correlation between production of crude steel and consumption of copper in the years 1934-38 and 1946-55 was 0.88 in the UK and 0.94 in Canada. In Japan the coefficient of correlation between production of steel and consumption of copper in 1947-55, the only years for which data were readily available, was 0.93. On the basis of these relationships, it is concluded that in a large industrial nation such as the USSR, production of crude steel can be used as the basis for estimating the demand for copper.

Reliable Soviet data on production of crude steel are available, although there is less confidence in the figures for the war years, 1941-45. On the whole, however, data on production of crude steel in the USSR are considered among the most valid available on any phase of Soviet industry. Data on consumption of copper in the USSR, however, are not available for any recent year. Data on production and importation of copper in 1929-33 have been released by the USSR. Exports of copper in these years were negligible.

In order to use production of crude steel as a basis for estimating the demand for copper, it is necessary to start from a base period during which the absolute demand for copper is known. As a first approximation, in the absence of any primary data, demand in such a period may be taken to equal production plus imports less exports. This equation would be correct, in principle, however, only if copper were freely available to the consuming sectors of the economy from domestic production and from imports, if there were no shortage of exchange with which to buy imports of copper on the world market, and if stocks of copper did not change significantly during the period. Available information indicates that the first two conditions were reasonably well satisfied during the period 1929-33, but primary data on changes in the levels of stocks of copper in the USSR are not available for this or any other period. To minimize the effect of changes in the levels of stocks of copper, an initial relationship is established between the average annual production of steel and the annual average algebraic sum of the amounts of copper produced, imported, and exported, which are known for these years. The demand for copper in succeeding years then is estimated on the basis of production of steel.

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An examination of the US data on production of crude steel and consumption of copper* reveals that consumption of copper per ton of crude steel produced increased by about 35 percent during World War II. This increase is due principally to production of ammunition; about 350 pounds of copper are required for each ton of ammunition produced. 178/ Inasmuch as the USSR also was engaged in a heavy program of production of ammunition during this period, the estimate of consumption of copper derived from production of steel was increased by 35 percent for the years 1941-45. The US data also indicate that in 1951-55, consumption of copper did not keep pace with production of steel because of competition from aluminum. In the US, consumption of copper increased only 94 percent as fast as production of steel. On the assumption that the USSR would lag 2 years behind the US in technological development, the estimates of consumption of copper in the USSR derived from production of crude steel were corrected by this factor for the years 1953-55.

There are no reliable data available indicating the distribution of copper among the consumers in the USSR for any year since 1933. In that year the percentage of the total consumption of copper by various industries was as follows 179/:

<u>Consuming Industry</u>	<u>Percent</u>
Nonferrous metalworking	34.1
Electrical engineering	42.0
Chemical industry	2.2
Ferrous metallurgical and other heavy industry	9.8
Machine building	7.7
Light industry	1.3
Other	2.9
Total	<u>100.0</u>

In view of the many applications of copper, its use pattern is especially complex. The tabulation given above indicates that copper was used in nearly every phase of the economy as long ago as 1933. Furthermore, its use pattern changes constantly as new metals, alloys, and uses are discovered and as prices of copper, alloying materials, and competitive metals fluctuate.

* See Table 9, p. 39, above.

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The most detailed and recent estimate of the use pattern of copper in the US was prepared for the President's Materials Policy Commission and covered the year 1950. The use pattern in the US in 1950 is shown by the following percentages 180/:

<u>Use</u>	<u>Percent</u>
Electrical equipment	24
Telephone and telegraph	7
Light and power	8
Radio and television	4
Other rod and wire	10
Automobiles (radiators)	12
Building (plumbing, flashing, and leaders only)	11
Railroads	2
Refrigerators	2
Ships (propellers and the like)	2
Air conditioning	2
Clocks and watches	1
Copper-bearing steel	1
Heating radiators (convectors)	1
Ammunition	6
Other	7
Total	<u>100</u>

These data indicate that in the US about 53 percent of the copper consumed in 1950 was used in production of "electrical machinery" -- electrical equipment, telephone and telegraph, light and power, radio and television, and other rod and wire. Assuming that the 240,000 tons of copper consumed in the USSR in 1955 for electrical machinery also made up 53 percent of the total consumption of copper, the total consumption of copper in the USSR can be calculated at about 452,800 tons for 1955, which compares very favorably with the 447,100 tons previously estimated,* using an entirely different methodology.

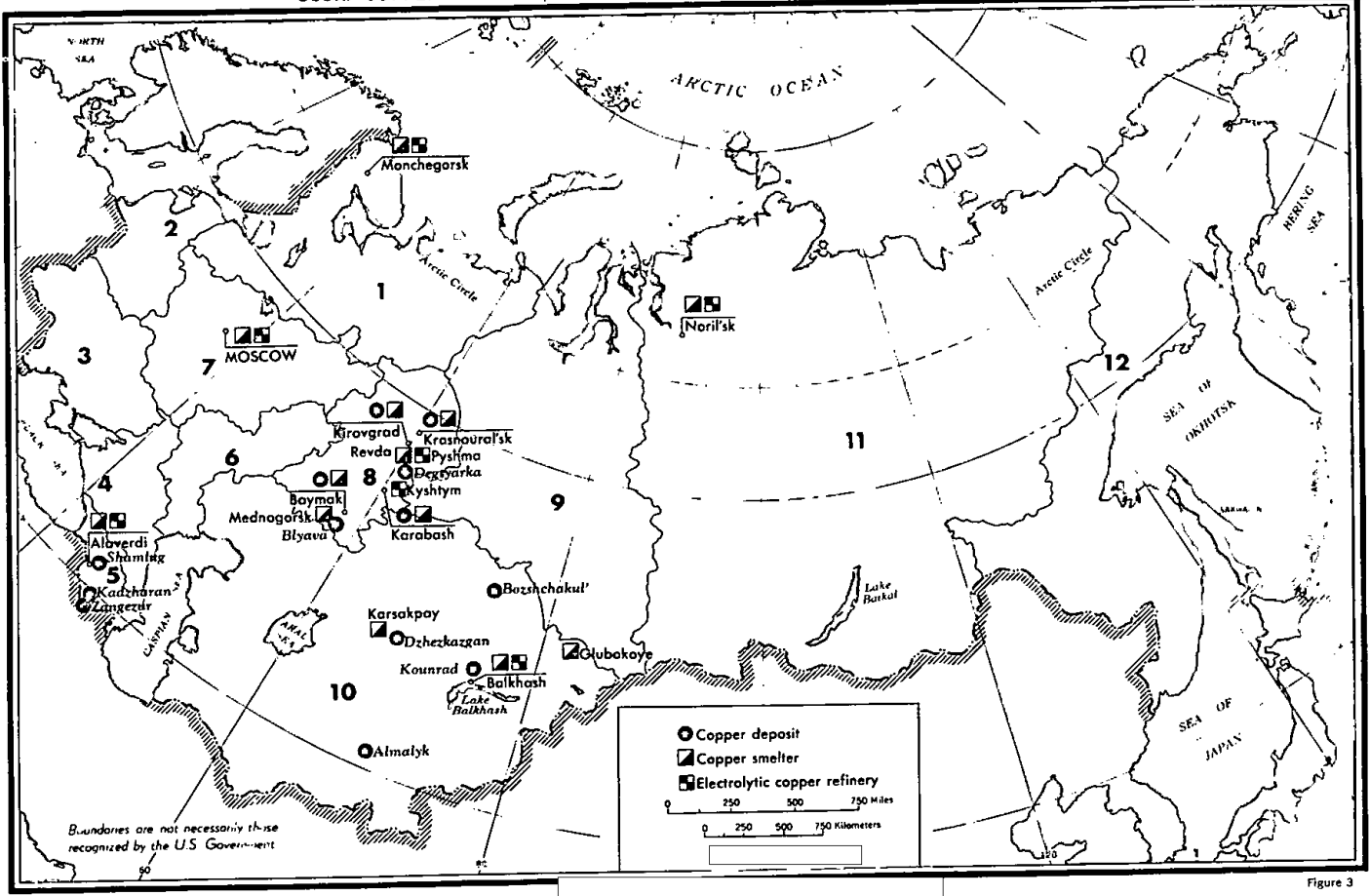
* See Table 4, p. 19, above.

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USSR: COPPER DEPOSITS, SMELTERS, AND ELECTROLYTIC REFINERIES, 1955



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Figure 3

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