NATIONAL INTELLIGENCE SURVEY

U/I

U.S.S.R.

MINERALS and METALS

MAY 1970

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This section was prepared for the NIS by the Central Intelligence Agency.

Approved For Release 2008/09/08 : CIA-RDP08S01350R000100080001-8

Minerals and Metals

A. General

1. Significance

The metallurgical and construction materials industries of the U.S.S.R. are ranked among the largest in the world, leading all countries in production of such basic commodities as iron ore, manganese ore, chromite, tungsten, asbestos, cement and precast concrete products, and ranking second in output of pig iron, crude steel, aluminum, magnesium, nickel, and others. The Soviet Union contributed the major share of the Communist countries' production of the most important minerals and metals in 1968, and a significant portion of the world output in that year. Estimated production of selected minerals, metals and construction materials in the U.S.S.R. in 1968, in metric tons[1] and expressed as a percent of the production of the world, the Communist countries, and the United States is shown in Figure 1.

Soviet trade in minerals and metals[2] represents a relatively insignificant portion of world trade in these commodities in terms of monetary value, but is of considerable importance to the U.S.S.R. as a source of foreign exchange. In 1968, Soviet trade in mineral and metal products and construction materials amounted to 2.6 billion rubles,[3] 14.2% of total trade, and was a net earner of approximately 1.1 billion rubles.

Soviet exports of minerals, metals, and construction materials were valued at nearly 1.8 billion rubles, or 19% of total Soviet exports in 1968. The bulk of these exports, about 79%, was directed to other Communist countries, and the large share of the remainder, some 17% went to the industrialized non-Communist countries. About 4% was exported to the developing non-Communist countries. Among the U.S.S.R.'s principal mineral and metal exports are finished steel, pig iron, ferroalloys, aluminum, copper, and iron ore. Soviet imports of minerals, metals, and construction materials were valued at more than 750 million rubles, or 9% of the worth of all Soviet imports in 1968. Ores and concentrates and finished steel, including tubular products, accounted for 80% of all metals and minerals imported. Estimated Soviet production and trade in selected minerals and metals in 1968 are shown in Figure 2.

The minerals and metals and construction materials industries rank among the leading employers in Soviet industry, employing in 1968 an estimated 3.2 million workers or 13% of all industrial workers. These industries contribute substantially to the gross value of Soviet industrial production, and account for an important share of state investment.

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During the Seven Year Plan (1959-65), estimated investment in the ferrous, nonferrous, and construction materials industries was 20.6 billion rubles, or about 20% of the total productive[4] investment for Soviet industry. In 1966-67, the first two years of the current Five Year Plan (1966-70), estimated investment in these industries was about 7.1 billion rubles, or about 19% of total industrial investment. These sums were divided as follows, in billions of rubles:

	1959–65	1966–67
Ferrous metallurgy	9.3	3.1
Nonferrous metallurgy	5.0	2.1
Construction materials	6.3	1.9
Total	20.6	7.1

2. Mineral resources

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Soviet resources of minerals and metals are both extensive and varied, providing the U.S.S.R. with probably the largest raw material base of any country in the world. The U.S.S.R. claims deposits of most minerals and metals essential to a modern economy and a leading position in world reserves of iron and manganese ores, of the principal alloying metals, and of many important nonferrous metals, including copper, lead, and zinc. However, reserves of high-grade ores, particularly nonferrous metals, are limited and declining and drops have been reported in the average metal content of ore of several metals, including iron, lead, zinc, copper, molybdenum, and tungsten. Considerable portions of the plentiful ore reserves cannot be processed economically. Low metal content or poor composition frequently requires the use of complicated and expensive extractive technology and the location of many deposits in remote areas, far from established transportation routes and cheap sources of power, and sometimes subject to severe climatic conditions, makes the cost of exploitation prohibitively high. In the current Five Year Plan the U.S.S.R. is intensifying geological exploration and surveying programs in order to expand reserves of good quality ores in favorable locations.

The raw materials base of the mineral construction-materials industry does not appear to suffer from these deficiencies and is considered adequate to permit great expansion of present production.

[1] All tons referred to in this section are metric tons.

[2] Gold has not been included as a traded commodity.

[3] At the official rate of exchange, one ruble equals US$1.11.

[4] Excludes investment in housing, social welfare facilities, and similar projects not related directly to production facilities.

FIGURE 1. ESTIMATED PRODUCTION OF SELECTED MINERALS AND METALS IN THE U.S.S.R. COMPARED WITH PRODUCTION OF THE WORLD, THE COMMUNIST COUNTRIES, AND THE UNITED STATES, 1968

(Production in thousands of metric tons unless otherwise indicated)

COMMODITY	PRODUCTION IN U.S.S.R.	PRODUCTION IN U.S.S.R. EXPRESSED AS PERCENT OF PRODUCTION OF: World	Communist countries*	United States
Crude steel	106,500	20	68	89
Iron ore	176,600	26	77	203
Manganese ore	6,564	39	89	**
Chromite	2,000	37	82	**
Nickel	124	24	82	**
Aluminum	1,435	18	80	49
Magnesium	84	38	100	93
Copper	992	15	79	59
Lead	528	15	59	125
Zinc	678	14	58	69
Tin	18	7	64	**
Mercury***	66,700	24	98	231
Platinum group metals†	2,000	59	100	**
Cement	87,500	17	61	129

*Including Cuba, Yugoslavia, and North Korea but excluding Communist China, for which production data are not always available; however, estimates of Communist Chinese production have been included for crude steel, iron ore, manganese ore, aluminum, tin, and cement.

**United States is almost wholly dependent on imports.

***In thousands of flasks, each of which weighs 34.5 kilograms.

†In thousands of troy ounces.

FIGURE 2. ESTIMATED PRODUCTION, IMPORTS AND EXPORTS OF SELECTED MINERALS AND METALS, 1968 25X1

(Thousands of metric tons) 25X1

COMMODITY	PRODUCTION	IMPORTS	EXPORTS
Pig iron	78,000	63.4	4,522.1
Finished steel	85,300	2,175.0	5,909.7
Iron ore	176,600	*560.0	32,201.0
Manganese ore	6,564	...	1,150.0
Chromite**	2,000	...	1,048.0
Aluminum	1,435	2.2	367.1
Copper	992	13.7	109.3
Lead	***623	39.1	90.9
Zinc	***811	36.4	78.7
Tin	***22	7.1	...
Asbestos	2,400	...	303.6
Cement	87,500	296.0	2,641.0

... Not pertinent.

*1967.

**Chrome ore and concentrates.

***Includes primary and secondary.

3. Level of technology

The general level of technology in the Soviet metallurgical and construction materials industries compares favorably with that of the United States and other advanced industrial countries. The U.S.S.R. has demonstrated its ability to develop special techniques and equipment for production of metallurgical and construction materials essential to the attainment of its military goals, although the general trend has been more toward improving technology for quantity than for quality production. In recent years greater attention has been devoted to programs for improving the quality of production, but results have not been satisfactory. In ferrous metallurgy, for example, development of finishing equipment essential to production of high quality rolled products continues to lag, whereas advances made in perfecting large-capacity ironmaking equipment and techniques are among the best in the world. The U.S.S.R. also gained recognition as a world leader in open hearth furnace steelmaking technology at a time, however, when this process was being supplanted in international practice by the oxygen converter steelmaking process. Soviet progress in adopting this new process has been slow.

Although the level of technology is very high, even outstanding in certain of the newest plants of the nonferrous metallurgical industry, in the older installations of the industry the general level of technology is lower than that found in similar industries abroad. Soviet technology and equipment for mining and concentrating ores traditionally have lagged behind world standards. Advances have been made in processing polymetallic ores which constitute much of the resource base for the copper, lead, and zinc industries, but recovery rates still compare unfavorably with those in the U.S. and elsewhere in the non-Communist world. New technologies have been developed for the processing of aluminous raw materials, but progress in making industrial-scale use of these innovations has been disappointingly slow.

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B. Ferrous metallurgical industry

1. General

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a. SUPPLY POSITION—The U.S.S.R. has the second largest ferrous metallurgical industry in the world. In 1968 it produced 176.6 million tons of iron ore, 78.8 million tons of pig iron, 106.5 million tons of crude steel, and 85.3 million tons of rolled steel. Production of crude steel in that year represented about 20% of world production, 68% of that in the Communist countries, and was equal to 89% of production in the United States. The U.S.S.R. has created only a small reserve steelmaking capacity and is less capable of achieving a rapid expansion in production than is the United States where capacity in recent years has been maintained at an estimated average level of about one-third above production. Soviet steelmaking capacity at the beginning of 1969, estimated at about 115 million tons, was 70% of estimated capacity in the United States.

The U.S.S.R. is an important source of supply of raw materials and steel for the Warsaw Pact countries. Soviet exports to these countries in 1968 included 28.7 million tons of iron ore, 603,000 tons of manganese ore, 172,000 tons of chromite, 2.9 million tons of pig iron, and net exports of 2.2 million tons of coke and 3.5 million tons of finished steel. The quantities exported to the Warsaw Pact countries from the U.S.S.R. in 1968 represented about 86% of the iron ore, 73% of the manganese ore, more than half of the chromite, 49% of the coke, nearly all of the pig iron, and 61% of the finished steel imports of these countries. The U.S.S.R. also contributed a large share of the alloying materials required by these countries. Soviet exports to other Communist countries in 1968 went principally to Cuba and Yugoslavia. The U.S.S.R. shipped only relatively small quantities of raw materials and steel to the Communist countries of Asia in 1968.

In addition to raw materials and steel products, the U.S.S.R. furnishes equipment and technical assistance to the steel industries of the Warsaw Pact countries. At the same time, the U.S.S.R. obtains part of its own equipment requirements from some of these countries. Imports of rolling mill equipment from East Germany and Czechoslovakia during 1964-68 totaled 181,100 tons, which equaled 28% of Soviet production of this equipment in those years.

Soviet exports to non-Communist countries during 1964-68 averaged 737,000 tons of chrome ore, 424,000 tons of manganese ore, 948,000 tons of coke, 102,000 tons of ferroalloys, 1,707,000 tons of pig iron and 769,000 tons of finished steel per year. These exports represented about 84% of the chrome ore, 38% of the manganese ore, 41% of the ferroalloys, 25% of the coke, 42% of the pig iron, and 15% of the finished steel exported by the U.S.S.R. in total during that period. These commodities, with the exception of finished steel, were marketed mainly in Western Europe and Japan. The main non-Communist recipients of Soviet finished steel in recent years were Finland and Turkey, but, in all, no less than 40 countries, principally the developing countries of Asia and Africa, received Soviet steel. Several developing countries also have received Soviet technical and financial aid, and equipment for the establishment of steel plants. The outstanding example is the Bhilai steel plant designed and built by the U.S.S.R. for India. This plant began production in 1959 with an initial crude steel capacity of one million tons and was subsequently enlarged to 2.5 million tons. The capacity of the plant currently is being expanded again to 3.2 million tons. The U.S.S.R. also contracted in 1965 to build an even larger plant for India at Bokaro with an eventual capacity of 5.5 million tons. Progress has been slow, however, and the first stage of the plant with a capacity of 1.7 million tons is not scheduled for completion until 1971. In addition, the U.S.S.R. is helping the U.A.R. to construct a steel plant at Helwan near Cairo and is committed to help build steel plants in Algeria, Iran, and Turkey.

b. NATURE OF THE INDUSTRY—With the growth of the Soviet steel industry the degree of concentration of production has increased steadily, reflecting Soviet conformity with the worldwide trend toward construction of large plants. In 1968 a dozen plants accounted for more than half of the total steel output of the U.S.S.R. and another dozen accounted for nearly an additional one-fifth of total steel output. Most of these are wholly integrated plants—those having facilities for converting raw materials into coke, pig iron, crude steel and finished steel products. Among the remaining major plants several lack only coking facilities and several others, being the leading specialty steel producers, are devoted only to the production of steel and steel products. A sharp contrast with these leading plants is provided by the industry's large number of small, relatively uneconomic plants, many of which date back to the pre-Soviet regime.

For the most part, iron and steelmaking technology in the U.S.S.R. is comparable to that practiced by leading non-Communist steel-producing countries. The size and productivity of modern Soviet blast furnaces and open hearth furnaces equal, and in many instances, exceed, those of other major steel-producing countries. The U.S.S.R., however, lags in electric furnace technology and in steelmaking by the basic oxygen converter method. In fact, construction of new open hearth furnaces was continued well into the 1960's at a time when major steel producers in non-Communist countries already had ceased such construction and were investing heavily in oxygen converters.

Soviet rolling mill and finishing line technology, while vastly improved in recent years, generally has remained inferior to that in the United States and Western Europe. While having a capability to manufacture modern blooming, slabbing and billet mills, heavy structural mills, and hot rolled sheet mills, the U.S.S.R. is relatively deficient in capability to produce finishing line equipment—cold rolling mills, pickling and annealing lines, and other equipment for further processing. With respect to the general level of mechanization and automation in the steel industry, including ancillary operations such as repair work, materials, and preparation of products for shipping, the U.S.S.R. also compares unfavorably with the United States and Western Europe.

The ferrous metallurgical industry of the U.S.S.R. is supported by indigenous raw material resources that surpass in extent and variety, if not always in quality, those of any other country. Continuing large investments are being channeled into the construction of facilities for the preparation of raw materials, particularly iron ore, to satisfy the increasing demand of the domestic iron and steel industry as well as foreign customers for higher quality raw materials.

c. HISTORY AND DEVELOPMENT

(1) *The Five Year Plans (1928-58)*—When the first Five Year Plan began, the annual rate of production of crude steel was only 4.3 million tons—about the same as in 1913. Hampered by technical incompetence, the Soviets were able to expand output only to 5.9 million tons by 1932. However, equipment and technology obtained from the United States during this period formed the base of notable progress in ensuing years. By 1940 output was expanded to 18.3 million tons; it dropped to 6.5 million tons in 1942 as a result of the German invasion in 1941. Despite tremendous efforts to evacuate essential equipment, the U.S.S.R. lost by 1942, 75% of its coking coal capacity, over 60% of the iron ore mining capacity, 68% of the blast furnace and 65% of its steelmaking

capacity—primarily in the Ukraine. That the Soviet Union was able to obtain sufficient steel to conduct its war effort reflected the drastic restrictions placed on steel allocations, a considerable steel plant construction program in the Urals, and the receipt of 2.5 million tons of finished steel and thousands of tons of war material from the United States.

The principal postwar objectives of the Soviet iron and steel industry were to restore war-damaged facilities and expand production by 1950 to 25.4 million tons of crude steel, 17.8 million tons of finished steel, 19.5 million tons of pig iron and 40 million tons of iron ore. With a productive investment of about 1.75 billion rubles during 1946-50 and with the aid of equipment taken as reparations, chiefly from East Germany and Manchuria, most of the plants in the Ukraine were rebuilt. Output goals for crude steel and finished steel in 1950 were exceeded and production of pig iron and usable iron ore fell only slightly below plan.

The industry continued to develop at a rapid pace during the fifth Five Year Plan, 1951-55, and output goals for 1955 were substantially exceeded in the case of crude steel and finished steel. The industry's capital construction program, however, was not fulfilled, the largest shortfall occurring in new iron ore mining capacity; only 41 million tons of the 67 million tons capacity planned for the five-year period were completed. The shortfall in steelmaking capacity amounted to 3.5 million tons and in capacity for rolled steel, 4.8 million tons.

The sixth Five Year Plan (1956-60) envisaged a larger expansion of production and capacity than the industry had achieved in any comparable period. By 1960, about 84 million tons of iron ore capacity, 16.8 million tons of blast furnace capacity, 15.8 million tons of steelmaking capacity and 16.3 million tons of rolled steel capacity were to be added. Production was to reach 114.3 million tons of iron ore, 53 million tons of pig iron, 68.3 million tons of crude steel, and 52.7 million tons of rolled steel. However, the effect of the fifth Five Year Plan failures was felt as early as 1956 and by mid-1957, the sixth Five Year Plan had been scrapped.

In 1958, the relatively modest production increases of a revised plan were met or exceeded and construction performance improved substantially, although there was a significant shortfall in installing new rolled steel capacity. The industry added 14.5 million tons of essential iron ore mining capacity—90% of the amount planned for the year.

(2) *The Seven Year Plan (1959-65)*—The ferrous metallurgical industry attained the original 1965 goals for production of major commodities, but its performance was less than impressive with respect to other important objectives of the Seven Year Plan. Construction of new productive capacity fell considerably below planned levels, not only delaying the introduction of new steel industry technology but setting back indefinitely schedules for retirement of old, outmoded facilities. Also, programs to improve the quality and broaden the assortment of steel products, undertaken to meet the increasingly sophisticated needs of the Soviet economy, were only partially successful.

Early in the plan period, in 1959 and 1960, production increases ran ahead of schedule and, in 1961, Soviet planners publicized the possibility of an attainment of production levels significantly higher than the original 1965 goals. As the capital construction program began to falter, however, the steel industry lost its momentum and late in 1963 the planners announced production goals for 1965 within the range set forth in the original directives of the Seven Year Plan. These versions of the plans for 1965, as well as the actual production levels attained, are summarized as follows, in millions of tons:

	Original 1965 goal	1961 version	1963 revision	Actual output–1965
Iron ore	150–160	165–170	153.9	153.4
Pig iron	65–70	72–73	65.7	66.2
Crude steel	86–91	95–97	89.3	91.0
Rolled steel	65–70	73–74	70.0	70.9

The extent of the difficulties encountered in the capital construction program for ferrous metallurgy during 1959-65 is indicated by the fact that plans for construction of new capacity were considerably underfulfilled in every sector of the industry. Construction of 218 million tons of iron ore mining capacity was planned but actual completions amounted to only 172 million tons. Planned construction of blast furnace capacity was 24-30 million tons, and actual construction, only 18.8 million tons. In the case of steelmaking capacity, planned construction was 28-36 million tons and steel construction, 23 million tons. In the rolled steel sector, planned construction was 23-29 million tons and actual construction, 17.2 million tons.

A variety of factors helped account for the shortfalls in capital construction. The U.S.S.R. had allocated 10 billion rubles for investment in ferrous metallurgy during the Seven Year Plan but actually expended only 9.3 billion rubles. Moreover, considerably less than optimum results were obtained from the expended funds because they were dispersed over a large number of projects, increasing the volume of uncompleted construction and tying up substantial sums over unduly protracted periods of time. Another decisive factor helping to explain the poor performance in capital construction was the neglect by the U.S.S.R. of that sector of the machine building industry responsible for the production of metallurgical equipment, particularly rolling mills and finishing equipment.

(3) *The Five Year Plan (1966-70)*—In spite of the construction shortfalls of the preceding plan period, the current Five Year Plan established ambitious goals for the production of iron and steel. The planned rates of increase in production were much the same as those attained during 1961-65, but, because of the larger size of the industry, the actual, or absolute, increases were to be considerably higher than those in the earlier period. By 1970 production of iron ore was to reach 224 million tons; pig iron, 94-97 million tons; crude steel, 124-129

million tons; and rolled steel, 95-99 million tons. In addition, programs for qualitative improvements in steel products, which met with indifferent success in the Seven Year Plan, were to be pursued more vigorously.

During the first three years of the 1966-70 plan, the Soviet steel industry increased production significantly and, in fact, drew closer to the United States rate of production. Nevertheless, the industry fell behind its planned pace of development. The rate of growth of crude steel production slowed considerably, making attainment of the 1970 goal problematical and the upgrading of Soviet steel products proceeded slowly.

Planned investment in the industry during 1966-70 was originally set at about 11.8 billion rubles and subsequently, in 1967, was reduced to about 10.8 billion rubles. Actual investment during 1966-68, however, is estimated at only 5.0 billion rubles. The lagging pace of investment has been reflected in shortfalls in the capital construction program. Construction of new steelmaking capacity during 1966-70, originally set at 29 million tons, was reduced to about 24 million tons, but actual construction in the first three years of the plan amounted to only 7.9 million tons. Similarly, the original goal of constructing 25 million tons of new rolled steel capacity was reduced to about 21 million tons, but actual construction during 1966-68 was only 8.2 million tons. In the case of blast furnace capacity, the original goal of 18 million tons has apparently not been changed, but actual completions during 1966-68 totaled only 5.4 million tons. New capacity of at least 150 million tons was planned for the mining of iron ore but actual construction in 1966-68 was only 65.6 million tons.

2. Iron and steel industry

a. PIG IRON AND SCRAP

(1) *Supply position*—The U.S.S.R. is the second largest producer of pig iron in the world. Production in 1968, including blast furnace ferroalloys, was 78.8 million tons—only 3% less than production in the United States. About 85% of the pig iron produced by the U.S.S.R. during 1964-67 was for steelmaking and about 15% for iron castings. The share for iron castings was relatively large compared to the corresponding shares in non-Communist countries—5% in the United States, 8% in West Germany, and 9% in the United Kingdom. The production of pig iron in selected years is shown in Figure 3.

The U.S.S.R. consumes most of the pig iron it produces, but exports are substantial. Exports of pig iron increased from 1.8 million tons in 1960 to about 4.5 million tons in 1968. Communist countries, principally East Germany, Poland, and Romania, received more than 68% of total Soviet exports in 1968. Among non-Communist countries, Japan was the largest importer of Soviet pig iron, receiving nearly 750,000 tons or more than half of total shipments to these countries. The U.S.S.R. imports only relatively small amounts of pig iron. In 1968, such imports, which came entirely from North Korea, amounted to 63,400 tons. Soviet exports and imports of pig iron, 1960-68, are shown in Figure 23.

The substantial surplus of pig iron available for export reflects, in part, the relatively greater success achieved by the blast furnace sector compared with the other sectors of the Soviet iron and steel industry. By the same token, however, domestic demand for pig iron has not increased as rapidly as expected because of the lag in adopting the oxygen converter method of steelmaking. The oxygen converter requires a relatively larger input of hot metal (pig iron) than is normally used in the open hearth furnace because its exothermic process limits the amount of scrap that can be consumed.

Scrap supplies in the U.S.S.R. appear ade[25X1] for essential requirements. Exports of scrap have increased steadily from 170,000 tons in 1960 to 664,000 tons in 1968 and there were no imports during this period. There is evidence, however, of regional shortages of scrap and even of tightness in overall supplies. Special efforts have been made to improve methods of scrap collection and processing to assure adequate deliveries to steel plants.

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FIGURE 3. PRODUCTION OF THE FERROUS METALLURGICAL INDUSTRY
(*Millions of metric tons*)

YEAR	MANGANESE ORE	USABLE IRON ORE	COKE	PIG IRON	CRUDE STEEL	FINISHED STEEL
1913	1.2	9.2	4.4	4.2	4.3	3.6
1928	0.7	6.1	4.2	3.3	4.3	3.4
1940	2.6	29.9	21.1	14.9	18.3	13.1
1945	1.5	15.9	13.6	8.8	12.3	8.5
1950	3.4	39.7	27.7	19.2	27.3	20.9
1955	4.7	71.9	43.6	33.3	45.3	35.3
1958	5.4	88.8	50.9	39.6	54.9	43.1
1959	5.5	94.0	53.4	43.0	60.0	47.0
1960	5.9	105.9	56.2	46.8	65.3	51.0
1961	6.0	117.6	58.6	50.9	70.8	55.3
1962	6.4	128.1	60.9	55.3	76.3	59.2
1963	6.7	137.5	63.9	58.7	80.2	62.5
1964	7.1	145.9	66.3	62.4	85.0	66.7
1965	7.6	153.4	67.5	66.2	91.0	70.9
1966	7.7	160.3	68.5	70.3	96.9	76.7
1967	7.2	168.2	69.9	74.8	102.2	81.7
1968	6.6	176.6	71.5	78.8	106.5	85.3
1970 plan	7.7	209.0	78.0	94.0	124.0	95.0

(2) *Blast furnace facilities*—Estimated Soviet blast furnace capacity at the beginning of 1969 was 85 million tons. In 1968, the U.S.S.R. had 131 blast furnaces in operation in 37 plants of which 20, with 99 of the blast furnaces, produced more than 1 million tons each and accounted for more than 90% of the nation's total output of pig iron. These major pig iron producers are listed in Figure 24 and their locations are shown on Figure 36.

Most of the Soviet blast furnace capacity is located in the two major metallurgical centers in the Ukraine and in the Urals. Most of the remainder is located in the central European part of the U.S.S.R. and in Kazakhstan and West Siberia.

(3) *Technology*—The level of blast furnace technology in the U.S.S.R. compares favorably with that of other major steel producing countries. High production rates have been achieved by the application of modern technology. Improvements in ancillary facilities of blast furnace plants, however, have not kept pace with the rapid progress in furnace and raw materials improvements. Output per worker consequently is lower in Soviet blast furnace plants than the average in the United States.

One of the most important factors in the high productivity of Soviet blast furnaces is the thorough treatment of raw materials, particularly iron ore, prior to charging. Because of its declining quality, an increased proportion of the available iron ore must be beneficiated.[5] This practice and the growing use of agglomerates have contributed significantly to increased production rates. The share of agglomerates in the total ore charge in Soviet blast furnaces, has grown from 73% in 1960 to 91% in 1968. The U.S.S.R. produced over 128 million tons of sinter in 1968 of which all but a few million tons was self-fluxing to some degree. While a leader in sintering, the U.S.S.R. has lagged behind other countries, including the United States, in the development of pelletizing. About 7 million tons of pellets were produced in 1968 compared to about 45 million tons produced commercially in the United States.

Other important developments adopted by the U.S.S.R. to improve blast furnace performance are the conversion of furnaces to high top pressure, the use of natural gas as blast furnace fuel, and the injection of oxygen in the blast. By the end of 1968, 106 blast furnaces were operating with high top pressure compared to 79 furnaces in 1960. A total of 102 blast furnaces were operated with the use of natural gas in 1968. These furnaces accounted for 66.9 million tons or 85% of total pig iron produced that year. In 1958, natural gas was used in only 13 furnaces which produced 3.1 million tons or 8% of the total pig iron. Production of pig iron with the use of oxygen reached 34.2 million tons in 1968 compared with only a few million tons in 1960.

Blast furnace productivity also has been increased through the construction of large-scale furnaces. During 1959-68 the U.S.S.R. constructed 22 new blast furnaces: 2 with a useful working volume of 1,513 cubic meters, 7 of 1,719 cubic meters, 12 of 2,000 cubic meters, and 1 of 2,700 cubic meters. An even larger furnace with a working volume of 3,000 cubic meters is under construction and designs are being prepared for a 3,200 cubic meter furnace. Soviet blast furnaces rank among the largest in the world.

The effectiveness of Soviet programs to increase blast furnace efficiency is reflected in a steady improvement in the coefficient of furnace utilization, shown for selected years in Figure 4.

b. CRUDE STEEL

(1) *Supply position*—The U.S.S.R. produced 106.5 million tons of crude steel in 1968—the equivalent of 90% of production in the United States. The goal for 1970 is 124-129 million tons which appears to be out of reach. If the U.S.S.R. achieves its plans to produce 112.6 million tons of steel in 1969, about 6 million tons more than in 1968, it would still be 11.4 million tons short of the lower limit of the goal for 1970. Average annual increases during 1966-68 were only 5.2 million tons. Production of crude steel in selected years is shown in Figure 3. Crude steel rarely enters into Soviet foreign trade since steel normally is traded in semifinished and finished form.

(2) *Steelmaking facilities*—At the beginning of 1969, the steelmaking capacity of the U.S.S.R. was estimated at about 115 million tons or 70% of estimated capacity in the United States. In 1968, more than 90% of all steel produced in the U.S.S.R. was made in about 70 plants of the iron and steel industry. The remainder was produced in plants assigned to other industries, mainly machine building plants. About 70% of the total production of crude steel was accounted for by 23 plants, all with individual capacities in excess of one million tons. The principal steel-producing centers in the U.S.S.R. are in the Ukraine and the Urals. The Ukraine accounted for about 42% of total steel production and the Urals only several percent less.

Most of the steel produced in the U.S.S.R. is made by the open hearth process, chiefly in basic refractory lined furnaces. Although only a few new open hearth furnaces have been constructed in the current plan period, production of steel by this method has continued to

FIGURE 4. BLAST FURNACE AND OPEN HEARTH FURNACE COEFFICIENTS OF UTILIZATION 25X1

YEAR	BLAST FURNACE*	OPEN HEARTH FURNACE**
1940	1.19	4.24
1950	0.977	5.36
1955	0.803	6.55
1960	0.741	7.69
1965	0.662	8.55
1966	0.646	8.74
1967	0.629	8.94
1968	0.614	9.09

*Cubic meters of usable blast furnace volume per ton of basic pig iron produced per 24 hours.

**Tons of crude steel per square meter of hearth area per 24 hours.

[5] Beneficiation or concentration describes processes for bringing a low iron ore content ore up to 55%-65% iron by elimination of undesirable material. Agglomeration refers to the sintering, pelletizing, or briqueting of fine ore into lumps suitable for blast furnace feed.

expand, reflecting Soviet efforts to intensify operations at existing open hearth shops to compensate for the lag in adoption of the oxygen converter steelmaking process. In contrast, production of open hearth steel has declined markedly in the United States since 1964 as rapid gains have been made in production of steel by the oxygen converter.

Soviet open hearth furnaces produced over 83 million tons of steel or 78% of the total output of steel in 1968, electric furnaces accounted for nearly 10 million tons of 9%, basic (top blown) oxygen converters 11.4 million tons or 11%, and Bessemer converters 1.8 million tons or slightly less than 2%. Of total steel production in the United States in 1968, open hearth furnaces accounted for 50%, electric furnaces nearly 13%, basic oxygen converters 37%, and Bessemer converters less than 1%.

(3) *Technology*—Attainments in Soviet open hearth technology compare favorably with those in the United States. The U.S.S.R. has built the largest open hearth furnaces in the world, including 600-ton units and even some 900-ton units. A comprehensive program has been conducted for many years to rebuild and enlarge older furnaces. The use of oxygen injection to speed the open hearth process has been steadily increased. In 1968, the production of open hearth steel with the use of oxygen amounted to 47 million tons compared to 14.6 million tons in 1960. Greater use also has been made of natural gas in place of mixed gases as fuel for the open hearth. This has made possible the simplification of furnace designs and, in turn, a reduction in building costs and an enlargement of the hearth area to accommodate larger charges. In addition, the use of improved refractories for furnace linings has lengthened the time of furnace operations and thereby reduced downtime for repairs. All of these factors have contributed to steady improvements in the coefficient of utilization of open hearth furnaces, as shown in Figure 4.

Results have been considerably less satisfactory with respect to the oxygen converter steelmaking process. In the early 1960's, when the principal steel producers of North America, Western Europe, and Japan were making steady headway in adopting the new process, the U.S.S.R. was experiencing various technical and planning difficulties in its converter program. In 1962, the U.S.S.R. contracted with Austria for the construction at the Novo Lipetsk Metallurgical Plant of a complete L-D converter shop with three 100-ton converters. This shop was put into operation in 1966. Converters of Soviet design and manufacture have also been put into operation in recent years but by 1968 Soviet production of steel by the basic oxygen converter process had only reached 11.4 million tons in comparison with 44.3 million tons in the United States and 45.7 million tons in Japan. The largest Soviet-built converters are 130-ton units whereas 300-ton units are in operation in Western Europe, Japan, and the United States. The U.S.S.R., however, is currently constructing a shop with 250-ton converters.

The U.S.S.R. also has encountered difficulties in its efforts to build large electric furnaces. An electric furnace with a capacity of 180 tons was in the design stage more than a decade ago but has still not been manufactured and put into operation. The largest electric furnaces currently in operation in the U.S.S.R. are 100-ton units. In the United States electric furnaces are in use with capacities over 200 tons.

The U.S.S.R. has several programs designed to improve steel quality and to develop new alloys for aircraft and missiles. One, in emulation of western developments, involves the use of large scale vacuum processing techniques. Vacuum induction furnaces and consumable electrode vacuum arc furnaces have been installed in special steel plants, including the Dnepr Special Steels Plant, the Chelyabinsk Metallurgical Plant, the Zlatoust Metallurgical Plant and the Elektrostal' Plant. Vacuum ladle and stream degassing have been used extensively to improve the quality of bearing, aircraft, electrical, and large forged rotor steels. In another area of vacuum metallurgy, electron beam remelting, the U.S.S.R. has made considerable progress, using some domestically manufactured equipment as well as a large number of electron beam furnaces imported from East Germany. In addition to vacuum processing the U.S.S.R. has devoted considerable attention to electroslag remelting, a less costly method of improving metal quality. Although not fully equal to vacuum processing, particularly in applications where the highest purity is desired, electroslag remelting has gained acceptance in a variety of other applications. The U.S.S.R. ranks as a world leader in development and industrial use of the process and has licensed its process for use in Japan and Western Europe. Electroslag remelting also is being developed, on an independent basis, in the United States and Western Europe.

c. FINISHED STEEL

(1) *Supply position*—The U.S.S.R. produced 85.3 million tons of finished steel[6] in 1968. Production in 1970 is planned at 95-99 million tons, requiring an average annual growth rate during 1969-70 of 4.9 million tons as compared with an average of 4.8 million tons during 1966-68. Production of finished steel in selected years is shown in Figure 3.

The Soviet product mix for rolled steel differs markedly from that in the United States. For example, the output of light flat rolled products, largely used in automobiles and consumer goods, accounted for about 26% of total output of rolled products in the U.S.S.R. as against 54% in the United States during 1967. Similarly, the proportion of cold-rolled sheet and strip, galvanized sheet and tinplate in the total output of finished light flat rolled products is much lower in the U.S.S.R. than in the United States. In the past decade the U.S.S.R. has sought to increase production of these types of steel but progress has been slow. The production of the more important types of Soviet steel mill products is shown in Figure 25.

Soviet exports of steel mill products have increased from 3.0 million tons in 1960 to 5.9 million tons in

[6] Includes all rolled steel, pipe from ingots, forgings from ingots and blanks for rerolling but excludes steel castings.

1968. Imports have fluctuated, increasing from 1.5 million tons in 1960 to 2.0 million tons in 1962, declining to 1.2 million tons by 1966, and then increasing again to 2.2 million tons in 1968. Net exports of steel increased from 1.5 million tons in 1960 to 4.1 million tons in 1967 but declined to 3.7 million tons in 1968. For the entire period, 1960-68, net exports represented about 4% of domestic production of finished steel.

Shipments to Communist countries accounted for 85% of the finished steel exported by the U.S.S.R. in 1960-68. East Germany received by far the largest single share of the exports to Communist countries. Shipments to non-Communist countries in recent years were distributed among 40 countries throughout the world. Exports of finished steel during 1960-68 are shown in Figure 26.

During 1960-67 the U.S.S.R. imported about the same amount of steel from non-Communist countries as it did from Communist countries. Imports of finished steel from non-Communist countries averaged about one million tons per year during 1960-62 but declined during 1963-66, reflecting, to a considerable extent, the influence of foreign exchange shortages. Imports from these countries rose again in 1968 to 988,700 tons from 379,000 tons in 1966. Most of the finished steel imported from non-Communist countries in recent years has been in the form of pipe and tube, cold-rolled sheet, and light structural shapes. Soviet imports of finished steel and the major suppliers during 1960-68 are shown in Figure 27.

(2) *Production facilities*—Finished steel is produced in approximately 500 plants of which 350 to 375, making only steel castings, are essentially captive foundries of other industries. Of an estimated 140 plants which roll steel, about 20 to 25 are small sheet mills which do not produce ingot steel but process slabs and sheet-bars from other plants. In 1968, 19 plants, each having an annual capacity of over one million tons of finished steel, accounted for an estimated two-thirds of total production. The principal plants producing finished steel and the type of product produced at each plant are shown in Figure 24. The location of the plants is shown on Figure 36, map.

The industry in 1958 reportedly had a total of 298 rolling mills producing hot-rolled steel products of which only 32 were classed as modern mills. The Seven Year Plan called for an increase in the total number of modern mills to 74 and a reduction in the total number of mills to 253, reflecting Soviet intentions to retire 91 obsolete mills, including 52 plate and sheet mills. These plans were not fulfilled. Only 31 rolling mills, including relatively few cold-rolling mills, were installed during 1959-65; construction of new steel rolling capacity amounted to 17.2 million tons, considerably short of the planned total of 23-29 million tons; and many obsolete mills were kept in service to compensate for shortfalls in construction of new capacity.

(3) *Technology*—Soviet rolling and finishing technology is less advanced than that in the United States. The lag in the rolling and finishing sector stems from a greater emphasis given in past years to iron and steelmaking technology and from long lead times in the design, manufacture and installation of the more complicated types of rolling mill equipment.

The production of rolling mill equipment during 1959-65 amounted to 782,000 tons, significantly below the planned amount which, according to one source, was 1,000,000 tons, and, according to a second source, was as much as 1,144,000 tons. Annual output reached 111,000 tons in 1965, only about half of the goal of 200,000 to 220,000 tons for that year. Under the current Five Year Plan production in 1970 is to reach 190,000 to 210,000 tons, somewhat less than the unattained goal for 1965. In 1968 production of rolling mill equipment reached a new high of 153,200 tons but Soviet officials acknowledged early in the year that construction was lagging on machine building facilities needed to achieve planned increases in production of rolling mills and finishing equipment.

The U.S.S.R. has the technical capability to design and construct practically any types of rolling mill, given adequate time and priority. It is relatively adept in the manufacture of blooming, slab, billet, rail-structural, bar, rod, plate, and butt and lap-weld pipe mills and has shown a growing capability to build continuous hot-rolled sheet mills such as the 6 stand, 2,500 millimeter and 1,700 millimeter mills; continuous cold rolling mills including 4 stand, 1,700 millimeter and 2,000 millimeter mills, and seamless and electroweld pipe mills including electroweld mills capable of producing pipe up to 1,220 millimeters in diameter. Special purpose mills also have been built and installed, including those with "multiple back-up" rolls to produce narrow strip. The first Soviet 20 roll, 1,200 millimeter "Sendzimir-type" mill was installed at the Novo Lipetsk Plant in 1963.

The U.S.S.R. has lagged considerably in the application of automated techniques to the rolling mill process and in the development of many types of finishing line equipment important to achieving high quality products. The first Soviet full-scale electrolytic tinning line was not installed until early 1964 at the Magnitogorsk Plant (a small semicommercial line has been in operation for a number of years at Zaporozh'ye) and the first Soviet continuous annealing furnaces were not installed until 1962-64. No additional units of these types are known to have been installed since then. Development of continuous galvanizing and pickling lines also has lagged.

The U.S.S.R. has pioneered in the commercial adaptation of the continuous casting process. By 1968, 85 continuous casting strands had been installed with a total rated capacity of 9.1 million tons, representing nearly one-fourth of known world capacity. Only slow progress has been made, however, in expanding production. The original Soviet goal for 1965 was 10 million tons, but by 1968 annual output from continuous casting installations in the U.S.S.R. had only reached 3.34 million tons.

(4) *Distribution and consumption*—Finished steel in the U.S.S.R. is shipped primarily by rail. Inadequate highways and high haulage costs make it generally impractical to ship steel by truck for other than short hauls. Waterborne

shipments are charged relatively low freight rates, but generally it is necessary to transfer cargo to rail facilities en route to the destination, in part because the north-south orientation of most waterways in the Soviet Union is not appropriate to the predominantly east-west movement of steel.

Disparate trends in regional production and consumption of finished steel have made for considerable cross-hauling of products. Between 1960 and 1967 this was reflected in an increase in the length of the average haul for ferrous metals (finished steel plus pig iron, ferroalloys, and scrap) from 1,037 kilometers to 1,201 kilometers.

The Soviet Union has consistently refrained from disclosing data on the usage of steel mill products by consuming industries. However, various studies in Soviet economic and technical journals provide some general indications of the consumption pattern. The largest share, some 55% to 60%, goes to machine building and metalworking industries. Another 20% to 25% is consumed in construction. Of the remainder, significant shares go for the maintenance and repair of capital goods and for the construction and maintenance of railroads and oil and natural gas pipeline systems.

d. Alloy and stainless steels[7]—For the most part, data are not available on the quantity of alloy and stainless steels produced in the U.S.S.R. It is clear, however, that production of these steels has been increasing, although most of the impetus for such production has been provided by strategic and other high priority programs. Efforts during the past decade to develop broader uses have met with some success, but, in general, Soviet industrial applications of stainless and alloy steels lag behind non-Communist countries.

In recent years the U.S.S.R. has given increased attention to the substitution of low alloy steel, where feasible, for more highly alloyed types and some carbon grades. Thus far, the largest application of low alloy steels has been in construction steels but other low alloy types of steel have been developed for tool and engineering steel. Production of low alloy steel was increased from 1.3 million tons in 1958 to 4.6 million tons in 1965, but was short of the target of 6.0 million tons.

The principal steel plants producing low alloy construction, engineering alloy, bearing, and tool steels in the U.S.S.R. are the Dneprospetsstal' Plant in Zaporozh'ye, the Chelyabinsk Metallurgical Plant, the Serp i Molot and Elektrostal' Plants in the Moscow area, the Krasnyy Oktyabr' Plant in Volgograd, the Serov Steel Plant, the Zlatoust Metallurgical Plant, and the Pervoural'sk Novo Trubnyy Pipe Mill.

In response to its needs for materials for aircraft structures and solid propellant rocket motor cases the U.S.S.R. has developed a variety of high strength, low alloy steels. Early steels in this group include grades 30KhGSNA and EI643, the latter being one of a number of Soviet steels which include tungsten as a major alloying element to achieve an increase in toughness. The tensile strengths of these two steels are 250,000 p.s.i. and 285,000 p.s.i., respectively. A special series of steels designated SP (ultra high strength or Sverkh Prochnaya) also has been developed with at least six carbon grades. Available information indicates that the steel with the best properties in this series is the 33Kh3SNVFMA grade with a tensile strength of 250,000 to 260,000 p.s.i. Still other steels have been developed which have been subjected to thermal mechanical treatment to yield tensile strengths of 300,000 p.s.i. and over. One example is the 40KhSNVF grade with an ultimate tensile strength of 390,000 p.s.i. and a yield strength of 320,000 p.s.i.

The U.S.S.R. conducts much of its research on maraging steels at a nondefense facility, the Central Scientific Research Institute of Ferrous Metallurgy. The primary purpose of the effort, however, probably is to develop steels for aerospace applications. The U.S.S.R. announced in February 1967 that it had produced tonnage quantities of a maraging steel but, on balance, it is believed to lag considerably behind the United States in this field.

The U.S.S.R. also has conducted research since 1954 to develop precipitation hardening stainless steels. The VNS series, which has been discussed extensively in Soviet technical literature, provides a measure of Soviet progress in this field. The series is being developed by the All-Union Scientific Research Institute primarily for the aerospace industry. VNS-5 appears to have the best combined properties with a tensile strength up to 220,000 p.s.i. and good notch toughness and elongation qualities. VNS-9 has shown a tensile strength of 285,000 p.s.i. but apparently is susceptible to stress corrosion.

Some of the stainless steels originally developed for aerospace programs have found applications in the chemical and power generating industries and others have been developed to provide a full range of stainless steels for industrial applications. A considerable effort has been made to develop a series of new and cheaper steels to replace such types as Kh18N10T and Kh17N13HZT which have a high nickel content. The principal producing facilities for stainless steels are the Dneprospetsstal' and the Chelyabinsk Plants; other important producers are the Krasnyy Oktyabr', Serp i Molot, Elektrostal', the Zlatoust and Kuznetsk Metallurgical Plants, and the Yuzhnotrubnyy Tube Mill (Nikopol').

e. Superalloys, refractory metals, and powder metallurgical products—Quantitative data are not available on Soviet output of superalloys, but the Soviet program for development of these alloys ranks generally on a par with such programs in industrially advanced non-Communist countries. Because of the relatively limited supply of cobalt in the U.S.S.R., however, Soviet research on cobalt-base alloys is less advanced than on nickel-base alloys. In addition, there is evidence that the Soviets have experienced difficulties in developing nickel-base alloys combining relatively high strength levels with desired corrosion-resistant qualities.

Soviet superalloys were developed primarily for use in the production of components for jet aircraft. Much

[7] Includes low alloy and alloy constructional and engineering steels, bearing steels, tool steels, stainless steels, and steels resistant to heat (up to 120°F.) and corrosion.

of the development work on superalloys has been carried out at research institutes in Moscow, particularly those associated with the aviation industry. In recent years, however, notable research also has been conducted in the Leningrad area, principally at the Central Boiler and Turbine Institute. Production is carried out mainly at the Elektrostal' plant, the principal producer of superalloys in the U.S.S.R.

Soviet melting practice for superalloys is based, in large part, on the use of the electroslag remelting technique. In contrast, the normal practice in non-Communist countries is to use the consumable-electrode, vacuum arc process. Soviet practice reflects both the position of the U.S.S.R. as a leader in development of electroslag remelting and the Soviet lag in building capabilities for vacuum processing. These latter capabilities are believed to have been sufficiently developed in recent years, however, to permit production of superalloys needed in exacting applications. Some use also has been made of electron beam melting for the production of nickel-base alloys.

Preparation of molybdenum and tungsten metals and alloys by powder metallurgy is employed in the U.S.S.R. using substantially the same techniques as in non-Communist countries. Plants engaged in the production of powder for power metallurgy are located at Moscow, Tula, Brovary, and Kiev. In addition, specialized sections have been established at various machine building plants to manufacture articles and parts by power metallurgical methods. A large number of institutes have participated in basic and applied research on power metallurgy. The Institute of Problems of Materials Science, Kiev, has played a leading role in research on sintered carbides and powder rolling. The Central Scientific Research Institute of Ferrous Metallurgy has conducted extensive research to develop new powder-metallurgical alloys as well as industrial methods suitable for the production of sintered billets.

The U.S.S.R. is the world's second largest producer of metalloceramic and fused hard alloys for cutting and drilling tools, drawing dies, facing materials, and in some instances, for armor piercing shells. The principal Soviet hard alloys are tungsten and tungsten-titanium carbides with cobalt or nickel binders and the fused cobalt-tungsten carbides (stellites).

The need for optimum properties in aerospace and advanced weapon applications has fostered work in the U.S.S.R. as in the United States on developing composites of metals and silicides, nitrides, carbides, and borides. Materials are required that will give extreme heat protection, possess far higher strength of weight ratios than any thus far achieved, resist corrosion, oxidation, and environmental effects such as radiation, and also be amenable to forming and joining.

f. Special metals and alloys[8]—Little information is available on Soviet production of types of materials in the special metals category other than electrical steels. The U.S.S.R. is a major producer of all grades of electrical sheet.[9] Production of electrical sheet in the U.S.S.R. has increased steadily from 494,000 tons in 1960 to 921,000 tons in 1968. As early as 1963 Soviet production exceeded U.S. production of electrical steel. The U.S. produced 668,000 tons of electrical steel in 1967 and only 631,000 tons in 1968. The quality of Soviet electrical steel has often been criticized, however. Soviet officials blame the poor quality of electrical sheet for high energy losses in the electric power industry. In the past several years the Soviets installed modern equipment for hydrogen annealing and coating of transformer strip, but the results have not been entirely satisfactory.

The most important plants for the processing of electrical sheet are the Novo Lipetsk Metallurgical Plant, the Magnitogorsk Combine, and the Verkh-Isetskiy plant. The latter plant is undergoing reconstruction and modernization. Other processing facilities are located at the Zaporozh'ye and Novosibirsk Metallurgical Plants and the Leningrad Steel Rolling Mill. Plants which produce only slabs for further processing include the Dneprospetsstal', Elektrostal', Chelyabinsk, Kuznetsk, and Nizhny Tagil plants.

Magnetic core materials based on iron, primarily Armco grade, are produced at Serp i Molot in Moscow and at the Krasny Sulin Metallurgical Plant in the Lower Don area. Serp i Molot is the largest producer of Armco iron in the Soviet Union. The principal use of Armco iron in the U.S.S.R. is probably as a starting material for the production of carbonyl iron. Electrolytic and carbonyl iron are produced in unknown amounts, probably at the Krasny Sulin Works. In addition to the iron-silicon and iron magnetic core materials mentioned above, the Soviets appear to have a full range of iron nickel (permalloy), modified iron nickel (molybdenum permalloy), and iron-cobalt alloys.

The U.S.S.R. is a major producer of cast and pressed powder permanent magnet materials in the majority of alloy systems currently found useful. The bulk of the output, as in other countries, is in the cast, iron-nickel-aluminum grades, primarily Alnico types. The quality (as measured by the energy level, coercivity, and resistivity) is below that found in the United States and Western Europe. In recent years the Soviets have devoted considerable attention to the development of ferrites as magnetic materials.

g. Iron and steel castings—The Soviet iron and steel foundry industry is in general highly fragmented and captive to other industrial operations. Of more than 2,000 iron foundries and 500 steel foundries in the U.S.S.R. only a few are centralized plants producing a wide variety of castings on a jobbing basis. Soviet foundries range in size from the large facilities at the Urals Heavy Machine Building Plant (Uralmash) with a capacity of over 200,000 tons of iron castings, to small operations producing less than 1,000 tons yearly.

[8] Includes magnetic core materials, permanent magnet materials, and other alloys with special electrical properties.

[9] Armature, electrical, dynamo, motor, transformer, and grain-oriented transformer sheet.

The U.S.S.R. is the world's leading producer of iron and steel castings, a reflection, in part, of the Soviet tendency to use relatively more cast components than in the United States, despite the comparatively higher cost and weight of the equipment and machinery that results in many cases. In 1968 the U.S.S.R. is estimated to have produced about 4 million tons of steel castings and 18 million tons of iron castings.

3. Basic raw materials

a. LIMESTONE—Limestone is used as a flux in Soviet blast furnaces and steelmaking units and in the production of self-fluxing sinter. Dolomitic limestone is used primarily in the output of low manganese pig iron, and as a constituent of refractory materials in open hearth bottoms and oxygen converters. Limestone is plentiful in the U.S.S.R. and quarries generally can be developed within 200 miles of a steel plant. Reserves on 1 January 1959 were as follows, in millions of tons:

	PROVEN RESERVES	INDICATED AND INFERRED RESERVES
Limestone	1,686	2,999
Dolomitic limestone	88	166

There are no known imports or exports of limestone by the U.S.S.R.

b. METALLURGICAL COKE—The U.S.S.R. produced 71.5 million tons of metallurgical coke in 1968 and plans to produce 78.0 million tons in 1970. Production in selected years is shown in Figure 3.

The U.S.S.R. is a net exporter of coke. Exports have increased from 2.6 million tons in 1960 to 3.8 million tons in 1968. Exports during 1964-68 ranged between 3.7 and 4.0 million tons. The chief recipients of Soviet coke in recent years have been East Germany, Hungary, Romania, and Finland. These four countries received 83% of total Soviet coke exports in 1968. Most of the remainder was shipped to Bulgaria, Czechoslovakia, North Korea, Cuba, Austria, Denmark, and Sweden. The Soviet trade handbook reports imports of coke from Poland but this is believed to be a continuation of an earlier arrangement providing for direct shipment on Soviet account of Polish coke to East Germany.

Reserves of coking coal in the U.S.S.R. amount to about 2.48 trillion tons, based on official estimates, which include measured, indicated, and inferred categories of reserves. A considerable part of these huge reserves, however, is not suitable for coking purposes because of high ash content, high sulfur content, or other undesirable qualities. Coking coal reserves of the four main supply basins for ferrous metallurgy, the Donetsk, Kuznetsk, Karaganda, and Pechora basins as of 1957 were as follows, in billions of tons:

Donetsk	31.3
Kuznetsk	300.0
Karaganda	51.0
Pechora	114.6

The location of these and other sources of coking coal are shown on Figure 37. For further information on coking coal reserves, see Section 62F.

The Ukraine in 1968 accounted for about 51% of total production of coke, most of the remainder was produced in the Urals and in West Siberia. Coke plants in the Ukraine obtain coal from the Donetsk Basin while those in the Urals operate on a blend of Kuznetsk and Karaganda coals. Pechora coals are supplied mainly to 25X1 the Cherepovets Metallurgical Plant in the north but, in the future, are to be supplied to the Urals, partially supplanting coals from Kuznetsk, which are to serve as the principal fuel source for the plants in West Siberia.

Technological improvements have been directed primarily toward maintaining the quality of coking coal, blending poorer grades with higher quality types, and toward the development of substitute fuels. By investing heavily in coal preparation plants, the Soviet coal industry has been able to maintain a fairly constant quality for the coal charged to the coke ovens. The increasing use of natural gas injections in blast furnace tuyeres and some concurrent use of oxygen and natural gas have contributed to significant economies in the consumption of coke. These and other measures enabled the U.S.S.R. to reduce its coke consumption per ton of pig iron produced from 724 kilograms in 1960 to 601 kilograms in 1967.

c. IRON ORE

(1) *Supply position*—The U.S.S.R. is the largest producer of iron ore in the world. It provides completely for its own needs and furnishes over 50% of the usable ore [10] requirements of the Eastern European Communist countries. In 1968, the U.S.S.R. produced 177 million tons of usable ore. The goal for 1970 was originally announced to be 224 million tons but was later reduced to 209 million tons. Production of usable iron ore in selected years is shown in Figure 3, and Soviet exports during 1960-68 are shown in Figure 5.

Declining ore quality in the U.S.S.R. has necessitated large-scale construction of concentrating and sintering plants. During the Seven Year Plan period, 218 million tons of new mining and beneficiating capacity were planned, of which about 172 million tons were commissioned. For the current plan period (1966-70), at least 150 million tons of new mining and beneficiating capacity are scheduled to be put into operation, but during the first three years only 66 million tons were actually commissioned. The U.S.S.R. also has been slow in adopting the new pelletizing process, the first facilities for which were commissioned at Sokolov-Sarbay in 1965 and Krivoy Rog in 1967. The output of pellets grew to about 3.7 million tons in 1968. In the case of sinter, production has been increasing steadily, reaching an estimated 128 million tons in 1968.

[10] The term usable iron ore as used in the U.S.S.R. includes shipping grade ore (that labeled as usable in blast furnaces and open hearth furnaces without further processing) and beneficiated ore (concentrates, sinter, pellets). Production of usable ore, however, is not equal to the sum of the output of shipping grade and beneficiated ore because increasing quantities of shipping grade ore are being processed further after leaving the mine.

FIGURE 5. EXPORTS OF IRON ORE [redacted]
(*Thousands of metric tons*)

25X1

	1960	1961	1962	1963	1964	1965	1966	1967	1968
Austria	341	293	316	434	401	400	355	314	334
Bulgaria	0	40	25	211	346	842	908	954	764
Czechoslovakia	5,066	5,078	5,988	6,914	7,638	7,966	7,662	8,665	9,533
East Germany	2,003	2,046	2,521	2,445	2,565	2,610	2,594	2,460	2,603
Hungary	1,683	1,725	1,999	2,032	2,339	2,267	2,572	2,645	2,709
Italy	0	3	0	0	0	0	10	329	620
Japan	0	0	0	0	0	28	251	382	957
Poland	5,238	5,993	6,432	6,769	7,154	7,353	7,850	8,584	9,990
Romania	851	1,068	1,386	1,633	1,667	1,714	2,428	2,670	3,138
United Kingdom	0	0	0	0	25	511	956	1,426	1,515
West Germany	0	29	268	339	465	447	532	256	36
Total*	15,182	16,283	18,935	20,789	22,600	24,138	26,118	28,685	32,201

*Includes small amounts of unidentified shipments.

FIGURE 6. PROVED RESERVES OF IRON ORE BY REGION, 1 JANUARY 1962 [redacted]
(*Billions of metric tons and percent*)

25X1

REGION	RESERVES	PERCENT OF TOTAL	AVERAGE IRON CONTENT
North and Northwest	1.7	*3.6*	32
Ukraine	11.8	*25.0*	44
Central	11.8	*25.0*	51
Urals	7.5	*15.9*	25
West Siberia	0.9	*1.9*	39
East Siberia	3.8	*8.1*	39
Southern	1.7	*3.6*	32
Kazakhstan	7.8	*16.5*	40
Transcaucasus	0.2	*0.4*	40
Total	47.2	*100.0*	40

Steady progress also has been made in increasing the average iron content of Soviet usable ore from 54.3% in 1960 to 58.4% in 1968, only slightly short of the 1970 goal of 58.6%.

(2) *Reserves*—As of 1 January 1962 proved (measured and indicated) reserves of iron ore were estimated at 47.2 billion tons. The regional distribution of these reserves and the average iron content of the ore in each region are shown in Figure 6. In 1968 the U.S.S.R. announced that the volume of its proved reserves of iron ore exceeded 58 billion tons, the largest in the world. Details concerning the geographical distribution of these additional reserves are not available. Total iron ore resources at the beginning of 1968 were estimated at more than 100 billion tons, including inferred and currently uneconomic ores. The quality of the huge Soviet reserves, as measured by the iron content of the ore, is below that of reserves in the United States, Sweden, or India, but is substantially higher than those in Western Europe. In 1965 the U.S.S.R. estimated the average iron content of its proved reserves at 38.4%. Reserves reportedly included 10.3 billion tons of direct shipping grade ore with an iron content of over 55% and 34.8 billion tons of ore requiring only simple concentration.

(3) *Mines and concentrating plants*—The most important iron ore producing area of the U.S.S.R. is the Krivoy Rog Basin which accounted for over 50% of the total usable ore output in 1968. Other important producing deposits include the Kursk Magnetic Anomaly, the Sokolov-Sarbay deposits near Kustanay, the Gorniya Shoriya area south of Novo Kuznetsk, the Olenegorsk and Kovdorsk deposits in the northwest, the Magnitogorsk and Kachkanar deposits in the Urals, the Abadan, Kerch', and Dashkesan deposits. The locations of major deposits are shown on Figure 37.

The Krivoy Rog Basin, about 60 miles long by one-half to 3 miles wide and centered on the city of Krivoy Rog, contains over 50 separate mining operations. Production of usable ore in 1968 was about 90 million tons. The bulk of the rich ore at Krivoy Rog extends in pockets to depths of over 5,000 feet, while low grade iron quartzites are obtained by strip or open pit operations. In 1967, there were ten underground mines and five open pits with a total capacity of 100 million tons of usable ore. The Gigant iron ore mine at Krivoy Rog, the largest in the U.S.S.R., will have a capacity of 7 million tons of crude ore annually when completed.

The Kursk Magnetic Anomaly (KMA), said to be the world's largest reserve of rich ore, is a heterogeneous collection of ore bodies covering 46,000 square miles between Orel and Kharkov. As of 1 January 1968, the KMA was reported to contain 40.4 billion tons of reserves, but a substantial part of this is at great depth and requires costly underground operations under difficult mining conditions. In 1968, enterprises of the KMA produced about 15 million tons of enriched ore and quartzites, and if current plans are successful, output is to reach 30 million tons in 1970 and 100 million tons by 1976. [redacted] The Soviets are hopeful that this level of output will cover ore requirements for the central region of the U.S.S.R., permit shipment to plants in the Ukraine, and eventually serve as an important source of exports to the Eastern European Communist countries.

25X1

The large Kustanay iron ore basin in northwest Kazakhstan was developed both to ease the gradual drain on resources

[redacted]

25X1

of ore in the Urals and to supplement the ore supplies of the Karaganda Metallurgical Plant in Kazakhstan. Proven reserves in the Kustanay region exceed 6 billion tons, of which 2 billion tons are in the Sokolov-Sarbay deposits which are currently in production. The other major deposits are at Lisakovsk, where production began in late 1968, and at Kacharsk, where production is expected to begin in 1970. In 1968, production of crude ore at Sokolov-Sarbay reached 20 million tons and the concentrating complex produced about 10 million tons of concentrate with an iron content of 65%. The planned production of pellets at Sokolov-Sarbay in 1969 is 5.3 million tons.

The Urals are dotted with producing iron ore deposits, two of which generally characterize the ore supplies of this region, the largest at Magnitogorsk, and the newest at Kachkanar. Magnitogorsk has been mined intensively since 1932 and is expected to be virtually worked out by 1980. Output began to decline during the Seven Year Plan period, and increasing amounts of ore were brought in from Sokolov-Sarbay to supplement the ore supply to the Magnitogorsk blast furnaces. The decrease in the supplies of high-grade ore in the Urals also is reflected, in part, by the start of operations at the Kachkanar deposits in 1963. The titanomagnetites composing the Kachkanar deposits have an iron content of only 16-17%, thus this is the largest low-grade iron ore project in the U.S.S.R. and probably in the world. The fact that the deposit is exposed at the surface and contains vanadium pentoxide, however, reportedly will make the resultant concentrate competitive with concentrates from Krivoy Rog. The concentrating combine at Kachkanar has an annual capacity to convert 8.3 million tons of raw ore into 1.5 million tons of concentrates averaging 54%.

d. MANGANESE ORE

(1) *Supply position*—Among the major steel-producing nations only the U.S.S.R. is fully self-sufficient in manganese. With reserves in excess of 2 billion tons, the U.S.S.R. is assured of an adequate supply for well over a century.

The U.S.S.R. produced about 6.6 million tons of manganese ores and concentrates in 1968 and plans to produce about 7.7 million tons in 1970. Production in selected years is shown in Figure 3. Production of manganese exceeds domestic requirements, leaving a sizable surplus for export. In 1968, Soviet exports of manganese amounted to 1,150,000 tons, slightly more than 17% of production. Exports satisfy virtually all of the requirements of East Germany and Poland, and a substantial portion of those of Czechoslovakia. Shipments to non-Communist countries in 1968—412,000 tons—represented about one-third of total exports of manganese. The major recipients were the United Kingdom, France, and Japan. Exports of manganese ores and concentrates are shown in Figure 7.

(2) *Mines and deposits*—The bulk of Soviet reserves of manganese is located in three deposits—Chiatura, Nikopol', and Bolshoy Tokmak. Production from mines in Chiatura amounted to about 3.4 million tons in 1968, and should increase to about 4.0 million tons by 1970. Output at Nikopol' was over 3.1 million tons in 1968, and is scheduled to reach about 3.7 million tons by 1970. Both Chiatura and Nikopol' have been expanded in recent years, but there is no evidence to indicate that production has started as yet at the Bolshoy Tokmak deposits.

Minor producing mines are located at Polunochnoye and other deposits in the Urals, at Marganets in Kazakhstan, and at Mazul' in Eastern Siberia. Additional deposits of manganese are found in central Kazakhstan (one in the western Karazhal iron ore deposit and another, near Dzhezkazgan) and in the central Urals. Soviet deposits of manganese ore are described in Figure 28.

4. Alloying materials 25X1

The U.S.S.R. claims abundant resources of the principal alloying metals and a leading place in world reserves of chromite, nickel, vanadium, molybdenum, and tungsten. Only cobalt resources are comparatively limited. Information

FIGURE 7. EXPORTS OF MANGANESE ORE AND CONCENTRATES 25X1
(*Thousands of metric tons*)

	1960	1961	1962	1963	1964	1965	1966	1967	1968
Austria	19	12	12	0	0	0	0	0	0
Belgium	0	0	0	0	0	0	42	63	2
Canada	0	0	0	0	0	0	0	2	16
Czechoslovakia	80	90	107	104	130	141	149	186	177
East Germany	158	179	216	209	174	171	198	216	108
France	116	108	99	106	103	90	116	65	99
Italy	18	14	16	24	10	8	7	19	21
Japan	13	21	74	71	72	92	106	100	107
North Korea	0	0	0	0	0	0	0	20	19
Norway	35	48	10	15	30	37	45	37	41
Poland	286	192	236	242	252	249	317	304	318
Sweden	8	21	10	25	37	27	26	30	26
United Kingdom	149	129	99	100	138	122	134	104	71
West Germany	79	78	66	65	0	27	21	0	29
Yugoslavia	12	4	3	2	0	0	0	37	22
Unidentified shipments	0	0	15	23	33	56	57	67	94
Total	973	896	963	986	979	1,020	1,218	1,250	1,150

concerning the actual reserves of most of these alloying materials is not available. With the exception of the rich chromite ores, most Soviet alloying metal ores are lean, complex, difficult to process, and often located in remote regions with severe climatic conditions. As a result, production costs are high and the domestic prices of alloying materials are many times the prices of other materials used by the steel industry.

Soviet production of alloying metals covers, in most cases, essential domestic industrial requirements and a substantial portion of the needs of other Communist countries. Some of the alloying metals also are exported to non-Communist countries.

a. CHROMITE

(1) *Supply position*—The U.S.S.R. is the world's largest producer of chromite, having mined in 1968 about 2.0 million tons of metallurgical and refractory grade chrome ore containing an estimated 867,000 tons of chromite (Cr_2O_3). Soviet exports of chrome ore and concentrates in 1968 amounted to 1,048,000 tons, of which 866,000 tons were shipped to non-Communist countries, including the United States (the largest importer with 326,000 tons). The remaining 182,000 tons were sent to Eastern European Communist countries, chiefly Poland, Czechoslovakia, and East Germany. Soviet production of chromite is shown in Figure 8.

Refractory, chemical, and metallurgical grade ores have been produced in the past in the U.S.S.R., both in Kazakhstan and in the Urals. At present, production apparently is largely confined to Kazakhstan which, according to Soviet claims, meets all requirements for chromite for domestic use and for export.

(2) *Deposits and mines*—The U.S.S.R. claims the world's largest explored reserves of chromite. Although details to support this claim are lacking, Soviet reserves undoubtedly are extensive. About 90% of Soviet chromite reserves are located in the Kazakh S.S.R. The remainder are found in the Ukraine, in the Urals (Sarany, Verbluzh'yagora, Alapayevsk, Monetnayadacha, Khalilovo, Akkarginsk, Serov), in Azerbaijan (Shorzhinskiy), and in the Far East (Koryakskiy Khrebet).

By far the largest and most significant chromite deposits in the Soviet Union are the Kempirsay deposits which cover an area of approximately 1,000 square kilometers in northern Kazakhstan, and contain about 70 individual deposits. The higher grade metallurgical ores occur in the southern district, chiefly in the Donskoye group, near Khrom-Tau. These ores are of excellent quality, containing 30%-60% Cr_2O_3, with low silica and a chrome-to-iron ratio as high as 4 to 1. Commercial ores, sold as fines, friable, and hard lump, contain at least 45%-50% Cr_2O_3, depending upon type, and have a chrome-to-iron ratio of more than 3 to 1. Under the current Five Year Plan, output of chromite in the U.S.S.R. is to reach 950,000 tons in 1970. Virtually all of the planned increases in production are to come from the mines in the Donskoye group in Kazakhstan. Further expansion probably will continue in this area until at least 1980.

FIGURE 8. ESTIMATED PRODU[redacted]OF ALLOYING MATERIALS
(*Metric tons*)

YEAR	CHROMITE*	TUNGSTEN	MOLYBDENUM	NICKEL	COBALT
1960	519,500	11,400	4,800	72,000	1,640
1961	544,800	12,000	5,200	82,000	1,840
1962	588,000	12,600	5,300	90,000	2,155
1963	658,000	13,100	6,370	93,000	2,520
1964	690,000	13,600	6,700	97,000	2,600
1965	735,000	14,000	7,300	100,000	3,400
1966	800,000	14,000	7,600	107,000	3,800
1967	830,000	14,000	8,000	115,000	4,000
1968	867,000	14,000	8,500	124,000	4,200

*Estimated Cr_2O_3 content of ore.

b. TUNGSTEN

(1) *Supply position*—Annual production of tungsten concentrate (60% WO_3) in the U.S.S.R. is estimated to have remained at approximately the same level—14,000 tons—since 1964. This represents about 22% of estimated world production in 1968, and about one-sixth more than the estimated Chinese Communist output. Soviet imports of tungsten ores and concentrates from Communist China have declined sharply in recent years, from 12,000 tons in 1963 to nothing in 1968. Soviet exports of tungsten ores and concentrates, chiefly to Western European countries, have fallen off gradually from 4,300 tons in 1963 to something less than 2,000 tons in 1967. Exports apparently were discontinued in 1968. Soviet production of tungsten in selected years is given in Figure 8.

The supply of tungsten available to the Soviet Union is adequate to permit a high rate of consumption. Tungsten is regularly substituted, where possible, for less abundant molybdenum. The U.S.S.R. also has devoted considerable attention to the development of alloy steels containing tungsten.

(2) *Deposits and mines*—In 1967, the U.S.S.R. claimed first place in the world in explored reserves of tungsten. The metal occurs chiefly in the form of scheelite or wolframite in combination with molybdenum, tin, manganese, gold, and other minerals. A large share of Soviet tungsten comes from skarn tungsten-molybdenum ores, which are found in the Caucasus (Tyrny-Auz) and Central Asia (Chorukh-Dayron, Tadzhik S.S.R. and Ingichka, Uzbek S.S.R.). The rest is derived from quartz veins, chiefly those in East Siberia (Dzhida deposit in the Buryat A.S.S.R. and lesser deposits in Chita Oblast'), the Far East (Iul'tin in eastern Chukotka and Vostok in Primorskiy Kray) and the Gorniy Altay (Belukha, Bukuka, Khirlovaya Gora). Soviet tungsten deposits are described in Figure 29.

25X1

(3) *Producing facilities*—The largest and most modern facilities for the recovery of tungsten in the U.S.S.R. are located at Tyrny-Auz and Nal'chik in the Kabardo-Balkar A.S.S.R. in the northern Caucasus. Ore is carried from the underground mines of the Tyrny Auz deposit by cableway to the Tyrny-Auz concentrating plant, where it is processed in concentrate form, then

shipped to the hydrometallurgical plant at Nal'chik. Here the tungsten and molybdenum are completely separated, without furnaces, by use of chemical reagents. The Nal'chik plant, which began operations in 1962, is reportedly highly mechanized.

Additional major facilities for the production of tungsten concentrates are known to exist at Dzhida and at Iul'tin, but comparatively little information is available on their operations. The Vostok tungsten mining and concentrating combine—located in northern Primorskiy Kray—is under construction with the first phase of the combine to be completed in 1971. The deposits here reportedly contain a high percentage of copper, bismuth and gold.

c. MOLYBDENUM

(1) *Supply position*—Although the supply of molybdenum available to the U.S.S.R. appears to satisfy its priority requirements and to permit some exports of concentrates and of ferromolybdenum, the metal is often referred to in Soviet literature as "deficit"—that is, in short supply. There is, in fact, ample evidence that molybdenum has been used sparingly and that tungsten frequently has been used as a substitute. Total estimated Soviet production, 1963-67, was slightly more than one-third of U.S. consumption during the same period. Estimated production of molybdenum (expressed in terms of molybdenum content of concentrate) rose from 6,700 tons in 1964 to about 8,500 tons in 1968. Prior to 1964, the supply of molybdenum was augmented by imports of ores, concentrates, and ferromolybdenum from Communist China. From 1964 to 1968, however, the U.S.S.R. reported no imports of Chinese molybdenum in any form. Soviet exports of molybdenum, mostly in the form of ferromolybdenum, fell from 3,500 tons in 1964 to something less than 500 tons in 1967. In 1968 the U.S.S.R. apparently stopped exporting molybdenum. About three-quarters of the exports during 1964-67 went to non-Communist countries. Estimated production of molybdenum for selected years is shown in Figure 8.

(2) *Deposits and mines*—The U.S.S.R. claims first place in the world in explored reserves of molybdenum. Described in 1947 as "adequate for decades," reserves have been increasing steadily since that time. The quality of reserves is low, however, and efforts are continuing to locate higher quality ores. The 1966-70 plan calls for the explored reserves of molybdenum to be increased 30 times in comparison with the amount to be mined during the same period.

Molybdenum is widely distributed throughout the U.S.S.R., with major deposits in the Caucasus (Tyrny-Auz), the Kazakh S.S.R. (Vostochno-Kounrad), and East Siberia (Sora and Dzhida). The ores are generally lean and difficult and expensive to process. Rich vein ores, which in 1945 accounted for almost 80% of production, now contribute only a small share, and other deposits, requiring heavy capital investments, account for most of the current production. The principal molybdenum deposits are described in Figure 29.

(3) *Producing facilities*—Plans for a substantial increase in the production of molybdenum during 1959-65 apparently were not fulfilled. The Seven Year Plan called for expansion of plants at Tyrny-Auz, Kadzharan (Armenian S.S.R.), Almalyk (Uzbek S.S.R), and Chita Oblast' (East Siberia), but new facilities were completed slowly, usually three to four years behind schedule. There is no evidence that construction has yet begun at the Chita Oblast' site.

The U.S.S.R's most important molybdenum-processing installation is the Tyrny-Auz-Nal'chik complex (see B, 4, b, (3), Producing Facilities) which may account for as much as 15%-20% of the current Soviet production of molybdenum. The principal Soviet facilities for processing molybdenum ores are listed in Figure 29.

d. VANADIUM

(1) *Supply position*—Soviet vanadium production, estimated at 1,050 tons (expressed in metallic content of 40% ferrovanadium) in 1958, probably declined considerably during the early 1960's, due to rapid depletion of traditional sources of raw materials and long delays in completing concentrating facilities. Actual production of vanadium in the U.S.S.R. during the 1960's is not known, but new mining and concentrating facilities opened at Kachkanar in the Urals in 1963 apparently provided enough raw materials to assure continued operation of the Chusovoy ferrovanadium plant and to permit export of ferrovanadium as well as vanadium slags for processing in Czechoslovakia and Hungary. Construction of additional facilities at Kachkanar was not completed on schedule in 1966, however, and it became necessary to supplement domestic supplies with imports. During 1966 and 1967 the U.S.S.R. imported about 1,000 tons of vanadium pentoxide from Finland.

Completion of the Kachkanar facilities was planned for sometime in 1969. Kachkanar is a potential source for 2,000 to 6,000 tons of vanadium annually. In addition, according to Soviet claims, 4,000 to 6,000 tons of vanadium could be obtained by exploiting the ores of Ayat and Lisakovsk (Kazakh S.S.R.) but no information is available on the development of this region.

(2) *Reserves*—Soviet reserves of vanadium are estimated at about six million tons of recoverable vanadium contained in titanomagnetite and limonite ores distributed throughout the country from the Kola Peninsula and the Crimea to Eastern Siberia. The major deposits are those of Kachkanar (titanomagnetites) and Ayat and Lisakovsk (limonites). Other important deposits are located at Kerch in the Ukraine and Pudozhgora (62°17'N., 35°54'E.) in Karelia. The Urals titanomagnetite deposits at Kusa and Pervoural'sk, the only Soviet sources of vanadium which had been exploited for industrial purposes until the opening of Kachkanar, are virtually exhausted.

e. NICKEL

(1) *Supply position*—The U.S.S.R. is the second largest nickel producer in the world. Its production in 1968 is estimated to have been about 124,000 tons, slightly less than half of Canada's output. Domestic supplies were augmented in 1968 by imports, almost entirely from Cuba in the form of sinter, oxide, or slurry, amounting to about 18,000 tons (contained nickel). The

U.S.S.R. also has exported nickel in recent years. The U.K. received 12,700 tons in 1966 and 6,600 tons in 1967. Communist China received 1,500 tons in 1966. By 1970, the output of nickel may reach nearly 150,000 tons. Estimated Soviet production of nickel for selected years is given in Figure 8.

(2) *Resources*—The U.S.S.R. claims the world's largest explored reserves of nickel. About four-fifths of these reserves are located in the copper-nickel sulfide deposits of the Soviet North (Pechenga, Monchegorsk, Noril'sk, Tal'nakh); slightly less than one-fifth occur in the lateritic deposits of the Urals (Yelizaveta, Cheremshan, Buruktal) and Kazakhstan (Aktyubinsk Oblast'); and the remainder in the nickel-cobalt arsenides of Tannu Tuva. Soviet ores are generally low-grade, the sulfides having an average nickel content of 0.3% to 0.6%, the laterites averaging about 1.5%.

The Soviet Union has devoted considerable attention to the expansion of the ore base of its nickel industry, through intensified development of known deposits and by extensive prospecting for new resources. Open pit mines began producing at Kaula and Alajiki (near Nikel' on the Kola Peninsula) in 1962 and at the Kimpersay deposits in Kazakhstan in 1963. Output began in late 1967 at the Tal'nakh deposits, which are deemed adequate to provide an entire new ore base for the Noril'sk combine. In the Urals, the discovery of extensive new deposits at Buruktal, 100 miles southeast of Orsk, has spurred plant construction in the area to process ore. The principal deposits of nickel are described in Figure 30.

(3) *Processing facilities*—The major nickel producing facilities of the U.S.S.R. are located above the Arctic Circle at Monchegorsk and Pechenga (Kola Peninsula) and Noril'sk (East Siberia). Together these plants account for about 85% of Soviet nickel output. The Noril'sk combine, the U.S.S.R's largest nickel producer, has been expanded in recent years and now consists of four mines, one central concentrator, and a large nickel smelter and refinery. Much of the Noril'sk expansion is based on the rich Tal'nakh deposits, as the high-grade deposits at Noril'sk are gradually being exhausted. It is estimated that Noril'sk accounts for nearly half of Soviet nickel output. The ores at Pechenga are mined by both underground and open pit methods; the largest and most important of the operations is the new Zhdanovsk open pit, which reportedly accounts for most of the area's nickel output. At Pechenga, the bulk of the ore is direct-smelted, with only a minor portion undergoing concentration and sintering prior to smelting. The Monchegorsk complex is composed of various mining operations, a smelter similar to that at Pechenga, and a refinery.

Other important nickel-producing facilities are located in the Central Urals, at Rezh and Ufaley, and in the Southern Urals at Orsk (Yuzhuralnikel'). These plants employ shaft furnace smelting to process the lateritic ores from the Urals and Kazakhstan. Nickel output from this area is expected to increase once the construction of new facilities at Buruktal is completed.

f. COBALT

(1) *Supply position*—The U.S.S.R.'s production of cobalt in 1968 is estimated at 4,200 tons, equivalent to about one-fourth of production in non-Communist countries, and to slightly more than 63% of the amount consumed in the United States in 1967. Of this total, the U.S.S.R. exported 100 tons. It is estimated that Soviet output of cobalt will increase to about 4,600 tons in 1970. Estimated production of cobalt in recent years is listed in Figure 8.

(2) *Deposits and mines*—The U.S.S.R. claims first place in the world in explored reserves of cobalt. In 1955, reserves were estimated at 50,000 tons, and by the end of 1958 they were reported to have reached 73,000 tons. Potential cobalt reserves have been deemed adequate for many decades.

In the U.S.S.R. cobalt occurs chiefly in combination with nickel in the sulfide ores of the Kola Peninsula and the northwest part of the Siberian Plateau; in the laterite ores of the Urals, Kazakhstan, and the Ukraine; and in the arsenide ores of Tannu Tuva. It occurs also in polymetallic ores which contain, besides cobalt, iron, manganese, copper, zinc, and other elements. These ores are found in the Urals, the Transcaucasus, Eastern Siberia, and the Far East. The principal deposits are described in Figure 30.

(3) *Processing facilities*—Cobalt is recovered mainly as a byproduct of nickel production at refineries associated with the nickel combines at Monchegorsk, Noril'sk, Orsk, and Verkhniy Ufaley. Cobalt-containing matte from the smelters at Pechenga and Rezh are processed at Monchegorsk and Verkhniy Ufaley, respectively. Concentrates from Dashkesan and the Far East are refined at Verkhniy Ufaley. The Tannu Tuva cobalt enterprises—"Tuvakobalt"—is planned for completion and initial output the last quarter of 1969. Cobalt-containing ores of the South Ural Buruktal mines probably will be processed at Orsk.

Some cobalt production, probably in relatively insignificant quantities, can be attributed to the Pyshminsk concentrating plant, which produces a cobalt-pyrite concentrate from the sulfide-magnetite ore of the Pyshma-Klyuchevsk deposits.

Production of high-purity metallic cobalt began in the early 1960's at Noril'sk, where a semiautomatic installation for quantity production was completed in 1962. High-purity metallic cobalt reportedly was also produced at Yuzhuralnikel' in 1963.

g. FERROALLOYS—Soviet production of ferroalloys in 1968 is estimated at 3.9 million tons, approximately 1.5 million tons of which were produced in blast furnaces. Spiegeleisen, standard-grade ferromanganese, and low-grade ferrosilicon form the large part of blast furnace ferroalloy output. Of the electric furnace ferroalloys, ferrosilicon, ferrochrome, and ferromanganese represent the bulk of production; ferrovanadium, ferromolybdenum, ferrotungsten, ferrotitanium, and other ferroalloys are produced in much smaller quantities. Planned production of ferroalloys in 1970 is not known but output is being increased to promote expansion of low-alloy steel production.

To maintain their position as a leading exporter of ferroalloys, the Soviets are seeking to improve the quality of their ferroalloys.

Soviet exports of ferroalloys in 1968 amounted to 312,000 tons. About two-thirds of this total was sent to other Communist countries to meet, in large part, the import requirements of their steel industries for ferroalloys; the remainder was shipped principally to Western European countries. Soviet imports of ferroalloys were insignificant—about 8,600 tons, in part ferrosilicon from North Korea.

In the near future the Soviets plan to discontinue production of ferroalloys in blast furnaces and expand use of the electric furnace method. During 1966-70 two new electric furnace ferroalloys plants are to be constructed at Nikopol' in the Ukraine and Yermak in the Kazakh S.S.R. and existing ferroalloys plants are being reequipped with electric furnaces. Electric furnace ferroalloy plants are listed in Figure 31.

(1) *Ferrosilicon*—Ferrosilicon is produced in the U.S.S.R. in grades ranging from 9% to 99% purity. The two principal ferrosilicon producers are located at Novokuznetsk in Western Siberia and Zaporozh'ye in the Ukraine. The Novokuznetsk plant provides for the bulk of the requirements for ferrosilicon in eastern regions of the U.S.S.R. and the Zaporozh'ye plant satisfies most of the demands of the western regions. Currently, most of the lower grades of ferrosilicon are electrothermally produced, and production technology has been improved by the introduction of mechanized charging of furnaces and the installation of closed and rotary furnaces.

(2) *Ferrochrome*—Soviet production of ferrochrome apparently is adequate to cover domestic requirements and to permit substantial exports. In 1968, Soviet exports of ferrochrome were 33,300 tons compared to 14,100 tons in 1963. Production of ferrochrome is centered mostly in the Aktyubinsk Ferroalloy Plant, located in the Kazakh S.S.R. close to the Donskoye chromite deposits. There is additional, but much less significant production at the ferroalloys plants in Chelyabinsk and Zaporozh'ye.

An increasing share of Soviet ferrochrome production comes from furnaces with rotating and tilting hearths and from converters employing oxygen, as opposed to the less advanced practice of producing ferrochrome in stationary electric furnaces by the silicothermic method. In recent years the Soviets also have devoted considerable attention to perfecting technology for vacuum processing of ferrochrome and for the production of electrolytic chrome.

(3) *Ferromanganese*—The considerable demand of the Soviet metallurgical industry for ferromanganese is being met increasingly by electric furnace rather than blast furnace production. Electric furnace facilities for the production of ferromanganese, silicomanganese, and metallic manganese are being installed at the existing plants at Zestafoni and Zaporozh'ye, and at the new plant at Nikopol'.

Further development of the Soviet ferromanganese industry is planned for the eastern regions of the country to serve the expanding steel industry in that area. To this end, technology has developed to process the high-phosphorous carbonate ores which form a large part of the Soviet manganese reserves and which abound in the Usa River Basin.

C. Nonferrous metals and minerals

25X1

1. General

a. Supply position—The U.S.S.R. is self-sufficient in most nonferrous metals and minerals. Some commodities—copper, lead, zinc, aluminum, magnesium, antimony, cadmium, asbestos, graphite, and apatite ore and concentrates—are produced in large enough quantities to permit substantial exports. There are shortages, however, in tin, fluorspar, piezoquartz, mica, and uranium ore and concentrate.

In 1956 the U.S.S.R. emerged as a net exporter of nonferrous metals and minerals, a position which the country has maintained in subsequent years. Net exports rose from the equivalent of approximately US$28 million in 1956 to over US$400 million in 1968, reflecting both the steady increase in exports since 1955 and the decline in imports since 1960. Similarly, the total volume of Soviet trade in nonferrous metals and minerals rose substantially from the equivalent of less than US$300 million in 1955 to nearly US$600 million in 1968. The value of Soviet trade in nonferrous commodities for the years 1955-68, as reported by official Soviet trade statistics, is shown in Figure 9.

The bulk of Soviet trade in nonferrous commodities with non-Communist countries since 1955 has been with industrialized countries, principally the United Kingdom, the Netherlands, and West Germany, and has consisted largely of primary metal rather than raw material. With the exception of large imports of copper prior to 1964 and imports of tin in recent years, the trade has been composed mainly of Soviet exports. Trade with the developing non-Communist countries has been characterized by exports to some two dozen countries and imports from only a few countries. In 1966 and 1967, for example, Soviet imports of nonferrous commodities were limited to mica from India, tin from Indonesia, and lead and zinc concentrates from Iran. Exports to the developing countries have consisted primarily of metal and metal products and asbestos.

Soviet trade with Communist countries has been principally with Eastern Europe and has consisted mainly of exports of aluminum, copper, lead, asbestos, graphite, mineral fertilizer raw materials and several other commodities. The U.S.S.R. also has supplied Cuba with sulfur, asbestos, and various nonferrous metals and metal products in exchange for nickel and copper ores and concentrates. Trade with the Communist countries of the Far East has been relatively small in recent years. In the 1950's Communist China had been an important supplier to the U.S.S.R. of such commodities as mercury, antimony, and tin but since the early 1960's shipments of these metals have been reduced to almost negligible levels. The U.S.S.R. is now dependent on non-Communist countries for a significant share of its tin requirements.

Approved For Release 2008/09/08 : CIA-RDP08S01350R000100080001-8

FIGURE 9. VALUE OF FOREIGN TRADE IN NONFERROUS METALS AND MINERALS 25X1
(*Millions of U.S. dollars*)

YEAR	EXPORTS			IMPORTS			NET	
	Nonferrous metals	Nonmetallic minerals	Total	Nonferrous metals	Nonmetallic minerals	Total	Exports	Imports
1955......	110.6	19.6	130.2	133.0	4.6	137.6	0	7.4
1956......	157.2	23.1	180.3	143.0	9.1	152.1	28.2	0
1957......	202.7	22.0	224.7	127.5	12.0	139.5	85.2	0
1958......	197.4	23.2	220.6	133.0	10.6	143.6	77.0	0
1959......	195.7	25.8	221.5	169.7	10.8	180.5	41.0	0
1960......	194.7	29.5	224.2	171.9	10.3	182.2	42.0	0
1961......	210.9	33.3	244.2	145.7	9.2	154.9	89.3	0
1962......	217.3	33.5	250.8	136.3	9.7	146.0	104.8	0
1963......	218.5	32.0	250.5	124.9	11.0	135.9	114.6	0
1964......	292.0	38.7	330.7	80.0	14.5	94.5	236.2	0
1965......	331.4	39.7	371.1	75.1	11.0	86.1	285.0	0
1966......	379.7	42.9	422.6	58.3	11.1	69.4	353.2	0
1967......	364.2	53.6	417.8	59.9	13.4	73.3	344.5	0
1968......	435.3	54.3	489.6	74.8	12.7	87.5	402.1	0

b. POST-WORLD WAR II DEVELOPMENT—By 1938 the U.S.S.R. with the aid of foreign capital and technology, had developed a substantial nonferrous metallurgical industry, particularly in such basic metals as copper, lead, and zinc. Since 1938, information on the U.S.S.R.'s nonferrous industry has been limited; data on most nonferrous metals and minerals are highly classified. Announcements about plan goals and achievements, improvement of work, and the construction and rehabilitation of mines and plants have been in generalizations. Information about increases in the production of nonferrous commodities has been expressed only in percentages.

Although it did not fulfill all nonferrous metallurgical goals during the fourth Five Year Plan (1946-50), the U.S.S.R. generally succeeded in recovering from the disruptions and dislocations suffered during World War II and in establishing a firm basis for accelerated expansion during the fifth Five Year Plan (1951-55). During the latter plan period the U.S.S.R. substantially increased its output of the major nonferrous metals—copper, lead, zinc, and tin—but did not fulfill its plan goals for any of them; the plan for production of aluminum was overfulfilled.

The directives of the sixth Five Year Plan (1956-60) and comments made by Soviet officials in connection with the implementation of the plan provided not only the usual production goals, in percentages, for a few nonferrous materials, but also an indication of the reasons for failing to achieve previous goals. For example, the scarcity of high-grade ore reserves and the difficulties encountered in processing available ores have been among the principal limitations to increased output of metal in the U.S.S.R. The sixth Five Year Plan placed considerable emphasis on augmenting reserves, particularly of higher grade ores, and increasing recovery rates, particularly in mining and concentrating, two sectors that traditionally lag technologically behind the metallurgical sector in the Soviet nonferrous industry. Nevertheless, the Soviet planners did not overlook the metallurgical sector; the plan, in general, stressed the application of technological advances to a far greater degree than any previous plan.

Production performance during the early part of the sixth Five Year Plan was poor. A major difficulty was the inability to expand the raw material base enough to produce the quantities of metals that had been planned. In mid-1957 the administration of the national economy was reorganized, with regional economic councils replacing central ministries in the administration of industry. Following the reorganization, the U.S.S.R. announced the decision to draft a new long-range economic plan covering the period 1959-65. One of the major reasons cited for abandoning the sixth Five Year Plan was the discovery of "new resources" and the allegation that the time remaining was too short to bring these discoveries to fruition.

During the Seven Year Plan (1959-65) the U.S.S.R. substantially increased production of nonferrous metals, but did not achieve all of the assigned goals. Investment in the nonferrous industries during 1959-65 amounted to about 5 billion rubles compared with planned investment of 5.5 billion rubles. The gross output of nonferrous metals was increased by 80%, compared with a planned increase of 100%. Probably most of this shortfall was accounted for by the failure to achieve the ambitious, if not unrealistic, planned increase for aluminum of 180% to 200%. The actual increase achieved by the aluminum was 100%, a notable accomplishment. Planned increases for the basic nonferrous metals, copper, lead, and zinc—90%, 50%, and 60%, respectively—are estimated to have been achieved. Production increases of varying magnitudes were achieved for most of the other nonferrous metals; planned increases were not announced.

During 1959-65 the technical level of nonferrous metallurgy was raised, primarily by the construction of new plants. For the most part, only slight progress was made in modernizing older plants. Although mining and concentrating technology improved as the scale of operations expanded, Soviet officials still complained about the low technical standards for Soviet mining, crushing, and concentrating equipment and about the poor quality of chemical reagents, a factor contributing to the low recovery rates for some metals and the high level of impurities in some concentrates.

c. CURRENT DEVELOPMENT—During the Five Year Plan (1966-70), gross output of nonferrous metals is to increase by 66%. Production of aluminum is to increase over the period by 90% to 110% and copper and zinc by 60% to 70%. Other nonferrous metals such as lead, magnesium, tin, nickel, titanium, precious metals, and semiconductor materials are to be produced in considerably larger quantities, but rates of growth have not been specified.

To achieve the production goals for nonferrous metals under the Five Year Plan, large capital investments amounting to 6 billion rubles—about 50% more than the amount invested in the preceding five years—are to be made. The main share of investments is to be made in the aluminum, copper, and nickel-cobalt industries. Important shares of planned investment also are earmarked for the lead and zinc industry and for the development of the tin, diamond, and gold industries in Siberia and the Northeast. Funds also have been allocated for modernization programs to raise the productivity and efficiency of the industry and to upgrade the quality and enlarge the assortment of metal products.

During the first three years (1966-68) of the Five Year Plan the U.S.S.R. claimed to have fulfilled its production plans for nonferrous metals. The gross volume of production increased by 34% and the production of aluminum increased by 44%, the production of zinc by 35%, nickel by 24%, copper by 28%, and titanium by 63%. In all, more than 100,000 tons of nonferrous metals were produced above plan.

Notwithstanding these gains, achievement of the goals of the Five Year Plan is by no means assured, as the U.S.S.R. has acknowledged. The plan for total volume of investment during 1966-68 was fulfilled, but construction lagged on various key projects, including both primary metal facilities and fabrication plants. In some cases facilities were completed and in operation for lengthy periods of time but designed capacities were not attained. Difficulties also were encountered in reequipping existing plants and improving operating practices. Finally, development of the raw materials base of the nonferrous metals industries continued to be a source of concern to Soviet planners. The supply of alumina was not expanded as planned because of the failure to overcome technical problems in the processing of new aluminous raw materials, namely, nepheline and alunite ores. Increased priority is being given to programs for geological exploration to discover new reserves of high quality bauxite and other important ores and minerals.

2. Light metals

a. ALUMINUM

(1) *Supply position*—The U.S.S.R. is the second largest producer of aluminum in the world, although Soviet output of over 1.4 million tons in 1968 was only half of that in the United States, the world's largest producer. In the past decade Soviet production of aluminum has nearly tripled and considerably exceeded the growth in domestic use of the light metal. In spite of the gains made in some applications, particularly as a substitute for copper in long distance transmission lines, the Soviet economy has not put aluminum to the many and varied uses found in Western Europe and North America. The resulting surplus has enabled the U.S.S.R. to become a major exporter of aluminum. Soviet exports of aluminum in 1968, amounting to 367,100 tons, were nearly five times greater than in 1960. The larger share of the exports has gone to the Communist countries of Eastern Europe with East Germany being the principal recipient. Western Europe and Japan have received most of the aluminum exported to non-Communist countries. Estimated Soviet production and exports of aluminum metal, 1960-68, are shown in Figure 10.

The Soviet Union has a wide variety of raw materials for the production of aluminum, but exploitation of

FIGURE 10. ESTIMATED ALUMINUM METAL PRODUCTION AND EXPORTS* 25X1

YEAR	PRODUCTION	EXPORTS: Total	EXPORTS: Non-Communist Countries	EXPORTS: Communist Countries	EXPORTS: Unidentified	APPARENT SUPPLY**
1960	630,000	77,100	16,903	57,134	3,063	552,900
1961	700,000	99,500	16,503	79,455	3,542	600,500
1962	770,000	137,100	39,921	89,661	7,518	632,900
1963	855,000	147,800	38,933	96,573	12,294	707,200
1964	945,000	209,300	55,381	128,764	25,155	735,700
1965	1,025,000	271,100	70,494	161,961	38,645	753,900
1966	1,160,000	310,500	108,038	182,675	19,787	849,500
1967	1,295,000	313,500	86,673	208,832	17,995	981,500
1968	1,435,000	367,100	76,377	265,547	25,176	1,067,900

*Production of primary aluminum and exports of primary and rolled aluminum.

**Slightly understated because the U.S.S.R. annually imports small amounts of rolled aluminum. In 1965, such imports reached their highest level—7,300 tons—during the 1960's.

these resources has not kept pace with the growth of the industry. As a result, both bauxite and aluminum have been imported to supplement domestic supplies. Greece and Yugoslavia have been the major suppliers of bauxite. Imports from Greece have averaged over 400,000 tons per year since 1958. Imports from Yugoslavia were not initiated until 1965, but by 1968 had reached 721,000 tons. The Soviet Union also imported 55,000 tons of bauxite from Guinea in 1968. In addition, imports of alumina have become significant in recent years, reaching 387,000 tons in 1968. In that year Hungary supplied 148,000 tons of alumina to the U.S.S.R. and, under the terms of a long-term agreement, such shipments are to reach more than 300,000 tons annually by 1980. The U.S.S.R. also began importing alumina from the United States in 1967. Imports that year amounted to 53,200 tons and increased to 194,000 tons in 1968.

(2) *Producing facilities*—Enterprises of the Soviet aluminum industry include nepheline and alunite mines as well as bauxite mines, facilities for the production of the intermediate product alumina, and reduction plants for the production of aluminum metal. The most important of these are located in the Urals, the Kazakh S.S.R., and in Siberia. The locations of aluminum reduction plants and other facilities are shown on Figure 11.

(a) ALUMINUM—Present Soviet capacity for the production of aluminum includes 13 reduction plants described in Figure 32. Four of these, located in Bratsk, Krasnoyarsk, Irkutsk, and Volgograd, are of recent construction and rank among the most modern and efficient plants in the world. Although already contributing an important share of current production, these plants are undergoing further expansion. Another new plant is under construction in Regar, Uzbek S.S.R., but it probably will not be put into operation until 1970 at the earliest. Earlier plans called for construction of new plants at Kirovabad and Pavlodar but the absence of information about them in recent years may indicate that these plans have been abandoned, at least for the immediate future. Older reduction plants in the industry are being reequipped and renovated.

(b) ALUMINA—Production of alumina has not kept pace with the steadily mounting requirements of the aluminum industry. The supply problem has been aggravated by the fact that, in many cases, reduction plants are located thousands of miles from the sources of available alumina. The high transportation costs for these long hauls have been the subject of much criticism in the Soviet press but they became unavoidable when the industry failed to meet schedules for the introduction of new technology for the processing of nepheline ores being mined in Siberia. The new technology was to be employed at an alumina plant in Achinsk which has been under construction for more than a decade and after repeated delays was scheduled for completion in 1969.

Alumina producing facilities include 8 plants: the Urals Aluminum plant at Kamensk-Ural'skiy; the Bogoslovsk Aluminum plant at Krasnotur'insk in Sverdlovskaya Oblast'; the Dnepr Aluminum plant at Zaporozh'ye in the Ukrainian

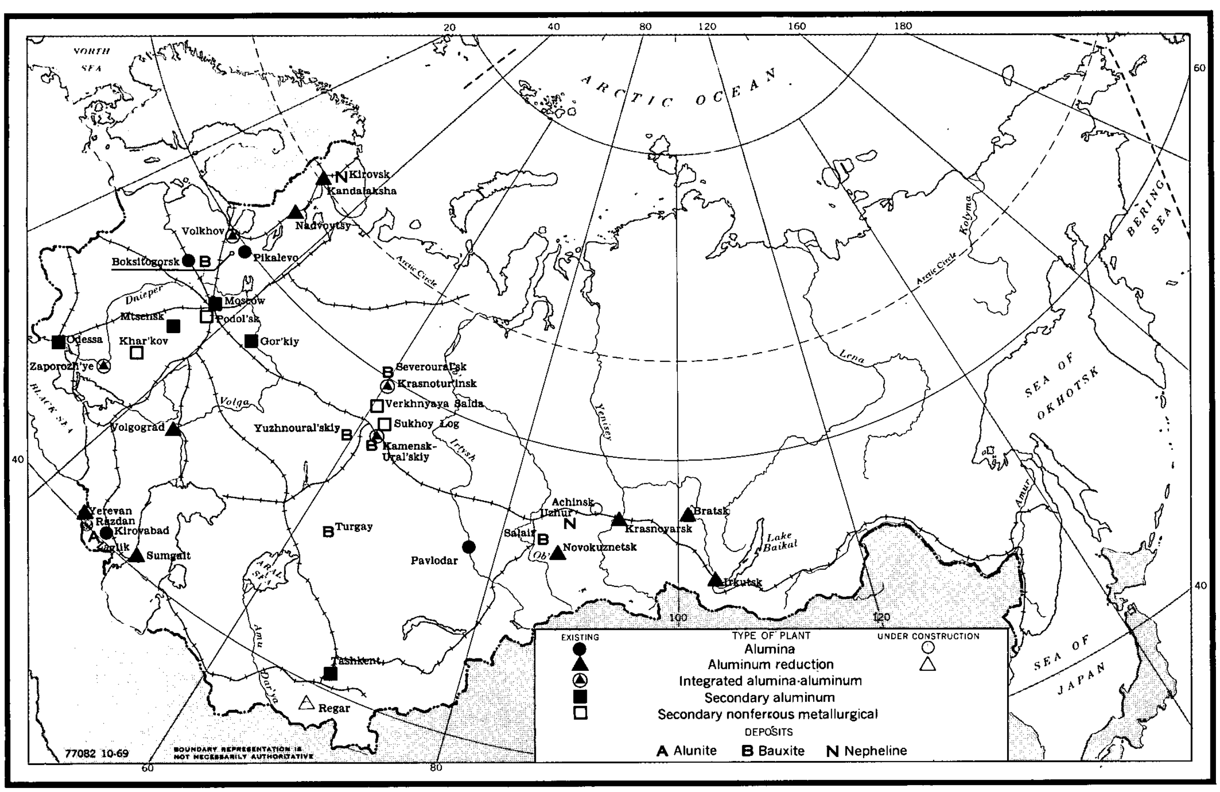

FIGURE 11. Aluminum industry, 1968

25X1

S.S.R.; the Pikalevo, Tikhvin, and Volkhov plants in the Leningradskaya Oblast'; the Pavlodar Alumina plant in the Kazakh S.S.R.; and the Kirovabad Alumina plant in the Azerbaijan S.S.R. The Urals and Bogoslovsk plants are presently the largest alumina producers in the U.S.S.R.; they accounted for about two-thirds of total alumina output in 1968. The Pavlodar plant is to be one of the largest in the U.S.S.R. but it is now only half completed. All of the plants, with the exception of the Pikalevo, Volkhov, and Kirovabad plants, use bauxite as a raw material. The Pikalevo and Volkhov plants use nephelines as a raw material and the Kirovabad plant uses alunite. The latter plant has been unable to reach full scale production because of the failure to perfect the complex process required to break down the alunite ore and separate the aluminum oxide content.

Plans for further increases in the production of alumina are based on completion of the plant at Achinsk and enlargement of the existing Urals, Bogoslovsk, Pavlodar, and Kirovabad plants. Although planned construction of additional alumina plants at Belogorsk, Akhtinsk and Asino has been announced, it is not known whether these plans are being carried out.

(c) BAUXITE—The principal bauxite mines of the U.S.S.R. are located in the Ural Mountains near Severoural'sk and Yuzhnoural'sk (both in the Sverdlovskaya Oblast'). Next in importance are the mines located in the Turgay regions of the Kazakh S.S.R. The only other bauxite mines of industrial significance presently being exploited are located at Boksitogorsk near Leningrad. The deposits in the North Urals are of high quality with an average content of 54% alumina and only 3.5% silicon. The other bauxite deposits in the Urals to the south contain 50% to 55% alumina, but they have a silicon content of 6% to 12%, which reduces the processing efficiency and increases the cost of aluminum made from them. The Turgay mines have an alumina content of 39% to 48% and a silicon content of 8% to 12%. The deposits at Boksitogorsk have an alumina content of 40% to 52% and a silicon content of up to 18%.

(3) *Resources*—The U.S.S.R. claims to have the world's largest prospected reserves of bauxite. However, the economic significance of these reserves is reduced by the generally low alumina and high silicon contents of the ores and by the unfavorable locations of some deposits. Most of the reserves are located in deposits already under exploitation in the Urals, in the Kazakh S.S.R., and in Leningradskaya Oblast'. Among the most important prospected but undeveloped deposits of bauxite are those located at Salair (Kuznetskiy Alatau), Priangarya (Krasnoyarsk), and Yuzhno-Timan (Komi A.S.S.R.).

Reserves of other aluminous raw materials are very large and consist principally of alunite and nepheline ores. The principal alunite deposit is located at Zaglik in the Azerbaijan S.S.R. and is the second largest in the world. Reserves of nepheline are particularly important and represent a seemingly inexhaustible source of alumina. Technical advances in processing of nephelines and the recovery of valuable byproducts, including fertilizers, cement, and soda, have helped to compensate for the relatively low alumina and high silicon contents of these ores. The principal reserves of nepheline are located at Kiya Shalter in the Kemerovo Oblast' and on the Kola Peninsula. The mines on the Kola Peninsula are worked primarily for apatite. The Kiya Shalter deposits supply the alumina plant at Achinsk. When in full-scale operation the Achinsk plant will be able to produce 800,000 tons of alumina per annum and will ease the supply pinch experienced by the new reduction plants in East Siberia. It is noteworthy, however, that the U.S.S.R. is seeking to locate and develop deposits of high quality bauxite for satisfaction of the long range alumina needs of reduction plants in East Siberia.

b. MAGNESIUM

(1) *Supply position*—The U.S.S.R., the second largest producer of magnesium in the world after the United States, produces magnesium for its domestic needs as well as modest quantities for export. During the period 1963-68, Soviet output of magnesium more than doubled, increasing from an estimated 39,000 tons in 1963 to 84,000 tons in 1968. Soviet exports of magnesium, which averaged about 2,000 tons annually in the late 1950's and early 1960's, increased to 8,600 tons in 1967 and 14,500 tons in 1968. Most of these exports went to other Communist countries.

(2) *Producing facilities and technology*—The U.S.S.R. produces magnesium at four plants, three of which also produce titanium. The newest and largest plant is the Ust'-Kamenogorsk Titanium-Magnesium Combine in Kazakhstan, which began production in early 1965. The other two titanium-magnesium plants, Dneprovsk at Zaporozh'ye in the Ukraine, and Berezniki in the Urals, began producing magnesium in 1956 and 1962, respectively. The fourth plant, Solikamsk, is located in the Urals. Plans have been announced for the construction in East Siberia of additional facilities for the production of magnesium, but there is no evidence that such construction has been started.

Most of the Soviet output of magnesium is produced electrolytically either by electrolysis of molten magnesium chlorides or by the electrolysis of magnesium oxides dissolved in molten salts. A small amount of magnesium may be produced by the silicothermic method, which is reported to yield a purer product than that obtained by electrolysis. High purity magnesium is essential in making strategic magnesium-base alloys, such as those containing zirconium, thorium, and rare earth metals.

(3) *Resources*—The U.S.S.R. has abundant reserves of the principal magnesium-bearing raw materials, magnesite, dolomite, carnallite, and sea water and lake brine. At present, the U.S.S.R., which is not known to use dolomite in its production of magnesium metal, relies primarily on carnallite as the raw material for its magnesium industry. The Verkhnekamsk deposit of carnallite in the Urals is claimed to be the largest single deposit in the world. The most important industrial occurrences of magnesite are in the Urals at Satkinskiy and Khalilovo. Recently the Soviets announced the discovery of the "world's largest magnesite deposit" in Irkutsk Oblast' near the village of Savinskoye, claiming that reserves at this deposit

amount to 2 billion tons. The best known deposits of dolomite are in the Donbass (Zhigulevsk, Nikitinsk), the Urals (Satinskiy), Leningradskaya Oblast' (Izvarov), and Moscovskaya Oblast' (Shchelkovo and Podol'sk). The Crimean lakes are the major sources of lake brine, and the Kara-Bogaz-Gol Gulf of the Caspian Sea is an important source of highly salty sea water.

c. Titanium

(1) *Supply position*—The U.S.S.R. has the capacity to produce large quantities of titanium sponge metal, the crude metal that requires further processing into ingot metal from which titanium mill products are made. The Soviet titanium industry has grown rapidly since the mid-1950's, and the output of titanium sponge in 1968 is estimated at 15,000 tons, about the same as that produced in the United States.

According to Soviet plan figures, the production of titanium sponge in the U.S.S.R. should reach about 17,000 tons in 1969 and 20,000 tons in 1970. At one time the Soviets discussed the construction of new titanium facilities in East Siberia which would raise production to 50,000 tons of titanium sponge by 1980. No recent information is available, however, on these or other long range plans for the Soviet titanium industry.

Beginning in late 1965, the U.S.S.R. began to export titanium sponge, chiefly to the U.S. By early 1968 the Soviets had exported a total of about 2,000 tons of titanium sponge to the U.S. These exports stopped in mid-1968, however, with the imposition by the U.S. of a punitive tariff as a result of a decision by the U.S. Tariff Commission that the Soviets were selling titanium sponge in the U.S. at less than fair value and that these sales were therefore injuring U.S. domestic producers.

(2) *Producing facilities and technology*—Since 1954, when the Soviets first began to produce titanium sponge on a commercial scale, three large titanium sponge-making facilities have been constructed. The Dneprovskiy Titanium-Magnesium Combine at Zaporozh'ye, in the Ukraine, was completed in 1960 and the Berezniki Titanium-Magnesium Combine in the Urals in 1962. In late 1965, after several years of lagging construction, the Ust-Kamenogorsk Titanium-Magnesium Combine in the Kazakh S.S.R., the largest of the three facilities, began operations.

Nearly all Soviet output of titanium sponge is produced by the standard Kroll process using magnesium as the reductant of the intermediate product, titanium tetrachloride. The basic material used in the preparation of the titanium tetrachloride is either ilmenite concentrate or slag melted from ilmenite concentrate. Ingots of titanium metal and alloys are produced from sponge in consumable electrode vacuum-arc furnaces or electroslag melting furnaces.

(3) *Resources*—Soviet reserves of raw materials for the production of titanium is ample to support a large-scale titanium industry. Although deposits of rutile—the principal low-cost mineral used for making titanium in the West—are limited, the Soviets claim "inexhaustible" reserves of other titanium bearing ores, principally ilmenite. The chief raw material base for titanium raw materials in the Soviet Union is the Verkhne-Dneprovsk Titanium Mining and Metallurgical Combine in the Ukraine. Titanium resources and producing facilities are shown on Figure 12.

d. Beryllium—The U.S.S.R. has ample reserves of beryllium, but, for the most part, the Soviet ores are complex and, as a result, are difficult and costly to process. Identified deposits are in Chitinskaya, Murmanskay, and Sverdlovskaya Oblast's, the Altayskiy Kray, and the Kazakh, Kirgiz, Tadzhik, and Uzbek S.S.R.'s. Only since 1962 has the U.S.S.R. made a significant effort to develop these deposits, because, in earlier years, Communist China supplied most of the Soviet needs for beryllium raw materials. A small amount of beryllium is obtained in the U.S.S.R. as a byproduct in the processing of other metals.

The U.S.S.R. produces beryllium oxide and beryllium metal in amounts adequate to satisfy priority domestic needs and leave a small surplus for export. The U.S.S.R. allocates most of its available beryllium to nuclear and space applications. Beryllium-copper and beryllium-aluminum alloys have been developed, but they have been put to only limited use, particularly in civilian applications. Such uses probably will increase, however, because the U.S.S.R. plans to increase the production of beryllium and beryllium alloys and is increasing its research effort in metal processing and in applications technology.

3. Basic nonferrous metals

a. Copper

(1) *Supply position*—Although the U.S.S.R. became a net exporter of copper in 1964, it still regards copper as a "deficit" metal. The high cost of production, reflecting both the generally low quality of domestic copper reserves and the lag in modernizing the copper industry, has led the Soviet government to encourage the substitution of other more abundant and cheaper metals, particularly aluminum. The estimated supply position of copper in the U.S.S.R. in 1960-68 is shown in Figure 13.

The U.S.S.R., the second largest copper producer in the world after the U.S., has increased its output of the metal substantially since World War II. Refined copper production reached an estimated 992,000 tons in 1968, an increase of 28% since 1965 and a doubling of output since 1960. The planned production for 1970 is estimated at 1.2 million tons.

Actual Soviet consumption of copper probably exceeded apparent consumption in most years during the 1950's and early 1960's. The gap between apparent and actual consumption probably was met by withdrawals from stocks, which because of large lend-lease shipments from the U.S. are believed to have been extensive at the end of World War II. In recent years, however, domestic requirements probably have been met from current output of primary and secondary copper. Nevertheless, efforts to conserve on the use of copper have not been relaxed and, in fact, have helped ease the drain on stocks. Estimated consumption of copper in 1967 was about 1 million tons, just over a quarter of the consumption of copper and copper-base products in the U.S. Some 50% of total

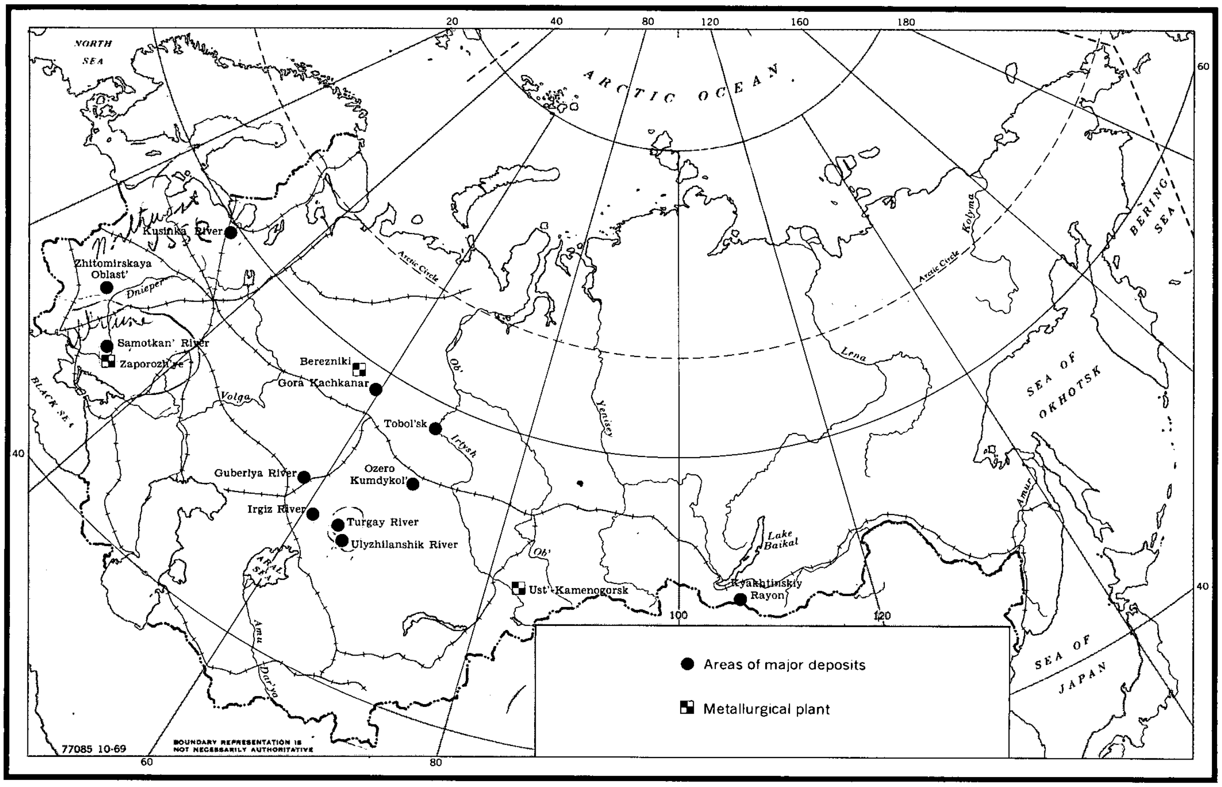

FIGURE 12. Titanium resources and producing facilities, UNCODED 25X1

FIGURE 13. ESTIMATED SUPPLY OF COPPER
(*Thousands of metric tons*)

YEAR	PRODUCTION	IMPORTS	EXPORTS	APPARENT SUPPLY*
1960	490	106.0	67.9	528.1
1961	530	82.2	67.7	544.5
1962	590	106.4	76.8	619.6
1963	640	88.0	77.7	650.3
1964	700	15.3	94.5	620.8
1965	772	4.9	98.6	678.3
1966	828	11.5	125.4	714.1
1967	915	5.4	99.8	820.6
1968	992	13.7	117.2	888.5

*Apparent supply equals production plus imports of metal minus exports of metal.

Soviet consumption is accounted for by electrical applications such as cable, wire, busbars, contacts, and collectors.

Prior to 1964 the U.S.S.R. was a net importer of copper. During the five year period, 1959-63, for example, Soviet imports, nearly all of which came from non-Communist countries, averaged 100,000 tons per year whereas exports of copper, shipped almost exclusively to other Communist countries, averaged 70,000 tons per year. In the subsequent years, however, the Soviet balance of trade in copper was sharply reversed. During 1964-68 Soviet imports of copper averaged only 10,200 tons per year compared with exports of over 100,000 tons per year. Other Communist countries, principally East Germany and Czechoslovakia, continue to be the principal recipients of Soviet copper but West Germany and the U.K. also have received significant quantities.

25X1

(2) *Resources*—The U.S.S.R. claims to have the largest copper reserves in the world and, in fact, no country is known to have larger reserves. The most recent official Soviet estimate of copper reserves was for 1939 when they were stated to total 19.5 million tons of contained metal. Available data indicate that Soviet copper reserves were increased to 35.2 million tons by the end of 1958 and to nearly 53 million tons by the end of 1965.

About one-third of Soviet reserves of copper are contained in cupriferous sandstones. Copper pyrites, copper porphyries, and copper nickel ores account for roughly equal shares of total reserves—some 16% to 18% each. Another 8% is found in polymetallic (copper, lead, zinc) ores. Soviet reserves of copper also include relatively small quantities of quartz-chalcopyrite ores, copper-iron-vandium ores, and silicate gangue.

The general quality of Soviet copper reserves is low. From 1940 to 1958 the average copper content of domestic ores reportedly declined from 1.8% to 1.36%. In the past decade the gradual decline in the quality of ores probably has continued. The important Kounrad deposit, for example, now has an average copper content of only 0.5%. The chalcopyrite ores of the Urals, with an average copper content of perhaps 2%, probably are the best, but these deposits are relatively small. The larger deposits in the U.S.S.R. contain generally leaner ores. These include the Dzhezkazgan deposit in the Kazakh

S.S.R. and the newly prospected Udokan deposit in the Transbaikal, which together are estimated to contain about 35% of total Soviet copper reserves.

(3) *Producing facilities*

(a) MINING AND CONCENTRATING—About half of the Soviet output of copper ore is mined in the Kazakh S.S.R., mainly in the Karagandinskaya Oblast' at Kounradskiy and at Dzhezkazgan and in the Rudnyy Altay area of Vostochno-Kazakhstanskaya Oblast'. About 10% to 12% of the total output is mined at Noril'sk in Krasnoyarskiy Kray in the R.S.F.S.R. About 15% is mined in Sverdlovskaya, Chelyabinskaya, and Orenburgskaya Oblast's and the Bashkirskaya A.S.S.R. in the Urals, the oldest copper producing region in the U.S.S.R. The Degtyarsk mine in Sverdlovskaya Oblast' probably is the largest producer of copper ore in the Urals. The remaining 20% of total Soviet output is mined in the Armenian and Uzbek S.S.R.'s and on the Kola Peninsula, Murmanskay Oblast'. Most of the Soviet ore is concentrated locally by variations of the flotation method. Available data indicate that the technical level of the mining and concentrating sector of the Soviet copper industry lags behind that of the smelting and refining sector. The principal Soviet copper mines, concentrating plants, and producing facilities are shown on Figure 14.

(b) SMELTING AND REFINING—Copper smelting facilities in the U.S.S.R. traditionally have been located near the domestic resources of copper. About half of the blister (crude) copper is produced in the Kazakh S.S.R. which possesses the largest share of Soviet reserves of copper. The Urals rank next in importance as a copper-smelting region. In contrast, copper refining facilities in the U.S.S.R. generally have been located closer to the consuming industries, particularly in the Urals. This pattern is being changed, however, by the recent and current construction of new refining capacity in areas east of the Urals—particularly in the Kazakh S.S.R.—near the sources of raw materials.

At present the U.S.S.R. has in operation 13 copper smelters processing ore and concentrate and 1 smelter, the Moscow Copper Smelting and Electrolytic Plant imeni Molotovo (55°45'N., 37°35'E.), processing copper scrap. Although the Kazakh S.S.R. is the largest producer of blister copper in the U.S.S.R, it has only 3 smelters in operation: the Balkhash Mining and Metallurgical Combine (46°49'N., 75°00'E.), the Karsakpay Copper Smelter (47°50'N., 66°45'E.), and the Irtysh Polymetallic Combine at Glubokoye (50°06'N., 82°19'E.). However, a fourth smelter is under construction at Dzhezkazgan. The smelter at Balkhash may produce as much as 30% of the total Soviet output of blister copper. Six small, relatively old smelters are located in the Urals: the Bashkir Copper-Sulfur Combine at Baymak (52°36'N., 58°19'E.), the Karabash Mining-Metallurgical Combine (55°29'N., 60°14'E.), the Mednogorsk Copper-Sulfur Combine (51°24'N., 57°37'E.), the Kirovgrad Copper-Smelting Combine (57°26'N., 60°04'E.), the Krasnoural'sk Copper Smelting Plant (58°21'N., 60°03'E.), and the Srednoural'sk Copper Smelting Plant at Revda (56°48'N., 59°57'E.). Copper also is smelted in Murmanskaya Oblast' at the Monchegorsk Nickel-

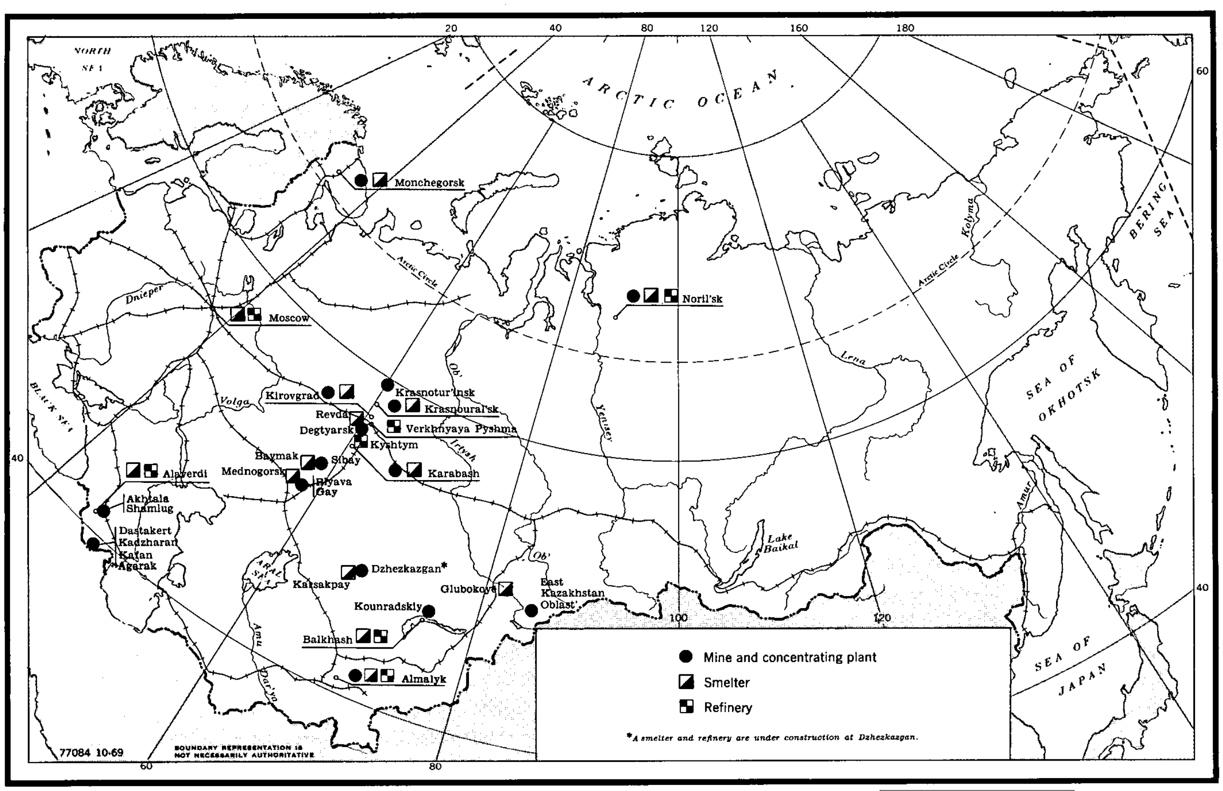

FIGURE 14. Copper resources and producing facilities, 1968

Copper Combine (67°56'N., 32°58'E.), in the Armenian S.S.R. at the Alaverdi Copper-Chemical Combine (41°08'N., 44°39'E.), in Krasnoyarskiy Kray at the Noril'sk Mining and Metallurgical Combine (69°20'N., 88°06'E.), and in the Uzbek S.S.R. at the Almalyk Copper Smelting Plant (40°50'N., 69°35'E.). In addition to the smelter at Dzhezkazgan, other new smelters are to be constructed during the current five year plan in Rudnyy Altai in East Kazakhstan and in Amurskaya Oblast'.

The Soviet output of blister copper is refined electrolytically at seven locations. The two largest refineries are the Balkhash Mining and Metallurgical Combine in the Kazakh S.S.R. and the Pyshma Electrolytic Copper Plant at Verkhnyaya Pyshma (56°55'N., 60°37'E.). The remaining refineries are the Alaverdi Copper-Chemical Combine in the Armenian S.S.R., the Moscow Copper Smelting and Electrolytic Plant imeni Molotovo, the Kyshtyn Electrolytic Copper Plant in the Urals, the Almalyk Copper Refinery in the Uzbek S.S.R., and the Noril'sk Mining and Metallurgical Combine. New construction underway at Noril'sk may double the capacity of this refinery by the end of 1970. The U.S.S.R also plans to construct two entirely new refineries, each of which is to be the equal of the Balkhash refinery, the largest in the Soviet copper industry. One is already started at Dzhezkazgan and the other will soon be started at the East Kazakh Combine.

b. Lead

(1) *Supply position*—The U.S.S.R, the largest producer and consumer of lead among the Communist countries, has experienced a shortage of lead raw materials for a number of years. Although estimated production of primary and secondary lead has exceeded estimated domestic consumption since 1955, the Soviet Union is partially dependent on imports to augment domestic supplies of ores and concentrates. Soviet consumption of lead, estimated at 530,000 tons in 1968, is about 42% of that of the United States. The principal uses of lead in the U.S.S.R. are in the manufacture of batteries, cable coverings, and solder. At present, there is considerable emphasis on the substitution of more abundant metals—steel, aluminum, and zinc—and plastics for lead.

In 1968, the U.S.S.R. produced an estimated 623,000 tons of lead. Of this, 528,000 tons consisted of primary lead, representing more than half of the output in Communist countries, and 95,000 tons was secondary lead. During 1966-68, production of primary lead increased at an average annual rate of some 7%, about the rate required to achieve the goal of 610,000 tons of primary production planned for 1970. Since 1960, the U.S.S.R. has been a net exporter of lead, although for the period 1955-62, the lead content of imported ores, concentrates, and metal exceeded that of export metal by more than 150,000 tons. Most Soviet imports of lead originate in other Communist countries, chiefly Bulgaria, North Korea, and Yugoslavia. About 65% of Soviet exports of lead have been to Eastern Europe, primarily East Germany and Czechoslovakia. The estimated supply position of lead for the U.S.S.R., 1960-68, is shown in Figure 15.

FIGURE 15. ESTIMATED SUPPLY OF PRIMARY LEAD 25X1
(Thousands of metric tons)

YEAR	PRODUCTION	(+) IMPORTS	(−) EXPORTS	APPARENT SUPPLY*
1960	324	39.7	69.8	293.9
1961	326	39.5	102.3	263.2
1962	346	26.1	94.4	277.7
1963	385	38.8	110.2	313.6
1964	408	49.9	96.1	361.8
1965	433	47.9	102.5	378.4
1966	463	31.1	87.9	406.2
1967	495	32.3	86.9	440.4
1968	528	39.1	90.9	476.2
69	563	28.8	97.9	496.9
70	597	38.8	92.4	543.4

*Apparent supply equals production plus imports of metal minus exports of metal.

(2) *Producing facilities and technology*

(a) MINING AND CONCENTRATING—The bulk of lead ore mined in the U.S.S.R is obtained from low-grade polymetallic lead-zinc deposits, which, for the most part, are worked inefficiently and at considerable cost by underground methods. The number of highly mechanized and economic open pit operations has increased gradually, however, and by 1970, 30% of the ore is to come from open pits. Lead-bearing ores are mined in East Siberia, the Central Asian republics, and in the Kazakh S.S.R., which alone accounts for more than 50% of Soviet lead ore production, most of it from the Rudnyy Altay mining district in Vostochno-Kazakhstanskaya Oblast'.

Soviet processing of poor-quality lead-zinc ores by simple techniques, chiefly flotation, results in a low metal recovery rate for lead and poor recovery of byproducts contained in the ore. In addition, Soviet concentrates contain considerably less lead than the 68% to 70% in concentrates of Western producers. The Soviets, however, are introducing new and improved concentrating techniques, including heavy media separation and cyanide free flotation. In the Ust-Kamenogorsk area, lead recovery rates were raised to 92% to 97% from 70% in 1955. Efforts also are underway to improve recovery of byproduct elements, which in some ores may number as many as 19. The principal Soviet lead mines and concentrating plants are located on Figure 16.

(b) SMELTING AND REFINING—About 75% of the Soviet output of primary refined lead is produced in two plants, at Chimkent (48°18'N., 69°36'E.) and Ust-Kamenogorsk (49°58'N., 82°40'E.), both in the Kazakh S.S.R. The remainder is produced at the Elektrotsink Plant at Ordzhonikidze (43°02'N., 44°41'E.) in the Severo-Osetinskaya A.S.S.R. in the Caucasus and at the Tetyukhe Plant at Tetyukhe-Pristran' (44°21'N., 135°49'E.) in Primorskiy Kray in the Far East. The Altyn-Topkan Lead-Zinc Plant, which was to be put into operation during the Seven Year Plan, is still under construction. All the lead-producing plants were expanded considerably during the Seven Year Plan, particularly the Ust-Kamenogorsk Plant.

The Ukrtsink Plant in Konstantinovka in the Ukrainian S.S.R. is considered to be the major Soviet producer

* also: Yuzhniy Combine at Frunze see PCNAST study for info and coordinates.

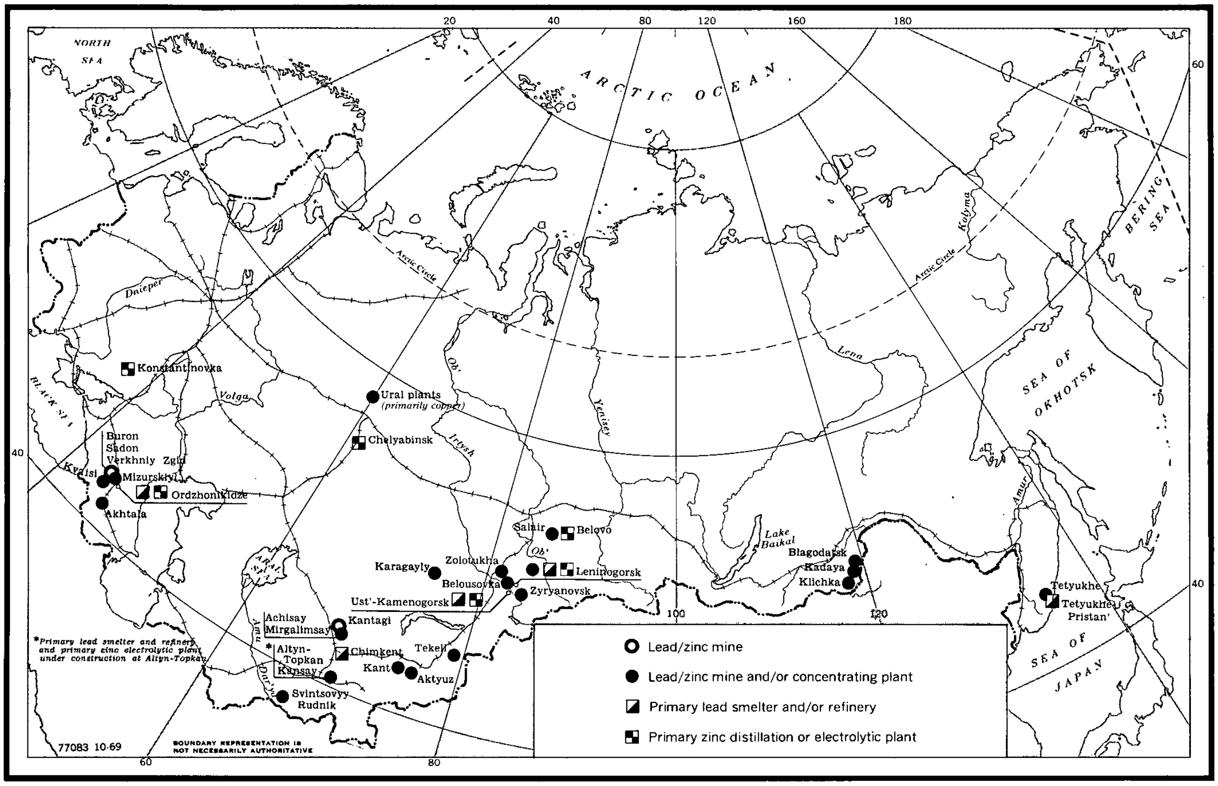

FIGURE 16. Principal lead and zinc facilities, 1968

of second lead. Secondary lead also is recovered at the Moscow Copper Smelting and Electrolytic Plant, at the Podol'sk Secondary Nonferrous Metals Plant, at the Verkhneyvinsk Secondary Nonferrous Metals Plant (location not established), and at two unidentified plants in the Urals.

(3) *Resources*—The U.S.S.R claims first place in the world in explored reserves of lead. Reserves of lead increased about 50% during 1959-65 to an estimated level of about 18 million tons. Although the quantity of proved reserves is being increased as a result of intensified exploration programs, the quality of newly discovered reserves is even lower than that of reserves already known. The average content of lead in reserves is generally below that of reserves of major Western lead producing countries and is steadily falling. The lead content of the ore at Leninogorsk, for example, fell from 1.39% in 1959 to 1.05% in 1965.

Lead reserves of the U.S.S.R. are located in the Central Asian republics, the Far East, East Siberia, the Caucasus, and most extensively in the Kazakh S.S.R., which has nearly two-thirds of total Soviet reserves. Nearly one-half of the republic's identified lead deposits are in Vostochno-Kazakhstanskaya Oblast'. Exploration and developmental programs in Central Asia may increase the relative importance of this area.

c. ZINC

(1) *Supply position*—In 1968, the U.S.S.R. produced an estimated 811,000 tons of zinc, of which 678,000 tons was primary and 133,000 tons was secondary. Production of primary zinc in 1965 was 504,000 tons.

The U.S.S.R. is estimated to consume more than 700,000 tons of zinc annually, 70% of which is used in galvanizing, in producing brass and bronze, and in diecasting alloys. Large amounts of ingot metal have been consumed in production of zinc oxide for use in the rubber and paint industries; efforts now are being made to obtain zinc oxide from other sources such as stack-gases of slag-fuming installations.

The Soviet Union is both an importer and exporter of zinc metal and also is an importer of ores and concentrates. In recent years, however, imports of ores and concentrates have declined considerably compared to the late 1950's and early 1960's. In 1968, the total volume of such imports, in terms of contained metal, probably was no greater than 15,000 tons. The suppliers of these ores and concentrates were North Korea and Iran. With respect to trade in zinc metal, the U.S.S.R. has consistently been a net exporter since 1957. In 1968, Soviet exports of the metal amounted to 78,700 tons, of which more than three-quarters went to the Communist countries of Eastern Europe, primarily to East Germany and Czechoslovakia. Non-Communist recipients of Soviet zinc in 1968 included India, the Netherlands, Finland, and Sweden. Soviet imports of zinc metal in 1968, amounting to 36,400 tons, were obtained from Poland and North Korea. The supply position of zinc in the U.S.S.R., 1960-68, is shown in Figure 17.

FIGURE 17. ESTIMATED SUPPLY OF PRIMARY ZINC (U/OU)
(*Thousands of metric tons*)

YEAR	PRODUCTION	IMPORTS	EXPORTS	APPARENT SUPPLY*
1960	364	72.7	90.4	346.3
1961	377	82.2	116.2	343.0
1962	403	63.1	108.0	358.1
1963	419	61.0	82.4	397.6
1964	436	71.0	149.8	357.2
1965	504	58.8	132.7	430.1
1966	551	16.3	86.3	481.0
1967	610	29.7	74.1	565.6
1968	678	36.4	78.7	635.7
69	748	50.1	97.4	700.7
70	800	53.3	95.1	758.2

*Apparent supply equals production plus imports of metal minus exports of metal.

(2) *Resources*—The U.S.S.R. claims that its reserves of zinc have doubled in the past 10 years and are the largest in the world. Reserves of ore are estimated for 1968 at 29 million tons, nearly half of which occur in polymetallic sulfide deposits containing copper-zinc ores or copper-lead-zinc ores. The Kazakh S.S.R., with about half of the total, has the largest zinc reserves in the U.S.S.R., followed by the Urals, the Far East, West Siberia, and the Caucasus, in that order.

The average zinc metal content of Soviet ores has declined from the level of former years as a result of the exploitation of the higher grade reserves and the failure to discover ore bodies of like metal content to replace them. The estimated average zinc content of ore mined in the U.S.S.R. at present is 4%, somewhat higher than the average zinc content of 3.5% for zinc-bearing ores being mined by the U.S.

(3) *Producing facilities and technology*

(a) MINING AND CONCENTRATING—Perhaps 80% of the zinc ore output in the U.S.S.R. is mined from low-grade polymetallic lead-zinc deposits in the Kazakh S.S.R, the Central Asian republics, the Caucasus, West Siberia, and the Far East and the remainder from copper-zinc ore in the Urals. The most important zinc mining district in the U.S.S.R. is the Rudnyy Altay area of Vostochno-Kazakhstanskaya Oblast' in the Kazakh S.S.R. which includes the Irtysh, Leninogorsk, and Zyryanovsk ore fields.

Soviet zinc producers benefit, as do lead producers, from increased open-pit operations in mining and from the introduction of advanced concentrating technology. By 1970 the U.S.S.R. hopes to increase the rate of recovery of zinc from lead-zinc ores to 92%-95% and the average zinc content of concentrates to 60%. Recently the recovery rate from domestic ores has been about 82% and the zinc content of concentrates, about 54%. The principal Soviet zinc mines and concentrating plants are shown on Figure 16.

(b) METALLURGY—Primary zinc is produced in six plants in the U.S.S.R. and a seventh, the Altyn-Topkan Lead-Zinc Plant in the Uzbek S.S.R., is scheduled for completion in 1969. The two largest producing plants are the Elektrotsink Plant at Ordzhonikidze in the Severo-Osetinskaya A.S.S.R. in the Caucasus and the Ust'Kamenogorsk Lead-Zinc Combine in the Kazakh S.S.R. A new zinc line was installed in the latter plant in 1968. Of lesser importance are the Chelyabinsk Zinc Plant in the Urals and the Ukrtsink Plant at Konstantinovka in the Ukrainian S.S.R., neither of which has undergone any expansion in the past decade. Another older zinc producing plant at Belovo (54°25'N., 86°18'E.) in Kemerovskaya Oblast' in West Siberia is small and is the only plant producing zinc by the distillation method. The newest plant in the Soviet zinc industry is the Leninogorsk Zinc Plant, which began operations in 1966 with the commissioning of two refining lines.

Only a few of the plants that produce secondary zinc have been identified. Among them are the Belovo Zinc Plant, the Moscow Brass and Bronze Works, and possibly, the Podol'sk Secondary Nonferrous Plant. Secondary zinc also is recovered at the Ukrtsink Zinc Plant which is to be enlarged during the current plan period.

d. TIN

(1) *Supply position*—The U.S.S.R. is the largest producer of tin among the Communist countries and is estimated to have increased its output from 6,300 tons in 1950 to about 18,000 tons in 1968. Planned output of primary tin in 1970 is estimated to be 22,000 tons. Current production of secondary tin makes a net addition of more than 4,400 tons per year to the Soviet supply. Most of this is recovered from copper-base and lead-base tin alloys; only small quantities are recovered from tin-base alloys.

The U.S.S.R. was a net exporter of tin to non-Communist countries during 1958-62, but shipments to the latter countries were actually reexports of tin obtained from Communist China as partial payment for Soviet aid in developing Chinese industry. In subsequent years, however, as imports from Communist China dwindled to almost negligible levels, the U.S.S.R. was obliged to import tin from non-Communist countries, primarily Malaysia and the U.K. During 1964-68 such imports averaged nearly 6,000 tons per year. Present indications are that the U.S.S.R. will remain dependent on non-Communist countries in the near future for a part of its tin requirements. For example, the U.S.S.R. recently has sought to establish long-term agreements with Malaysia and Bolivia to provide technical assistance (in the case of Bolivia specifically for its tin industry) in exchange for supplies of tin. The supply position of tin in the U.S.S.R, 1960-68, is shown in Figure 18.

The chief uses of tin in the U.S.S.R. are for tinplate, bronze casting, solder, and for Babbitt metal. Consumption of tin increased by 90% from 1955 to 1965, reaching an estimated 23,000 tons in the latter year. Because of the tight supply situation, the U.S.S.R. has planned only a 20% increase in consumption during 1966-70.

(2) *Producing facilities and technology*

(a) MINING AND CONCENTRATING—The major tin ore mining and concentrating enterprises of the U.S.S.R. are in Eastern Siberia and the Far East, which between them account for 85% to 90% of Soviet tin ore production. Probably the two largest of these enterprises are the Solnechnyy Mining and Concentrating Combine in

FIGURE 18. ESTIMATED SUPPLY OF TIN 25X1
(*Thousands of metric tons*)

	PRODUCTION					
	Total	Primary	Secondary	IMPORTS	EXPORTS	APPARENT SUPPLY
1960	13.4	10.6	2.8	17.8	11.5	19.7
1961	14.3	11.3	3.0	11.2	5.7	19.8
1962	15.1	12.0	3.1	9.9	0.5	24.5
1963	16.0	12.7	3.3	7.8	0.7	23.1
1964	16.9	13.4	3.5	5.5	0	22.4
1965	17.6	14.0	3.6	5.8	0	23.4
1966	19.2	15.2	4.0	4.8	0	24.0
1967	21.0	16.7	4.3	5.7	0	26.7
1968	22.4	18.0	4.4	7.1	0	29.5

Khabarovsk Kray and the Khrustal'nyy Mining and Concentrating Combine in Primorskiy Kray. A listing of the most important enterprises is given in Figure 33.

Of the tin mined in the U.S.S.R., 65%-70% is from lode deposits and the remainder from placer deposits; in non-Communist countries about 70% of the tin ore is mined from placer deposits. Placer deposits can be exploited by dredging or open pit methods, whereas lode deposits generally are worked by more expensive underground methods. In the U.S.S.R., a shift from underground operations is taking place and quarry methods are now being applied to the exploitation of an increasing number of lode deposits.

The principal methods used for treating tin ores in the U.S.S.R. are gravitational and magnetic separation. Because of the complex nature and low tin content of Soviet ores, the ores usually undergo initial concentration at the mining sites. These concentrates, containing 10% to 30% tin, are shipped to central concentrating facilities—for example, the Central Finishing Plant at the Novosibirsk Tin Plant—where concentrate with a tin content as high as 70% is produced.

(b) METALLURGICAL REDUCTION—Nearly all of the metallurgical reduction and refining of tin is carried out at the Central Tin Plant in Novosibirsk (55°02'N., 82°55'E.), which doubled its capacity during 1959-65 in order to process the increasing volume of concentrates. Tin reduction plants also are located in Ryazan' (54°38'N., 39°44'E.) and Podol'sk (55°26'N., 37°33'E.), but both of these plants process other metals such as titanium, niobium, and tantalum, and are primarily concerned with developing new methods for processing waste materials, poor quality ores, and scrap materials. About 10% of the Soviet output of primary tin is recovered from polymetallic ores processed by the Moscow Copper Smelting and Electrolytic Plant imeni Molotovo, the Chimkent and Tetyukhe lead plants, and the Ukrainian Zinc Plant (Ukrtsink) in Konstantinovka.

Sizable quantities of tin are lost in the smelting process. Until recently the practice in the U.S.S.R. was to allow from 9% to 50% of the tin content of the concentrates to pass into slags and dusts, which were discarded as waste products. Now through improved technology some of this tin is being recovered. Tin-containing slags of other nonferrous installations also are being processed. Although results are not known, by 1966 the U.S.S.R. had planned to produce nearly 1,000 tons of tin annually from slags generated at lead plants alone. The U.S.S.R. claims that producing tin metal from these wastes is more economical than processing low-grade tin ore.

Although the pyrometallurgical method is the principal method of tin smelting in the U.S.S.R., an increasing share of Soviet tin is being smelted by the electrolytic method. The refined metal has a minimum tin content ranging from 96.35% to 99.90%. Tin of ultrahigh purity also is produced. Processes employed include vacuum filtration, vacuum distillation, and zone refining, at least one of which produces metal with a tin content of better than 99.99%, which is suitable for use in semiconductors.

Facilities for the recovery of secondary metal have been installed at the Moscow Copper Smelting and Electrolytic Plant imeni Molotovo, at the Krasnyy Vyborzhets Plant in Leningrad, and at plants in Verkhneyvinsk and Podol'sk. Scrap also is treated at some of the ferrous metallurgical installations where tinplate is produced and fabricated. Hydrometallurgical methods and resmelting in reverberatory furnaces both are used in production of secondary tin. Much of the secondary tin is used in alloyed form and consequently does not require refining.

(3) *Resources*—Tin resources of the U.S.S.R. are located primarily in the Far East and East Siberia. New discoveries in these regions, particularly in the Khabarovsk Kray, have emphasized the importance of these areas to the Soviet tin industry. Tin resources also have been discovered in Kazakhstan and Central Asia, but these hold little promise for making a significant contribution to Soviet tin supplies. Further intensive prospecting is likely because the U.S.S.R. indicated that in 1965 prospected reserves were insufficient to guarantee planned output after 1970.

4. Miscellaneous metals

a. ANTIMONY

(1) *Supply position*—Production of primary antimony in the U.S.S.R. has increased only modestly in the 1960's, reaching an estimated 8,500 tons in 1967 and 1968. In the 1950's and early 1960's domestic supplies were augmented by imports from Communist China, and

FIGURE 19. ESTIMATED SUPPLY OF ANTIMONY
(*Thousands of metric tons*)

	PRODUC-TION	IMPORTS FROM CHINA	EXPORTS	APPARENT SUPPLY
1960	7.6	0	2.5	5.1
1961	8.0	2.0	3.5	6.5
1962	8.1	0	3.9	4.2
1963	8.1	2.0	3.3	6.8
1964	8.2	0	4.3	3.9
1965	8.2	0	2.7	5.5
1966	8.3	0	2.4	5.9
1967	8.5	0	1.3	7.2
1968	8.5	0	0.8	7.7

the U.S.S.R. regularly exported significant quantities. With the cessation of imports from China and a steady growth in domestic consumption in recent years, Soviet exports of antimony declined to less than 1,000 tons by 1968. The estimated Soviet supply position for antimony is shown in Figure 19.

Currently the U.S.S.R. consumes about 7,000 tons of antimony annually, principally as an alloy with lead or tin and in the form of compounds. The main uses for metallic antimony in the U.S.S.R. are in battery plates, bearings, printing types, ammunition, and solder. Antimonial compounds are used in paint, ceramics, fireworks, matches, rubber, the burnishing of steel, photography, dye, optical instruments, medicine, and fireproofing materials.

(2) *Resources and producing facilities*—Explored reserves of antimony in the U.S.S.R., though extensive, are low in quality. The Kirgiz S.S.R. (Kadamdzhay deposit at Frunze—40°07′N., 74°44′E.) has the largest reserves. Additional reserves are located in the Tadzhik S.S.R. (Dzhidzhik deposit—39°08′N., 68°26′E.), the Kazakh S.S.R. (Turgay deposit—49°38′N., 63°30′E.) and Krasnoyarskiy Kray in East Siberia (Razdolinsk deposit—58°25′N., 94°37′E.).

The Kirgiz S.S.R. is also the largest producer of antimony in the U.S.S.R. The Yuzhnyy Mining and Metallurgical Combine imeni Frunze at Frunze is the major producer in the country. It includes the Kadamdzhay, Khaydarken, Tereksay, and Chauvoy mines and concentrating facilities. Production in the Kirgiz S.S.R. is to be increased by renovation and enlargement of these facilities. The Yuzhnyy Combine also processes the antimony concentrate produced at Dzhidzhik in the neighboring Tadzhik S.S.R. A new concentrating plant is under construction at the latter location. Metal and compounds are produced locally at Turgay in the Kazakh S.S.R. and at Razdolinsk in Krasnoyarskiy Kray. Primary antimony also is produced on a small scale as a byproduct by the Chimkent and Leninogorsk lead plants and the Ust'-Kamenogorsk Lead-Zinc Combine in the Kazakh S.S.R.

b. BORON—The U.S.S.R. has been increasing production of boron materials in recent years, but domestic supplies have been insufficient to meet the needs of the economy. To make up the deficit, the U.S.S.R. has regularly imported borax, almost exclusively from Communist China. Imports from the latter averaged about 11,000 tons per annum during 1960-67, although on a year-to-year basis the quantities have fluctuated considerably. Early in the 1960's, when shipments from Communist China declined sharply, the U.S.S.R. sought, with little success, to import borax from non-Communist countries. Since 1964, however, the supply position apparently has been eased as shipments from China approached earlier levels.

25X1

The Soviet Union has claimed to have a large number of boron-containing deposits, but they are generally of poor quality and few new discoveries have been made in recent years. The Inder deposits at Ozero Inder (47°27′N., 51°54′E.) in Kazakhstan, which have been exploited for many years, apparently will continue to be the principal source of domestically produced boron raw materials in the near future.

Boron is used in a wide variety of applications in the U.S.S.R.; in the manufacture of abrasives and refractory materials; as an additive in ceramics and glass; in fertilizers; as a deoxidizing agent; and in the making of special steels and composite materials. The U.S.S.R. also has tested boron as an additive in rocket fuels.

c. CADMIUM—The U.S.S.R. is second only to the United States in world production of cadmium metal, although its production in 1968, estimated at 1,900 tons, represents only about half of U.S. output in that year. Soviet imports of cadmium have amounted to approximately 200 tons per year since 1963; exports have declined from 1,000 tons in 1963 to 700 tons in 1968. The decrease in exports and steadily increasing domestic production have made possible a substantial growth in the apparent supply of cadmium available for domestic use. In 1967 the apparent supply amounted to about 30% of the consumption of the United States. The estimated supply position of the U.S.S.R. for cadmium in 1960-68 is shown in Figure 20.

In the Soviet Union, cadmium metal is recovered almost exclusively as a byproduct of lead and zinc production from zinc sulfide and from polymetallic sulfide ores. More than half of Soviet reserves are in the Kazakh S.S.R. which amounts for about half the U.S.S.R.'s metal output. Cadmium metal is produced at the Chelyabinsk and Elektrotsink zinc plants, the Ust'-Kamengorsk Lead-Zinc Plant, and the Leninogorsk and Chimkent lead plants. Electrolytic cadmium was produced for the first

FIGURE 20. ESTIMATED SUPPLY OF CADMIUM
(*Metric tons*)

25X1

	PRODUC-TION	IMPORTS	EXPORTS	APPARENT SUPPLY
1960	1,050	288	913	425
1961	1,090	334	1,057	367
1962	1,160	334	1,100	394
1963	1,210	259	1,000	469
1964	1,260	155	700	715
1965	1,450	237	900	787
1966	1,600	182	600	1,182
1967	1,780	220	500	1,500
1968	1,900	235	700	1,435

time in the U.S.S.R. at the Leninogorsk Lead Plant in 1965. The U.S.S.R. imports cadmium primarily from Poland. It exports to other Communist countries and to several non-Communist countries. Exports to non-Communist countries are believed to exceed those to Communist countries.

By far the largest use of cadmium in the Soviet Union is in plating and alloying. Cadmium also is used in making pigments, plastics, batteries, and electronic devices.

d. GERMANIUM AND SILICON—The U.S.S.R. produces both germanium and silicon in crystalline form primarily for use in semiconducting devices—transistors, diodes, rectifiers, and integrated circuits. In recent years the output of each of the metals has been increased and the Soviets claim that domestic requirements will be fully satisfied during the current Five Year Plan. Further evidence of a definite easing of the supply pinch of the early 1960's is provided by reports of the availability of some metal for export and by the fact that domestic prices for germanium and silicon were reduced in July 1967. The quality of the metals also has been improved and probably is satisfactory for current uses. Previously, the quality of Soviet monocrystalline silicon had been subjected to considerable criticism.

e. GOLD

(1) *Resources*—The principal deposits of gold in the U.S.S.R. are placer deposits in the Northeast region of the country. Long established as the most important source of Soviet gold, the Northeast probably will retain this position for some time. In recent years, however, the emphasis in geological prospecting has shifted to the location of lode deposits. Important discoveries have been made in Central Asia and Kazakhstan—areas far more favorable for gold mining operations than the Northeast where the working season is sharply curtailed by the harsh climate. In the next several years production at these new deposits is planned to reach significant levels.

Gold reserves of importance also occur in Soviet polymetallic ores. A small amount of this gold is recovered during the initial processing of the ore, but most of it is recovered from the slimes generated during the electrolytic refining of the primary metals, principally copper, lead, and zinc. The U.S.S.R. claims that these ores supply an increasing share of total output.

(2) *Production*—Production of gold in the U.S.S.R. has increased steadily during the 1960's at about 7% to 8% annually and by 1968 is estimated to have been 184 tons or 5.9 million troy ounces, the second largest output in the world. The Northeast region accounted for about 55% of this output. Mining in other areas of the U.S.S.R. supplied about 28%, and byproduct output supplied the remainder.

(3) *Holdings*—Gold reserves of the U.S.S.R. were sharply reduced to about US$1 billion equivalent by large sales during 1963-65, but since then have risen steadily. At the end of 1968 they reached an estimated value of US$1.4 billion. Reserves are expected to continue growing and may reach US$2.0 billion by the end of 1970 unless sales are dictated by economic or political needs.

f. MERCURY

(1) *Supply position*—In 1967 the U.S.S.R. became the world's largest producer of mercury. Whereas the U.S.S.R. had steadily increased its output in the preceding years, Italy and Spain—the other leading world producers—experienced declines in output. Estimated Soviet production of mercury in recent years is given as follows, in terms of thousands of flasks (one flask equals 34.5 kilograms; 1 metric ton of mercury contains approximately 29 flasks): 25X1

1960	32	1965	48
1961	35	1966	52
1962	38	1967	64
1963	41	1968	67
1964	44	1969	70

25X1

Once both an active importer and exporter of mercury, the U.S.S.R. has virtually ceased all trade in this metal. During the 1950's and early 1960's domestic production of mercury was augmented by substantial imports. Communist China, the major supplier, reported that it shipped 224,000 flasks of mercury to Soviet destinations during 1950-62. Yugoslavia provided an additional 3,700 flasks in 1960 and 2,900 flasks in 1963. In 1963 the U.S.S.R. imported 11,600 flasks of mercury from China, but by 1967 such imports had dwindled to 1,000 flasks. In 1968 the U.S.S.R. reported no imports of mercury from China. In the past the U.S.S.R. also exported mercury in significant quantities, principally to Eastern Europe, with East Germany having been the principal recipient. Only small amounts of mercury were shipped to non-Communist countries. Exports declined sharply since 1964, however, probably reflecting the growing demands of domestic consumers. In 1967 and 1968 the U.S.S.R. did not report any exports of mercury. Soviet exports of mercury in 1960-67 are listed in the following tabulation, in thousands of flasks:

1960	15.6	1964	26.2
1961	18.1	1965	8.3
1962	17.4	1966	6.9
1963	14.5	1967	0.6

The consumption pattern for mercury in the U.S.S.R. is believed to be similar to that of other countries, the chief uses being in pharmaceuticals and drugs; in control and measuring instruments such as thermometers; in the production of chlorine caustic acid and other products such as acetaldehyde, dyes, and antifouling paints; in the production of mercury fulminate for explosives; in the manufacture of felt; in the production of mercury vapor lamps and rectifiers and of typographic matte; in agriculture as a seed mordant and in the production of insecticides and pesticides; and in the amalgamation of gold.

(2) *Resources and producing facilities*—The largest reserves of mercury in the U.S.S.R. are found in the Kirgiz S.S.R., principally in the deposits at Khaydarken (39°57'N., 71°20'E.), Chauvay (40°08'N., 72°08'E.), and Ulugtau (40°24'N., 72°08'E.). Other important reserves are located in the Ukrainian S.S.R. (Nikitovka deposits—50°22'N., 38°25'E.), the Far East (Chukotskiy National Okrug), and the Caucasus (Akhva deposit in the Georgian

S.S.R. and the Perevalnyy deposit—44°13′N., 39°26′E.—in Krasnodarskiy Kray). Although the U.S.S.R. apparently has extensive reserves, the average mercury content of Soviet ores is low and geological exploration is being expanded in an effort to increase reserves by 70% during 1966-70.

The Kirgiz S.S.R. produces more mercury than any other republic in the U.S.S.R. During 1959-65 it doubled its output of mercury. Next in importance is the Ukrainian S.S.R., followed by West Siberia, the Tadzhik S.S.R. and the Kazakh S.S.R. Plans to increase the output of mercury by 50% during 1966-70 are based on the expansion of operations at the major producing sites in the Kirgiz and Ukrainian S.S.R.'s as well as on production from several new deposits already under development. Among the latter are new facilities at Gorlovka and Zakarpatskiy in the Ukraine and new mines in the Azerbaijan S.S.R., the Tadzhik S.S.R., Chukotsk, and Krasnodarskiy Kray. The U.S.S.R. also obtains mercury as a byproduct of lead and zinc production at the Chimkent and Leninogorsk lead plants and the Ust'-Kamenogorsk Lead and Zinc Combine.

g. Niobium and tantalum—Deposits of niobium-tantalum bearing ores have been reported in many areas of the U.S.S.R. Some of the larger deposits are in the Chitinskaya Murmanskaya and Sverdlovskaya Oblast's, the Khabarovskiy and Krasnoyarskiy Krays, and the Kazakh S.S.R. The deposit in the Murmanskaya Oblast' on the Kola Peninsula is probably one of the largest in the world. Small amounts of niobium and tantalum also are recovered from tin, tungsten, and titanium ores.

Although reserves of niobium-tantalum bearing ores are extensive, the ores are complex and difficult as well as costly to treat. In addition, the tantalum content is very low, resulting in a relative scarcity of this metal compared with niobium. One of the principal tasks of Soviet geologists in the current plan period is to discover new deposits of ores containing tantalum and niobium which can be worked economically.

The U.S.S.R. is believed to have started industrial scale production of niobium and tantalum in 1963. Since then production has increased steadily and use has been made of vacuum arc, electron beam, and plasma arc melting techniques to consolidate high quality ingots. A variety of tantalum-base and niobium-base alloys have been developed and the Soviets have demonstrated growing competence in the fabrication of both the metals and their alloys. Production of niobium is adequate for domestic needs and some exports have been noted. Production of tantalum, however, is still not sufficient to meet domestic needs. Efforts have been made to import tantalum-bearing ores and concentrates from non-Communist countries, but these efforts are not known to have been successful.

Niobium is used principally in the U.S.S.R. in the form of ferroniobium for alloying steels required in construction, gas turbines, and jet engines. Niobium also is used in chemical machine building, atomic energy, electronics, superconducting magnets, and carbide tools. The use of tantalum has been restricted primarily to military electronics, in capacitors and rectifiers. The supply of tantalum has not been adequate to meet the growing demand for it in chemical machine building and other corrosion-resistant applications.

h. Platinum group metals and silver—The U.S.S.R., with an estimated annual output of 2 million troy ounces, is the largest producer of platinum group metals in the world. Soviet production comprises more than half of world output and is more than twice that of South Africa, the second largest producer. About 70% of the Soviet output of platinum group metals consists of palladium, about 25% is platinum, and the remaining 5% consists of the other metals of the platinum group (iridium, osmium, rhodium, ruthenium). Because it makes up only a relatively small share of the total, Soviet production of platinum, the most important metal of the group, is less than half that of South Africa.

The U.S.S.R. has been an important supplier of platinum group metals to Free World countries for more than a decade. Only very small amounts of these metals are shipped to Communist countries. In 1966 and 1967 Soviet shipments to the Free World approached 1 million troy ounces annually. Available information indicates that such shipments probably exceeded 1 million troy ounces in 1968, a record high for Soviet exports of platinum group metals. An estimated 80% of these exports were of palladium, reflecting the large proportion of palladium in Soviet production of these metals.

Soviet platinum group metals are recovered principally as byproducts from the Noril'sk Copper-Nickel Combine. The extension of present ore bodies at Noril'sk and the discovery of rich new deposits in the area assure continued high output for many years. Platinum group metals also are obtained from copper-nickel mines in the Kola Peninsula. Another source is represented by the platinum placers in the Urals near Nizhniy Tagil (57°55′N., 59°57′E.) and Sysert (56°29′N., 60°49′E.). The metals of this group also occur as a slight admixture with gold in placer deposits in the Urals, the Northern Caucasus, and in some part of Siberia. Finally, small amounts of platinum are obtained as byproducts at Soviet copper refineries.

The U.S.S.R. is one of the major producers of silver in the world, although virtually all of it is obtained as a byproduct of nonferrous metals. Most Soviet silver apparently is consumed domestically, although small amounts were shipped to the U.K. in 1965, 1966, and 1967.

The largest Soviet reserves of silver are located in the Kazakh S.S.R., principally in deposits of polymetallic ores. The major producing areas in this republic are in the vicinity of Zyryanovsk in Vostochno-Kazakhstanskaya Oblast', near Tekeli in the Khrebet (mountain range) Dzhungarskiy Alatau, and near Mirgalimsay in the Khrebet Karatau. Also rich in silver-bearing polymetallic ores are the Altyn-Topkan and Kansay areas of the Tadzhik S.S.R., the Boardy area of the Kirgiz S.S.R., the Salairskiy Kryazh (Ridge) and Kilyvanskiy Khrebet in West Siberia, the Verkhoyanskiy Khrebet in the Yakutskaya A.S.S.R., and the Kavalerovo region near Tetyukhe. Silver also is found associated with the copper-nickel ores at Noril'sk and on the Kola Peninsula.

i. Selenium and tellurium—Selenium and tellurium are recovered in the U.S.S.R. primarily as byproducts of the production of nonferrous metals, principally copper, lead, and nickel and sulfuric acid. Selenium has been produced in the U.S.S.R. since the late 1920's, tellurium since about 1940. Neither the total Soviet output nor the output of any specific producing facility has ever been revealed. However, production apparently is adequate to meet most consumption requirements. In the U.S.S.R. both selenium and tellurium are used chiefly as semiconductor materials in the manufacture of rectifiers and other electronic equipment. The following enterprises in the U.S.S.R. are reported to produce either selenium or tellurium or both:

Alaverdi Copper Chemical Combine
Chelyabinsk Zinc Plant
Chimkent Lead Plant
Karabash Mining and Metallurgical Combine
Kokand Superphosphate Plant
Krasnoural'sk Copper Smelting Plant
Leninogorsk Lead Plant
Noril'sk Mining and Metallurgical Combine
Pyshma Electrolytic Copper Plant
Samarkand Superphosphate Plant
Ust'-Kamenogorsk Lead-Zinc Combine

j. Uranium

(1) *Supply position*—The uranium available to the U.S.S.R. from domestic production and from Communist countries, chiefly East Germany and Czechoslovakia, is considered to be adequate to meet Soviet needs. Production is estimated at close to 20,000 tons of recoverable uranium metal per year. From World War II to mid-1968 the Soviet Union has procured an estimated 300,000 tons of uranium metal equivalent from all sources. These estimated values could be higher or lower by 25%.

(2) *Producing facilities*—The main uranium mining and ore concentrating areas in the U.S.S.R. are the Krivoy Rog iron ore district in the Ukraine, the Central Asia areas, and the Caucasus. Small mining operations are located in other producing areas from which ore is shipped to the concentration plants in the main producing areas, or directly to feed materials plants for upgrading.

The Pervomaysk and Zheltaya Reka uranium mines in the northern section of the Krivoy Rog iron ore district probably produce about 3,000 tons of uranium oxide a year from veinlike and disseminated limonite ores averaging 0.2% uranium. The Zheltaya Reka ores are concentrated at the Zheltiye Vody mill (capacity 1,500 tons or more per day) but most other ore from the district is probably shipped to concentrating plants at Dneprodzerzhinsk which are believed capable of processing at least 6,000 tons of ore per day.

The Ferganskaya Dolina (Fergana Valley) in Central Asia is probably producing about 2,000 tons of uranium oxide a year from vein-type deposits and sedimentary rock formations. Mines and concentrating plants are located at Taboshar and Adrasman at the western end of the valley, and at Mayly-Say at the eastern end. Additional chemical concentrating plants are located at Leninabad and Mayly-Say.

A second uranium district in Central Asia is located near Frunze and Ozero Issyk-kul' (Lake Issyk-Kuk'). This area is believed to produce about 2,000 tons of uranium oxide per year from sediments, subbituminous coals, and perhaps some veins. Deposits are near Bokombayevskoye, Min-Kush, Sosnovka, and at Kurday Pereval. Concentration plants are located at Bokombayevskoye, Min-Kush and near Stalinskoye.

The Pyatigorsk area of the northern Caucasus probably produces sufficient ores from which 300 tons of uranium oxide can be derived per year. The ore is concentrated at a plant near Lermontov which has a capacity of 1,000 tons of ore per day. The uranium is probably in hydrothermal vein deposits in the laccolithic mountains of the area and deposits in the sediments immediately adjacent to them. Average assay of the ore is probably 0.1% uranium. Limited information is available on other deposits of uranium in the U.S.S.R. Probably about 1,300 tons of uranium oxide is derived from the deposits of Estonia, Karelia, the Kola Peninsula, the Permian Basin near Perm, the Urals, Krasnoyarsk, the Ust'-Kamenogorsk area, the Tuvinskaya Avtomnaya Oblast' centered about Kyzyl, the south end of Lake Baykal, and possibly other sites in the Far East.

Ore concentration plants are well designed and have substantial capacities, usually of 500 to 1,000 tons of ore per day, although several plants have substantially larger capacities. The newer plants are using modern ion-exchange and solvent extraction recovery methods.

Uranium metal and other feed materials are produced at Elektrostal', near Moscow; at Glazov, just west of the Urals; and at Novosibirsk in Central Siberia. The combined output of these plants is considered adequate to meet all Soviet needs.

(3) *Resources*—The Soviet uranium procurement program has steadily expanded, probably largely due to the success of their prospecting efforts in locating workable deposits of uranium ores. A variety of deposits are exploited, including veins, sandstones, shales, limestones, subbituminous coals, and metamorphosed iron-uranium formations.

Possibly half of Soviet production is from vein-type deposits in which reserves are difficult to forecast before actual mining operations and are often high cost because of the large amounts of waste rock mined to get at rich portions of the deposit. The remainder of Soviet internal production comes from sedimentary deposits often folded and faulted or of such low grade that mining costs probably approach the costs of vein-type operations. Estonian shales, which average 0.01% uranium assay, and coals mined in Central Asia and Southern Siberia, which assay about 0.05%, are low-grade ores compared with the overall average of United States deposits of about 0.20% uranium. Soviet reserves of the better grade sedimentary deposits probably run about 5,000 to 15,000 tons of uranium as recoverable metal each which compares favorably with U.S. deposits.

Two unique Soviet developments in uranium mining and milling technology are recovery of uranium from iron ore and from coals. The northern part of the Krivoy

Rog district has two vein-like and disseminated iron-uranium ore deposits with average uranium assay of 0.2%. Reserves are probably 30,000 to 40,000 tons of uranium and may be much higher because vein deposits are frequently difficult to estimate until actual mining operations commence. Jurassic coals mined at Min Kush and Bokombayevskoye probably have an average assay between 0.05% and 0.85% uranium. About half of the uranium recovered in this district is obtained from lignitic and subbituminous coals and the remainder from sandstones. The success of these unique operations and the discovery of higher grade deposits permitted the Soviets, starting about 1957, to shut down some low-grade operations and older isolated operations in the Far East.

k. Zirconium—The U.S.S.R. has ample reserves of zirconium to meet its present requirements. Deposits of zirconium-bearing minerals are located in the region of Zhdanov in the Ukrainian S.S.R., in the Murmanskaya, Sverdlovskaya, and Tomskaya Oblast's, and in the Kazakh, Tadzhik, and Uzbek S.S.R.'s.

Both technical-grade and reactor-grade zirconium are produced in the U.S.S.R. The technical-grade material is used in the manufacture of refractories and ceramics as well as in the chemical industry for its corrosion-resistant properties. Reactor-grade zirconium is used in nuclear submarines and power reactors. Another Soviet use of zirconium, probably the higher quality reactor grade, is in the manufacture of superconducting alloys.

Soviet methods for the production of zirconium differ markedly from those employed in the West. To accomplish the difficult separation of zirconium from hafnium (an inevitable companion in zirconium-bearing minerals, but one which cannot be tolerated in most nuclear applications), the Soviets use a repetitive recrystallization process which is not as efficient as the liquid-liquid extraction processes used in the U.S. Metallic zirconium is produced in the U.S.S.R. by the electrolysis of molten salts followed by the iodide refining process. These methods are quite costly compared with the magnesium (Kroll) or sodium reduction processes used in the West. Some progress apparently has been made, however, in reducing costs by expanding the volume of production, improving the electrolytic cells, and reducing the number of steps in the refining process. Consolidation of the metal in ingot form is carried out by conventional vacuum melting techniques. Two zirconium-base alloys, one with 1% niobium and another with 2½% niobium are used extensively by the U.S.S.R. in nuclear reactors. Facilities for the production of zirconium are located at Podol'sk, Osipenko, and Belyayevo.

5. Nonmetallic minerals

a. Abrasives—Although the U.S.S.R. has steadily increased production of abrasives since World War II, it continues to be a net importer of these materials, primarily from East Germany, Czechoslovakia, Hungary, and Poland. As in most of the rest of the world, the depletion of reserves of high-grade natural abrasives, such as corundum and emery, and mounting requirements, have led the U.S.S.R. to produce artificial abrasives, including silicon carbide (carborundum) and aluminum oxide, which are produced in large quantities and boron carbide and boron nitride, which are produced in small quantities. In 1968, the output of natural abrasives probably was less than 2% of the total Soviet output of abrasives. The two most important enterprises are the Zaporozh'ye Abrasives Plant and the Chelyabinsk Electrometallurgical Plant. Several new plants are under construction, but it is noteworthy that considerable attention is now being devoted to the development of tools using industrial diamonds rather than abrasives. The growing interest in the use of industrial diamonds apparently reflects, in part at least, the persistent inability of the abrasives industry to raise the quality of its products to satisfactory levels. In 1968, the abrasives industry was taken away from the Ministry of Nonferrous Metallurgy and put under the control of the Ministry of Machine Building.

b. Asbestos—Since World War II Soviet production of asbestos has been adequate to meet domestic requirements and to provide a surplus for export to both Communist and non-Communist countries. Production has increased from about 240,000 tons of graded asbestos in 1951 to about 2.4 million tons in 1968, making the U.S.S.R. the largest producer of asbestos in the world.[11] According to the current Five Year Plan, production is to reach about 3 million tons in 1970.

The U.S.S.R. has been an exporter of asbestos since the modernization and expansion of the industry after World War II. In addition to supplying a major part of the requirements of Eastern Europe, Soviet exports have competed with Canadian and African asbestos in the West European market. In 1965, total Soviet exports amounted to about 248,000 tons compared to only 65,000 tons in 1955. Exports have continued to increase since 1965 and reached 303,600 tons in 1968. The larger share of annual Soviet exports has usually gone to non-Communist countries. In 1967 and 1968, however, the exports were about equally divided between Communist and non-Communist countries. Among the latter, West Germany and France have been the largest importers. East Germany, Poland, and Czechoslovakia are the major Communist importers of Soviet asbestos.

Most of the Soviet output of asbestos is obtained from processing plants near the city of Asbest in Sverdlovskaya Oblast'. These plants process ore from the Bashenovsk deposit nearby which, although it has been exploited since Tsarist days, probably is still the largest known deposit of asbestos in the world.

In 1963 the U.S.S.R. launched a major campaign to expand productive capacity in the asbestos industry. At the Dzhetygara deposit in Kazakhstan the first stage of a large new combine—with an annual capacity of 200,000 tons—was commissioned in 1965. An even larger

[11] One Soviet source indicates that roughly only one-third of current output is of the first six grades. On this basis, the remaining two-thirds of estimated Soviet output would be grade seven, the lowest grade of asbestos. Lower grade materials, it may be noted, make up a large part of the world production of asbestos, but detailed statistics by grades are not available to permit a ranking of producers by the quality of their output.

second stage (400,000 tons annual capacity) originally scheduled for completion in 1967, is still under construction. Another new combine near Asbest went into partial operation in 1967. When completed, the combine will have an annual capacity of 350,000 tons. Other plants recently completed are the Kiembi plant in Orenburgskaya Oblast' with a capacity of 125,000 tons and the Aktovrak plant in the Tuva A.S.S.R. with a capacity of 160 to 180 thousand tons. New discoveries of additional deposits in Chita Oblast', in southern Kazakhstan, and in Vostochnyy Sayan may lead to the construction of additional facilities.

c. Fluorspar

(1) *Supply position*—The U.S.S.R. is not self-sufficient in fluorspar even though it has increased domestic output substantially in recent years. Production is estimated to have reached about 600,000 tons in 1968 or twice the level of production in 1962, but an accompanying increase in annual requirements (mostly for chemicals used by the aluminum, nuclear, and other industries but also as a flux in steelmaking) has kept the U.S.S.R. dependent on imports for a share of these requirements. Imports have averaged more than 90,000 tons annually during 1960-68, ranging from 75,000 tons in 1960 to 132,000 tons in 1964. Imports in 1968 amounted to 102,000 tons.

(2) *Resources and producing facilities*—The U.S.S.R. possesses extensive reserves of fluorspar occurring primarily in the eastern regions of the country. The largest reserves of fluorspar are located in Primorskiy Kray (Voznesenka, 44°12'N., 132°12'E.) and Khabarovskiy Kray in the Far East followed by Chitinskaya Oblast' (Kalanguy, 51°01'N., 116°31'E.; Solnechnyy, 54°14'N., 121°40'E.; Abagaytuy, 49°35'N., 117°19'E.; and Usugli, 52°39'N., 115°16'E.) and the Tuvinskaya A.S.S.R. in East Siberia; the Tadzhik S.S.R. (Takob, 38°50'N., 68°57'E.), the Uzbek S.S.R. (Naugarzen, location not precisely established), and the Kirgiz S.S.R. in Central Asia; the Kazakh S.S.R. (Auyrakhmet, 41°34'N., 70°07'E.); Arkhangel'skaya Oblast' (Amderma, 69°45'N., 61°39'E.) in the Northwest. Soviet reserves of fluorspar have been increased by recent discoveries of new deposits in the Ukraine, Central Asia, and in the Kazakh S.S.R.

The principal producer of fluorspar in the U.S.S.R. for a number of years has been Chitinskaya Oblast'. The Kalanguy facility alone reportedly accounted for one-half of all the fluorspar produced in the U.S.S.R. in 1966. Other important producers in Chitinskaya Oblast' are located at Solnechnyy and Usugli. Facilities at Solnechnyy have been expanded in recent years. Primorskiy Kray has increased its production of fluorspar following the recent construction of new facilities at the rich Voznesenka deposit. Another facility which has been enlarged and is gaining in importance as a producer of fluorspar is located at Naugarzen in the Uzbek S.S.R. Other significant producers of fluorspar are located at Hoy Tyube in the Uzbek S.S.R., Takob in the Tadzhik S.S.R., and Auyrakhmet in the Kazakh S.S.R.

d. Graphite—The U.S.S.R. is a leading world producer of graphite, ranking second only to North Korea. Soviet production, which is estimated to have been about 69,000 tons in 1968, is adequate to cover domestic needs and leave a surplus for export. From 1960 through 1968 the U.S.S.R. increased its exports of graphite from 3,800 tons to 10,200 tons. Average annual exports during the period were 6,800 tons and the principal recipients were the Communist countries of Eastern Europe.

Soviet reserves of natural graphite, distributed throughout the country from the Ukraine to the Far East, totaled more than 1 billion tons as of January 1939. The largest reserves occur in East Siberia—the Igarka and Noginsk deposits in Krasnoyarskiy Kray and the Botogol'sk deposit in the Buryatskaya A.S.S.R. Other deposits are found at Zaval'ye in the Ukraine, at Tas-Kazgan in the Uzbek S.S.R., at Tayga in the Urals, and in the Kazakh S.S.R.

East Siberia is the leading producing area of natural graphite, although the largest combine or individual producer is located at Zaval'ye in the Ukraine. Artificial graphite is produced in the Ukraine at the Zhdanov Graphite Combine in the Donetskaya Oblast'.

e. Industrial diamonds

(1) *Supply position*—Until the mid-1950's, production of industrial diamonds in the U.S.S.R. was negligible, and Soviet industry depended largely on imported diamonds and artificial abrasives for most of its requirements. Since 1957, however, the production of natural diamonds has increased markedly, reaching an estimated annual output of about 6 million carats in 1968. Some 80% to 90% of these diamonds are industrial quality stones and the remainder are of gem quality. Of even greater significance for the Soviet supply of industrial diamonds has been the recent development and mastery of new technology for the manufacture of synthetic diamonds. The Soviets claim that synthetic diamonds now supply over 76% of their total requirements for industrial diamonds. Based on the estimated level of current consumption, Soviet production is on the order of 12 to 15 million carats annually, probably making the U.S.S.R. the world's largest producer of synthetic diamonds. With this remarkable improvement in its supply position, the U.S.S.R. has been able to offer industrial diamonds and industrial diamond tools for export. There is, however, a continuing shortage of large industrial stones, particularly those used in drilling. Domestic production of natural industrial stones of this type has been inadequate to satisfy Soviet requirements. Moreover, Soviet synthetic diamond technology, at present, is limited to the production of bort and small stones.

(2) *Resources*—One of the major gaps in the mineral wealth of U.S.S.R. until the 1950's was industrial diamonds. As recently as the mid-1950's, the only known deposits in the U.S.S.R. were a number of small placers located in the Urals, from which insignificant quantities of industrial and gem diamonds were extracted.

After World War II, the U.S.S.R. intensified its search for diamonds particularly in Siberia where geologists believed that geological conditions were such that diamonds might be present. Discoveries of small placer deposits along the banks of streams in the Yakutskaya A.S.S.R. were encouraging, but it was not until 1954 that the first lode deposits, the Zarnitsa, was discovered in this area. Later discoveries have included nearly a hundred lode deposits of which three, the Mir, the Udachnaya, and the Aikhal, have been judged rich enough to justify large-scale exploitation.

Exploitation of the Mir, the first lode deposit to be developed, began in 1957. A town for about 20,000 people was built near the deposit and several processing plants were erected. Production from this deposit has been increasing each year since 1957 and it is now the largest single source of diamonds in the U.S.S.R.

Development of the Aikhal lode deposit began in 1960 and output of diamonds on a small scale was achieved in 1961. Although development of this deposit is considerably behind that of the Mir due to its later discovery and remote location, production eventually is expected to exceed that of the Mir.

Development of the Udachnaya, which is located north of the Arctic circle over 1,000 kilometers from the nearest river port, presents an even greater problem in logistics than either the Mir or the Aikhal. This deposit has been placed third in priority for development and probably will not be producing at capacity before 1970 although one large concentrating factory was put into operation in 1966.

f. MICA—Despite abundant reserves of phlogopite mica and adequate reserves of muscovite mica and the increasing scale of production of both, the U.S.S.R. is believed to be short in mica, at least that of high (block) quality.[12] Production of crude mica is estimated to have been about 35,000 tons in 1968. Probably no more than 10% of the crude output after processing results in the high quality block mica that can be used in electrical insulation.

To meet its shortage in block mica the U.S.S.R. has emphasized the production of synthetic mica. Considerable progress has been made and synthetic mica is being used extensively for many electrical purposes. In addition, the U.S.S.R. continues to import high quality mica for special applications. Imports were more than 1,100 tons in both 1959 and 1960 with Communist China the main supplier. In 1967 and 1968 imports amounted to 155,000 tons and 160,000 tons, respectively. These imports, also consisting of high quality mica, were obtained from India, the sole supplier of this commodity to the U.S.S.R. since 1962.

East Siberia—primarily the Yakutskaya A.S.S.R. and Irkutskaya Oblast'—holds first place in the U.S.S.R. in the mining of both muscovite and phlogopite, and is reported to produce nearly all of the high grade mica used by the electrical industry. The Yakutskaya A.S.S.R., represented mainly by the Aldan Mica Combine, produces about 90% of the total Soviet output of phlogopite, and Irkutskaya Oblast', represented mainly by the Mama Mica Combine, produces about 75% of the total Soviet output of muscovite. Most of the rest of the Soviet output of phlogopite probably is produced at Slyudyanka; and most of the rest of the Soviet output of muscovite probably is produced in the Karelian A.S.S.R.

[12] Of the nine varieties of mica, only five—muscovite, phlogopite, vermiculite, biotite, and lepidolite—are widely used in industry. Of these five, only certain grades of muscovite and phlogopite block mica are considered strategic.

g. MINERAL FERTILIZER RAW MATERIALS

(1) *Supply position*—The U.S.S.R. does not produce enough fertilizer for domestic requirements and has drawn up and embarked upon plans for a tremendous increase in fertilizer output. The expansion of the fertilizer industry may correct the present imbalance between mineral fertilizer raw material output, which has been large enough to permit the exportation of sizable quantities of apatite ore and concentrates and of potassium salts, and the output of chemical fertilizers which has not been sufficient to meet the needs of Soviet agriculture. Soviet exports of mineral fertilizer raw materials during 1960-68 are shown in Figure 21.

The U.S.S.R. possesses vast reserves of phosphate and potash mineral fertilizer raw materials which could satisfy a much higher level of agricultural requirements than at present and provide for the continuance of large exports for many years. A major problem for the Soviet mineral fertilizer industry is that the better reserves, particularly phosphate, are located at great distances from major fertilizer-consuming areas. To date the U.S.S.R. has tended to concentrate on the exploitation of the better, but remote, deposits, but because of the long transportation hauls, exploitation of such reserves has been expensive.

(2) *Resources*

(a) PHOSPHATE—Soviet reserves of phosphate are estimated to be about 5.4 billion tons, made up of about equal shares of phosphorites and apatite. Deposits of phosphorites are located principally in the Kazakh S.S.R. in the Kara-Tau (44°18'N., 52°00'E.) region at Czhambul'skaya Oblast' and in the Leningrad and Moscow Oblast's. More than 80% of the apatite reserves occur in the Khibiny (67°45'N., 33°45'E.) deposits of the Kola Peninsula. Of particular concern to the Soviet mineral fertilizer industry is failure thus far to discover economic phosphate reserves in the Ukrainian S.S.R., the Caucasus, the Volga region, Central Asia, and the Far East, where an important share of the total Soviet requirements for phosphate fertilizer originates.

(b) POTASH—The U.S.S.R. has large reserves of potash amounting to about 20 billion tons. About three-quarters of the Soviet reserves are located in the

FIGURE 21. EXPORTS OF MINERAL FERTILIZER RAW MATERIALS 25X1
(*Thousands of metric tons*)

	APATITE ORE	APATITE CONCENTRATE	POTASSIUM SALTS
1960	121.4	1,805.6	628.9
1961	166.8	2,053.3	761.6
1962	142.9	2,242.1	877.7
1963	81.4	2,222.1	992.2
1964	64.9	2,989.5	754.2
1965	81.6	3,493.1	825.5
1966	78.8	4,280.5	1,089.2
1967	90.4	4,509.6	1,365.3
1968	60.5	5,107.5	1,721.5

Urals, in the Verkhnekamsk deposit area of Permskaya Oblast'. Other important deposits of potash are found in the Belorussian S.S.R. (Starobin—52°44'N., 27°28'E.—deposits now called Soligorsk) and the Ukraine (Stebnyk—49°18'N., 23°24'E.—and Kalush—49°01'N., 24°22'E.). Smaller deposits are located in the Kazakh S.S.R. and the Turkmen S.S.R.

(3) *Production and producing facilities*

(a) PHOSPHATE—Soviet production of phosphate amounted to 36.2 million tons in 1967, including 21.2 million tons of apatite ore and 15 million tons of phosphorite rock. The Apatite Combine on the Kola Peninsula accounts for virtually all of the Soviet output of apatite ore and concentrates. The combine consists of four mines and two beneficiation plants with an annual capacity of 9.5 million tons of concentrate. The principal producer of phosphorities is the Kara-Tau Mining and Concentrating Combine in the Kazakh S.S.R. Next in importance is the Kingisepp combine in the Leningrad Oblast'. A third important producing area is in the Moscow Oblast'.

(b) POTASH—The U.S.S.R. produced about 4 million tons of potash of K_2O equivalent in 1968. Nearly half of the total output probably was accounted for by the traditionally important producers in the Urals, the Solikamsk and Berezniki combines, both located in the Permskaya Oblast'. The newly developed Soligorsk Combine in the Belorussian S.S.R. accounted for 1.6 million tons of total production in 1968. Two other significant producers are the Stebnyk and Kalush combines in the Ukrainian S.S.R. New facilities are being constructed in the industry, particularly at the Soligorsk and Berezniki combines, to enable the U.S.S.R. to increase production of potash to 5 million tons by 1970.

h. QUARTZ CRYSTALS—Despite reportedly large deposits of high grade (piezoquartz) quartz crystals, the U.S.S.R. is believed to be short in this important electronic material. The largest deposits of piezoquartz in the U.S.S.R. are located in East Siberia (Yakutskaya A.S.S.R.), in the Urals, in Central Asia (Pamirs), and in the Kazakh S.S.R. Little is known about Soviet production but exploitation of domestic deposits apparently does not fully satisfy growing demand for quartz crystals which are used for the manufacture of piezoelectric units primarily in the form of oscillator plates for frequency control but also in the form of filter plates, telephone resonator plates, transducer crystals, and other items.

To meet its requirements for quartz crystals, the U.S.S.R. imported large quantities of piezoquartz, approximately 392 tons during the 1950's and early 1960's, principally from Communist China. More recently the only known imports of quartz crystals have been those obtained from France. During 1964-66 France supplied the U.S.S.R. with 5.2 tons of piezoquartz and 14.2 tons of optical quartz. Shipments of optical quartz reportedly were to continue through 1969, according to a French-Soviet trade agreement signed in 1965. If obtained in crystalline form, the optical quartz could be diverted to electronic use. The U.S.S.R. also has mastered the production of synthetic quartz crystals and is making increasing use of them to satisfy its requirements.

FIGURE 22. TRADE IN SULFUR 25X1
(Thousands of metric tons)

	IMPORTS	EXPORTS
1960	50.3	113.8
1961	44.5	218.1
1962	32.1	169.1
1963	85.1	103.7
1964	145.8	147.1
1965	25.2	154.2
1966	27.3	219.5
1967	46.5	281.6
1968	9.4	291.2

i. SULFUR

(1) *Supply position*—Although the U.S.S.R. currently does not produce enough sulfur to meet growing domestic requirements, it has been a net exporter of elemental sulfur, as well as of pyrites and sulfuric acid, for a number of years. For Soviet trade in elemental sulfur in 1960-68, see Figure 22.

Production of sulfur from all sources in the U.S.S.R. in 1968 is estimated to have been equivalent to about 4.2 million tons compared to about 3.5 million tons in 1965 and 2.2 million tons in 1960. Production during 1959-65 is believed to have fallen short of planned levels. About 80% of the sulfur is consumed in the production of sulfuric acid.

Of the total Soviet output of sulfur in 1968, approximately 45% was obtained from pyrites, 27% from waste gases, and 28% from mined native sulfur. Plans for future growth in production are based, in large part, on programs for increasing byproduct recovery of sulfur from waste gases at metallurgical combines, petroleum refineries, and coke-chemical combines.

(2) *Resources and producing facilities*—The U.S.S.R. possesses virtually inexhaustible reserves of sulfur-bearing raw materials. Reserves of native sulfur are claimed by the U.S.S.R. to be the largest in the world, and pyrites and other sulfide ores and sulfurous industrial wastes are available in large quantities.

(a) NATIVE SULFUR—Native sulfur deposits in the U.S.S.R., unlike those of the Gulf of Mexico, are low quality. More than 75% of the reserves are in large sedimentary deposits in the Ukrainian S.S.R. such as the Rozdol (49°28'N., 24°04'E.). The Turkmen S.S.R. with such large deposits as Gaurdak (37°50'N., 66°04'E.), Sernyy Zavod (39°59'N., 58°50'E.), and Darvaza (40°11'N., 58°24'E.) probably holds second place in Soviet native sulfur reserves. Other noteworthy sedimentary deposits of native sulfur are located in Kuybyshevskaya Oblast', R.S.F.S.R., at Alekseyevka and Vodino (53°22'N., 50°26'E.); in Central Asia in the Uzbek S.S.R. at Shor-su (40°16'N., 70°48'E.); and in the Kirgiz S.S.R. at Changyrtash (40°52'N., 72°50'E.).

Total Soviet output of native sulfur in 1968 is estimated to have been about 1.2 million tons. The largest quantities of native sulfur are believed to be mined at the Rozdol and Gaurdak deposits, both of which were extensively developed during the Seven Year Plan.

(b) PYRITES—Pyrites constitute the largest reserve of sulfur in the U.S.S.R. Deposits of pyrite in the form

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of iron disulfide are located mainly in the Urals, primarily in Sverdlovskaya and Chelyabinskaya Oblast's; in the Kazakh and Kirgiz S.S.R.'s; and in the Transcaucasus, the Urals, Vostochno-Kazakhstanskaya Oblast', West and East Siberia, and Primorskiy Kray. Pyrites also commonly occur in Soviet coalfields.

The Soviet output of sulfur from pyrites in 1968 is estimated to have been about 1.7 million tons. Most of the output of pyrites is recovered as a byproduct during the processing of complex polymetallic ores and coal. The iron disulfide pyrite reserves in the Urals are not mined. The copper pyrites of the Urals, however, which are mined primarily for their copper content, are the source of a large percentage of annual Soviet output of pyrite concentrates. Pyrite concentrate is recovered also as a flotation residue in several Soviet lead enterprises. Pyrites also are extracted from coal in the Moscow Basin.

(c) WASTE GASES AND OTHER SOURCES—A variety of miscellaneous sources supplement the reserves of native sulfur and pyrites. Waste gases from copper, lead, zinc, petroleum, and coke-chemical enterprises are excellent sources of sulfur. Total recovery from such sources is estimated to have been about 1.2 million tons in 1968. Other sources available such as gypsum apparently are not exploited for sulfur at present.

D. Construction materials

1. General

The construction materials industry of the U.S.S.R., a large, countrywide complex of more than 5,000 major and about 15,000 minor or auxiliary installations employing about 2 million people, has made steady progress in expanding production in recent years. From 1960 through 1968, its annual rate of growth, based on the Soviet index of the gross value of output for construction materials, averaged 9%, ranging narrowly between 8% and 11%. The expansion of output has enabled the U.S.S.R. to rank as a leading world producer of cement, prefabricated reinforced concrete, and other basic construction materials. In spite of this steady increase in production, however, the industry has failed to keep pace with growing requirements for construction materials, as evidenced by sporadic shortages of such products as cement, reinforced concrete, brick, tile, soft roofing materials, and window glass.

Part of the reason for the failure of the construction materials industry to meet all of the requirements levied upon it may be found in the lagging rate of investment during the 1960's. Annual investment in the industry had increased sharply from 627 million rubles in 1958 to 997 million rubles in 1960, but in subsequent years the annual outlays dropped off to 841 million rubles by 1964 before staging a gradual recovery to 975 million rubles in 1967. In contrast, total industrial investment increased at an average annual rate of 6.4% from 1960 through 1967. Indicative of the decline in the relative importance of investment in the construction materials industry is the fact that it accounted for 7% of total industrial investment during 1960-63 but only 5% of the total during 1964-67. The industry also has been hampered by inefficient use of available investment funds, as evidenced by delays in completing new facilities. Moreover, new facilities, once they are completed, often require long break-in periods and, in some cases, have yet to attain designed capacities.

Some difficulties have been encountered by the construction materials industry in adapting to the current transition in the Soviet construction industry from conventional methods to quick assembly techniques using large standardized factory-prefabricated sections and light materials. The industry, for example, has steadily increased its aggregate production of precast reinforced concrete, but the assortment of products has not always been adequate to meet domestic needs. Frequently plants have favored production of large, heavy wall panels in order to meet assigned tonnage goals and, as a result, have tended to neglect production of the various other types and sizes needed in Soviet construction.

The quality of some construction materials also has been criticized and there have been complaints that failure to keep equipment in good repair has accounted for production shortfalls in many construction materials plants. The industry is devoting attention to these problems by allocating a large share of available investment funds to programs for the reequipment and modernization of existing plants. Probably the most notable gains in raising the technical level of the industry, however, stem from the construction of large, modern plants which compare favorably with those in other industrialized countries with respect to mechanization and automation. Most of the equipment for these plants is produced domestically although some is purchased abroad.

25X1

Resources of raw materials are capable of supporting great expansion of the construction materials industry. Most of the proven reserves of raw materials occur in the European part of the U.S.S.R. Other large deposits are located in the Urals, Volga, North Caucasus, the Kazakh S.S.R., Central Asia, Western Siberia, and Eastern Siberia. Potential reserves appear to be enormous in most parts of the country.

The chief national administrative authorities controlling production of construction materials are the State Committee for Construction of the Council of Ministers of the U.S.S.R. (*Gosudarstvennyy Komitet po delam Stroitel'stva Soveta Ministrov SSR*—GOSTROY S.S.S.R.) and the Ministry of Construction Materials Industry of the U.S.S.R., both in Moscow. Regional jurisdictions are vested in the Councils of Ministers of Soviet Republics and in the ministries of the construction materials industry in the capitals of the republics. Appropriate branches are found in oblasts, krays, or autonomous administrative centers. Some construction materials plants, most of them small, are administered by other authorities. The Ministry for Local Industry and the Ministry of Agriculture direct some operations where industrial byproducts are used in the production of construction materials. Local administrative, cooperative, or kolkhoz organizations direct production of small quantities of locally used construction materials such as brick, lime, and cement.

The construction materials industry operates a network of branch scientific research and design institutes employing about 30,000 people, some of whom are eminent scientists and specialists. Many of the institutes maintain design bureaus and their own experimental plants.

2. Cement

The U.S.S.R. is the world's leading producer of cement. Production has been increasing each year, although at an irregular rate, as shown by the following, in millions of metric tons:

1960..........	45.5
1965..........	72.3
1966..........	80.0
1967..........	84.8
1968..........	87.5
1970..........	100.0 (planned)

In spite of increased production each year and the elimination of a general shortage, there are sporadic shortages of cement at some construction sites because of delays or losses in transit, or from excessive use or waste at these sites. In 1968 such shortages totaled about 5 million tons, or nearly 6% of national production for the year.

Another factor which may help account for inadequate shipments of cement to construction sites is the increasing demand on available supplies by export customers. As recently as 1963 the U.S.S.R. was a net importer of cement, but since then exports have increased steadily and imports have been reduced sharply, as shown by the following, in millions of tons:

	Exports	Imports
1962......	0.5	1.6
1963......	1.1	1.4
1964......	1.4	0.3
1965......	2.0	0.1
1966......	2.2	0.3
1967......	2.3	0.3
1968......	2.6	0.3

Cement is produced in 98 plants of which 41 have capacities of one million tons or more. Figure 38 shows location of plants; Figure 34 describes the plants. About 90% of the cement is produced by the wet process, and the remainder by the dry process. Plant equipment is generally of Soviet manufacture. Wet process equipment includes large horizontal rotary kilns of 3.6 x 150 meters, 4 x 150 meters, 4.5 x 170 meters, and 5 x 185 meters with annual designed capacities of 300,000, 350,000, 450,000, and 600,000 tons, respectively. Modern rotary kilns, 4 x 60 meters, with 300,000-ton annual designed capacities, are used in the dry process. Difficulties have been encountered, however, in attaining designed capacities at many plants. Along with modern kilns, numerous plants employ older, less economical rotary kilns of foreign and domestic manufacture which still account for about 30% of total output. This percentage will continue to be reduced, however, as more large, modern kilns are put into operation. Most kilns now being installed are the 5 x 185 meters size. The design for a huge 7 x 232 meter rotary kiln with an annual designed capacity of 1,000,000 tons has been completed, and an experimental kiln of this size is under construction at Balakleya (Map Reference No. 31). If testing proves the design successful, construction of kilns of this size should occur after 1970.

The newer Soviet cement plants are mechanized and have automatic controls on much of the equipment, including two-way feed rotary kilns, slime concentrators at kilns, conveyor and hydraulic transport systems for bulk handling of raw materials, and electric cement dust filters. Electronic computers, closed circuit television, and automatic quantitative analyzers of chemical composition of raw materials are being installed in pilot projects.

Production is largely concentrated in highly developed economic regions where the cement consumption is highest. The most outstanding of these are the Donets-Dnepr region in the Ukraine, the central region, which includes the Moscow area, and the Volga and the Urals regions. Annual cement production in each of these regions now ranges from 8 to 9.7 million tons. Notwithstanding this degree of concentration, significant changes have taken place in the geographic distribution of cement production in the 1960's. Cement is now produced in all of the union republics and relatively large increases in production have been achieved in Central Asia, West Siberia, the northwest region of the R.S.F.S.R., the southern region of the Ukrainian S.S.R., and the Moldavian S.S.R. Regional self-sufficiency has been increased and the average distance for transport of cement to consumers has been reduced. Figure 38 shows significant groupings of cement production, most of them in areas with readily workable raw materials.

Raw materials are adequate for a continuing expansion of production of cement. Total proven reserves of limestone, chalk, and marl, the principal carbonate rocks used in cement manufacture, are about 15 billion tons, most of which are concentrated west of the Ural Mountains. Extensive deposits of limestone, the most extensively used rock, occur in the basin of the Don River, in the Moscow area, and on the west slopes of the Urals. Other limestone deposits are in the Crimean Peninsula, along the middle reaches of the Volga River, in the Kursk area, and in the Moldavian S.S.R. Chalk deposits occur mainly in the Volga and Central Economic Regions of the R.S.F.S.R. and in the Ukrainian S.S.R. Beds of high quality marl occur in the Khrebet Varada in the northern Caucasus, and in the Donetskaya and Voronezhskaya Oblast's, but they are in part dolomitic, and the beds are commonly thinner.

Extensive use is made of slag from metallurgical industries. Cement plants have been built near metallurgical plants or designed as parts of industrial combines at Lipetsk, Dneprodzerzhinsk, Dnepropetrovsk, Krivoy Rog, Rustavi, Nizhniy Tagil, Magnitogorsk, Karaganda, Novokuznetsk, and elsewhere to make use of industrial slag.

The principal types of cement produced in the U.S.S.R. are ordinary portland, slag-portland, and portland-pozzolan. Production of ordinary portland cement increased steadily from 20.3 million tons in 1960 to 49.1 million tons in 1965, and reached 53.5 million tons in 1967. Production of slag-portland cement increased only marginally from 16.6 million tons in 1960 to 18.2 million tons in 1965, but probably increased substantially by 1967. Production of portland-pozzolan declined from 7.8 million tons in 1960 to 3.9 million tons in 1965 and the trend in production since 1965 is not known. The U.S.S.R. also produces rapid-hardening, sulfate-resistant, plasticized portland, hydrophobic, colored, and other special purpose cements. Special cements accounted for 1.5% of total production of cement in 1965.

Official Soviet data available through 1965 indicate that the average grade of cement has been increased gradually from year to year. The grades of cement are expressed by the crushing strength of fully set cement in kilograms per square centimeter (using 1962 standards):

	Portland	Slag-portland	Portland-pozzolan
1959	474	354	427
1960	482	363	434
1961	496	373	436
1962	487	388	446
1963	497	398	459
1964	505	415	457
1965	508	415	456

Although the average grade of ordinary portland cement was only 508 in 1965, grades as high as 900 have been produced for special purposes.

The All-Union State Scientific Research and Planning Institute (Giprotsement), the Scientific Research Institute of Cement Machinery (NIITsemmash), and other large institutes have important roles in the development of the industry. Standards for the various types of cement are issued by the All-Union State Scientific Research (NIITsement) under the GOSSTROY S.S.S.R. and were most recently revised in 1967.

3. Concrete products

The U.S.S.R. is the world's leading producer of precast concrete products. They are the basic materials for most modern construction in that country, being used widely in industrial, urban, transport, and hydrotechnical facilities, as well as airfields and numerous other civil and military structures. Precast concrete is particularly well adapted to the mass construction now underway since it reduces construction time and amounts of steel needed. Precast concrete is used in wall blocks, and, when reinforced, for panels, pipe, and other elements related to housing and industrial construction. Reinforced concrete that is prestressed is used for pillars, beams, girders, spans, trestles, and elements for arch bridges. After considerable experimentation, the U.S.S.R. has started to use prefabricated, room-size modules in construction of low-cost apartments.

Production of precast concrete amounted to 82.0 million cubic meters in 1968, about 2.5 times more than in 1960. The goal of 90.0 million cubic meters for 1970 is likely to be attained. Of the total output of precast concrete in 1968 reinforced concrete accounted for about 90%. Production of prestressed reinforced concrete, however, has lagged behind schedule. The plan for 1970 calls for production of 27.0 million cubic meters, but output in 1968 was 16.0 million cubic meters, an increase of only 6.0 million cubic meters since 1965.

Production of precast reinforced concrete wall panels has increased rapidly as shown by the following, in millions of square meters:

1960	5.5
1965	33.9
1966	40.5
1967	45.7
1968	47.9

This substantial increase has helped support the extensive housing program in the U.S.S.R. Large panels are produced by 200 plants and 80 housebuilding combines. Sixty-one additional enterprises were under construction in 1966-67. The production of wall panels of lightweight cellular concrete for industrial construction has lagged, however. Large precast concrete silicate wall blocks that are not reinforced and other wall blocks of stone and concrete continue to be used in housing and industrial construction, but production of these materials has increased relatively slowly in recent years, as shown by the following, in millions of standard brick:

	1960	1965	1966	1967	1968
Large concrete and silicate wall blocks	1,311	1,514	1,736	1,965	1,757
Small wall blocks	2,917	1,937	2,168	2,352	2,395
Wall blocks of natural stone	4,666	4,495	4,747	4,907	5,215
Wall blocks of cellular concrete	16	113	115	191	261

The precast concrete industry employs 650,000 persons or about one-third of the total work force in the construction materials industry. About 2,400 plants are engaged in year-round operations and they produce 95% of all precast concrete and reinforced concrete products. The remaining production is accounted for by more than 3,000 small seasonal open yards. The major plants of the industry include 100 large plants with annual capacities of more than 100,000 cubic meters and about 250 plants with capacities of 50,000 to 100,000 cubic meters. More than 1,500 plants have capacities of less than 20,000 cubic meters. Most of the major plants of the industry are well equipped and highly mechanized and usually are located near large cities or construction sites, primarily in the European U.S.S.R. The locations of the major reinforced concrete plants are shown on Figure 38.

In order to save cement and reinforcing steel and to reduce the weight of concrete structures, various departures have been made from the use of standard concrete with normal rock aggregate. Various types of lightweight porous or cellular concrete are used for structural elements in which maximum strength is not required. Low specific weight is also achieved by the use of a variety of low-density aggregates such as "keramzit," a porous clay filler; "termozit," a slag pumice; perlite; and natural low-density rocks such as pumice and porous volcanic tuffs. Reinforcing agents other than steel, such as glass fiber, bamboo, and reeds, have been used with varying success. Another material which has been used in the production of bricks and panels is silicalcite or silica concrete. It is made by combining 70% to 80% quartz sand with 30% to 20% unslaked lime and curing under a pressure of 8 to 10 atmospheres.

The U.S.S.R. is a leading producer of asbestos cement products. Most of the manufacturing facilities are either combined with, or located close to, major cement plants. Major plants are located at Asbest, Vol'sk, Voskresensk, Kiev, Kramatorsk, Novorossiysk, and Sukhoy Log. The principal products are pipe, roofing tile, and wall sheet.

Asbestos cement pipe, used for water and sewage lines, is manufactured with inside diameters of 10 to 60 centimeters. Production of pipe with an average inside diameter of 20 centimeters increased from 18,700 kilometers in 1960 to 43,500 kilometers in 1968. By 1970 production is to increase to 62,000 kilometers.

In recent years an increasingly large share of the production of asbestos cement roofing tile and wall sheets has been in the form of large panels of 175 centimeters up to 250 centimeters in length. Production of these large panels is to reach 3 billion standard units (40 x 40 cm.) in 1970 or nearly half of the total planned output. Recent production of asbestos-cement roofing tiles and wall sheets, expressed in billions of standard units, follows:

1960........	3.0
1965........	4.2
1966........	4.5
1967........	4.9
1968........	5.8
1970........	6.5 (planned)

Reserves of high-grade asbestos are among the largest in the world and are adequate to supply the cement industry requirements. The principal deposits are chrysotile asbestos in the Ural Mountains in the areas around Asbest, Chelyabinsk, and Orenburg. Other large reserves have been discovered recently in Kazakhstan near Kustanay, and in East Siberia near Lake Baikal.

4. Construction glass

The U.S.S.R. is the world's leading producer of window glass. Production has increased steadily during the 1960's, but even larger increases will be required if the goal for 1970 is to be attained. Production in millions of square meters follows:

1960..........	147.2
1965..........	190.3
1966..........	200.7
1967..........	204.9
1968..........	214.0
1970..........	243.0 (planned)

Production of various types of construction glass has been increased, including plate glass, laminated safety glass, glass tile, blocks, brick, pipe, fiber, wool, and foam. Other types of products have been developed, such as large stained glass panels called "stemalit," colored mosaic tiles used widely for facing buildings, heat and sound insulating glass, and glass panels used in making doors, shop windows, and monitor roofs. A new type of profile glass called "stekloprofilit" is used as a translucent wall material in the construction of public and industrial buildings. A wide range of technical glass also has been developed for laboratory and household use as well as for industry and transportation.

Glass production has been increased by the construction of new plants in recent years in Saratov, Lisichansk, Konstantinovka, Salavat, Sumgait, Anzher-Sudzhensk, Ulan-Ude, Ashkhabad, and Raychikhinsk. In all, there are about 130 glass plants, about 40 of which specialize in production of construction and technical glass. Eastern regions have been favored in recent construction activity, helping provide a more balanced geographic distribution of production. Another large plant, under construction in Tokmak east of Frunze, is to be completed in 1970. Its planned annual capacity of 12 million square meters of window glass is intended to help meet the requirements of Soviet Central Asia. At present, however, it is still necessary to ship glass products long distances to the Asian U.S.S.R. Glass plants of the industry are located on Figure 39, and described in Figure 35.

Glass production also has been increased in recent years by the intensification of manufacturing operations and reequipping of existing facilities of the industry. Extensive mechanization and automation of basic production processes, cutting, packaging, and transportation of glass have been carried out. At numerous glassworks, mechanized shops for the preparation of sintering mixture have been built and equipped with facilities for flotation, electromagnetic and air separation, grinding, drying, and mixing of raw materials. Loading of sintering mixtures into furnaces has been mechanized. Many melting furnaces have been reconstructed and enlarged, increasing the overall hearth area by more than 55% since 1960. In addition, significant economies in fuel costs as well as improvements in operating efficiency were achieved by the conversion of many plants to natural gas and liquid fuels in place of traditional fuels such as coal, peat, firewood and various mixed fuels.

The glass industry, an employer of about 200,000 workers, has experienced several difficulties, however, which help account for the failure to expand production at planned rates. Delays in the delivery and installation of new equipment have set back schedules for activation of new facilities. The relatively short life of refractory linings in furnaces has resulted in considerable downtime for repairs and relinings. Probably the greatest single difficulty is encountered in the raw materials sector of the industry. The quarries do not have enough modern equipment and, in many cases, lack beneficiation plants because construction of such plants has lagged. Raw sand is delivered unwashed and ungraded, containing at least 15% of impurities, which must be discarded at glass plants as waste. Much of the raw material consumed in the Asian U.S.S.R. is transported long distances, although sulfates and borates necessary for glass manufacture are abundant in the Aral and Caspian Sea regions. Raw materials, including their transportation, account for about 35% of the total cost of construction glass in the U.S.S.R.

Another problem of the glass industry has been that of breakage. A large amount of breakage occurs in transit due in part to poor packaging. Breakage also occurs at construction sites in cutting and trimming operations made necessary by the fact glass often is not delivered in the sizes needed for window openings.

The architectural trend toward the use of larger window areas has made it necessary for the glass industry to produce thicker glass. The share of 2.5-mm and 3.0-mm glass in total production has increased markedly in recent years as the share of 2.0-mm glass declined. Only slight progress has been made, however, in improving the quality of glass. Grade I glass accounted for 76% of the total in 1965, only 6.5% above the corresponding percentage in 1958. Production difficulties at some of the newer glass plants have slowed the planned pace for improving the quality of glass.

Considerable emphasis is being placed on development of new glass materials and new uses for glass in construction. Extensive work has been done in recent years to develop technology for production of construction glass from "sitall," a crystallized glass made from conventional glass materials, metallurgical slag, and certain volcanic rocks. The new material reportedly is noncorrosive, lighter than aluminum, and harder than steel, but industrial-scale production has not been achieved. In addition, research is conducted to improve existing methods of production in the glass industry. Of particular importance has been the work on new drawing methods and automatic controls for the production of sheet glass. Efforts also have been made to improve technology for the production of profile glass.

Known reserves of glass sand, most of them in the European U.S.S.R., are adequate to supply an expanding industry, but some of the operating quarries, such as the Novoselovskiy and Lyubertsy, are being depleted rapidly and development of new quarries has been delayed by inadequate allocation of funds and equipment. A serious shortage of raw materials may result in the 1970's if other deposits are not developed. The most significant quarrying operations are conducted at Lyubertsy near Moscow, at Avdeyevka near Donetsk, at Novaya Ladoga east of Leningrad, in the Kalinin and Ul'yanovsk areas, and at Novoselovskiy in the Khar'kov area. Pegmatite deposits are quarried west of Lake Onega and kaolins in the Dnepropetrovsk and Vinnitsa areas in the Ukraine.

5. Brick, tile, and ceramic pipe

Annual production of brick remained fairly constant during 1960-64, averaging nearly 36 billion standard bricks per year, but has increased gradually since then, reaching 40 billion bricks in 1968. Soviet policy favors the use of other materials, notably precast concrete, in wall construction but in 1967-68 bricks still accounted for nearly two-thirds of wall construction, a far higher proportion than the 35% goal which had been set for 1965.

The U.S.S.R. produces red brick, silicate brick, and brick blocks made of slag and other industrial byproducts. Silicate brick is made from a mixture of quartz sand or ground siliceous materials and slaked lime. The standard size of red brick and silicate brick in the U.S.S.R. is 25 x 12 x 6.5 centimeters; compressive strength is 50, 75, 100, 125, or 150 kilograms per square centimeter, according to the grade. In 1967, red bricks accounted for 76% of the total output of bricks, and silicate bricks the remainder. Production of silicate bricks has been increasing at a somewhat faster rate than red bricks since 1960, however.

There are several thousand red brick plants in the country, but many of them are small or operate only seasonally. In brickmaking, as in other branches of the construction materials industries, however, the trend is toward the establishment of large, well-equipped, mechanized plants. In recent years most large brick plants were reconstructed and reequipped and a number of new plants were built. Most of the modern plants have annual capacities of at least 50 million standard bricks. The silicate brick industry is relatively new and generally better equipped than the red brick industry. There are 103 brickworks producing silicate brick. Production is largely concentrated at plants with annual capacities of 80 to 300 million standard bricks each. Major red brick and silicate brick plant locations are shown on Figure 40. About four-fifths of all brick production is accounted for by the European part of the U.S.S.R.

Types of tile produced include roof, wall, and floor tiles. Tiles are generally one of several products of a ceramic plant, but some large plants produce only tile. Production of wall and floor tiles has increased rapidly, from 17 million square meters in 1960 to 32 million in 1968; plans call for production of 38 million in 1970. In contrast, production of ceramic roofing tile, which is being partially supplanted by asbestos-cement shingles and soft roofing materials, decreased from 51.5 million square meters for the peak year 1961 to 28.8 million in 1964 and to 16.3 million in 1968.

Increased production of wall and floor tiles has been made possible largely by the recent construction of new plants near Moscow, in Leningrad, Voronezh, Kuybyshev, and Volgograd; in the Ukraine near Kiev, Khar'kov, Poltava, L'vov, and Slavyansk; as well as in Tbilisi, Baku, Sverdlovsk, Novosibirsk, and Irkutsk. New production equipment at large plants includes a number of special large drying-glazing conveyors, with an annual capacity of 150,000 square meters of tile each. This equipment has changed production technology, shortened the production cycle, and improved the end product.

Production of ceramic sewer pipe has not been adequate to meet construction needs. Production increased from 8,700 kilometers in 1960 to 11,300 kilometers in 1967 and a further increase to 14,000 kilometers in 1970 is planned.

The refractories industry produces chamotte (refractory clay) brick, Dinas (high-silica) brick, magnesite and chrome-magnesite brick, and metallurgical magnesite powder in quantities adequate to meet the needs of industry. Total annual production of refractory products increased from 7.7 million tons in 1960 to 9.5 million tons in 1967. The industry is producing high-alumina refractory cement with admixtures of magnesite and chromite for experimental use in place of refractory brick.

Deposits of argillaceous raw materials suitable for common brick and tile are widespread, and reserves are practically unlimited. Refractory raw materials are less widespread, but reserves are adequate to supply an expanding industry.

6. Lime

The U.S.S.R. is the world's leading lime producer, with a total production of 20.7 million tons in 1968, of which about 40% was used in construction. The planned output of lime in 1970 is 23 million tons.

Lime is produced at several hundred plants, but the majority have annual capacities of only 2,000 to 10,000 tons each per year. These plants are dispersed throughout the country and usually are attached to cement, metallurgical, chemical, silicate brick, and other plants. The large, highly mechanized plants, not attached to other plants, have annual capacities ranging from 100,000 to 300,000 tons each. These important lime plants are located in the Central and Northwest economic regions of the R.S.F.S.R., the North Caucasus, the Urals, and the Ukraine.

There are regional shortages of lime, often necessitating transport of lime over long distances to consumers. Areas in which lime has been in short supply are the Central, Volga, and Urals regions, as well as Siberia and the Far East. These shortages are being gradually reduced by the renovation of old plants and construction of new ones, particularly in the Urals and Siberia.

The development of the lime industry has been neglected, and the industry is technically backward. Radical reorganization of the lime industry, including establishment of a single national administrative authority, is being proposed. Other remedial measures already underway include reconstruction, retooling, and expansion of existing plants and construction of additional large, modern plants.

The U.S.S.R. is well supplied with raw materials for lime production. Large limestone deposits are available in almost all areas of the country. There are particularly large proven reserves of limestone in the European U.S.S.R. and also in certain eastern regions, the Urals, Kazakhstan, and Central Asia.

7. Gypsum and plaster

Production of construction gypsum has increased only gradually in recent years, from 4.4 million tons in 1962 to 4.7 million tons in 1968. The pace of expansion apparently is adequate, however, to keep pace with the growth in domestic needs.

One of the principal uses of gypsum is in plasterboard partitions for light construction and insulation. In 1967 the U.S.S.R. produced 56 million square meters of dry plaster and 31 million square meters of partition panels and insulation plates. Other products of the gypsum industry include gypsum-concrete blocks, technical gypsum, and raw ground gypsum for fertilizer.

The gypsum industry operates about 100 processing plants. Large modern gypsum products plants are located in Moscow, Leningrad, Novomoskovsk near Tula, Minsk, Volgograd, Rostov-na-Donu, and Chelyabinsk. There are older but important plants in the areas of Kuybyshev, Gor'kiy, Perm', and Donetsk. Gypsum processing plants have modern equipment including mining mills for simultaneous grinding and drying operations, gypsum boilers and drying drums for digesting processes, rotary forming machines, and automatic conveyor lines for production of dry plaster. Particularly noteworthy are the 70 conveyor lines at various plants for production of large partition panels; their aggregate annual output is 30 million square meters.

Reserves of gypsum and anhydrite are extensive. They include more than 300 proven deposits. The largest gypsum deposits are located in the northern regions of the European U.S.S.R., the Donets-Dnepr region, the Moscow and Tula area, the Perm' and Orenburg areas of the Urals, and the vicinity of Irkutsk in Eastern Siberia.

8. Stone, sand and gravel, and aggregate

Crushed rock, sand, and gravel are obtained from numerous quarries, but there is a shortage of graded-rock products for aggregate, chiefly because of the small size and low efficiency of most quarrying and crushing installations. Production has steadily increased, however, from 313.5 million cubic meters in 1960 to 432.0 million in 1968.

Much of the aggregate produced in the U.S.S.R. is of low quality because of the low strength of rock and high content of impurities. In order to improve the quality of aggregate as well as expand production, large, highly mechanized quarrying installations are being developed in various parts of the country. Particularly important is the large quarrying installation near Volokolamsk, about 120 kilometers west of Moscow.

To help compensate for deficiencies in the supply of normal rock aggregate and economize on the use of cement and reinforced steel, increasing attention has been given to the development and production of lightweight aggregates.

Reserves of rock for crushing, and of sand and gravel are extensive. Important deposits are found in the Northwest and Southwest regions of the R.S.F.S.R., the Moldavian S.S.R., the North Caucasus, the Urals, Central Asia, West and East Siberia, and the Far East regions. During the 1960's, new deposits of raw materials have been discovered in the Moscow, Gor'kiy, and Arkhangel'sk areas as well as near Krasnoyarsk, Frunze, and Dushanbe.

Natural stone suitable for construction purposes occurs in virtually all of the mountainous regions of the country. Quarrying activity is greatest in the Central European U.S.S.R. and in the Caucasus and the Ural Mountains.

9. Asphalt products

Bituminous sedimentary rocks that yield natural asphalt are generally associated with oilfields in the U.S.S.R. Major deposits occur in the Caucasus, in the Volga-Urals area from Saratov to Perm', on the northeast and east shores of the Caspian Sea near Gur'yev and Krasnovodsk, in the Fergana valley east of Tashkent, and in northern Sakhalin. The middle reaches of the Ob' River contain potential deposits. Several types of deposits are known: (1) fine-grained rocks, generally clay or shale, containing about 50% bitumen; (2) limestone and dolomite containing as much as 25% disseminated bitumen; (3) sandstone containing 3% to 20% disseminated bitumen; and (4) consolidated sand containing, in places, as much as 50% bitumen. The amount of natural asphalt produced is not known, but it is being increasingly supplanted by petroleum asphalt.

The principal uses of asphalt products include road paving, waterproofing, electrical insulation, and roofing. Asphalt concrete, used predominantly for road surfacing, is produced at a number of plants in the Western U.S.S.R., including 16 plants in Moscow and 7 in Leningrad. The production of a tar- or asphalt-impregnated paper, called soft roofing, has increased from 750,000 square meters in 1960 to 1,171,000 in 1968. Planned output in 1970 is 1.8 million square meters.

E. Statistical data

This subsection consists of detailed statistical data in tabular form in general order of reference in text.

FIGURE 23. IMPORTS AND EXPORTS OF PIG IRON

(Thousands of metric tons)

	1960	1961	1962	1963	1964	1965	1966	1967	1968
Imports:									
Finland	0	0	0	0	0	100.2	103.1	98.8	0
Communist China	166.2	107.0	93.7	154.4	150.3	0	0	0	0
North Korea	42.1	27.2	47.3	75.2	45.1	47.7	35.4	55.2	63.4
Subtotal	208.3	134.2	141.0	229.6	195.4	147.9	138.5	154.0	63.4
Exports:									
Communist countries:									
Bulgaria	88.1	99.1	113.5	132.8	132.6	159.0	137.3	157.2	208.3
Cuba	18.8	44.7	47.8	17.9	26.6	32.3	42.2	60.2	45.6
Czechoslovakia	135.6	90.9	185.3	122.1	50.1	86.0	100.7	199.1	399.8
East Germany	663.6	556.4	623.9	660.3	786.8	742.9	670.5	717.3	701.1
Hungary	34.8	35.8	94.8	69.3	70.9	100.5	129.8	160.7	190.3
Mongolia	0.7	0.8	1.0	0.2	0.8	0.6	0.8	0.9	1.0
North Vietnam	3.3	4.3	2.6	4.0	0.2	0.1	0.1	0.1	0.1
Poland	0.5	3.0	0	11.1	234.9	395.9	737.0	699.8	938.2
Romania	4.0	9.8	8.4	90.3	209.1	357.9	342.2	384.3	503.2
Yugoslavia	43.8	36.7	76.2	52.2	122.3	171.9	175.6	160.0	96.7
Subtotal	993.2	881.5	1,153.5	1,160.2	1,634.3	2,047.1	2,336.2	2,539.6	3,084.3
Non-Communist countries:									
Argentina	23.9	12.0	6.0	0	0	102.7	45.7	39.1	70.2
Austria	28.6	17.7	18.5	81.0	120.3	89.0	38.3	41.6	46.7
Belgium	26.3	21.2	39.0	17.0	13.0	7.2	8.9	14.6	13.4
Denmark	40.5	16.8	24.9	24.4	35.5	21.5	27.5	11.1	5.4
India	0	0	0	0	100.0	86.4	8.9	0	0
Italy	158.6	190.5	201.0	229.5	221.7	211.1	220.0	218.7	206.5
Japan	326.4	505.5	263.1	809.4	853.6	771.8	1,192.9	1,287.7	748.6
Sweden	76.1	57.1	56.3	68.8	96.1	94.1	105.8	53.9	83.7
United Arab Republic (Egypt)	19.4	41.8	49.8	21.0	54.2	51.8	18.5	47.4	63.8
United Kingdom	16.5	5.0	54.2	14.6	37.5	25.6	43.7	36.9	8.1
West Germany	63.7	33.9	373.2	36.7	5.1	30.0	30.0	21.1	38.9
Other	26.6	29.4	28.7	38.0	22.2	116.0	304.6	118.8	147.6
Subtotal	806.6	930.9	1,114.7	1,340.4	1,559.2	1,607.2	2,044.8	1,890.9	1,432.9
Total exports*	1,800.8	1,814.0	2,274.2	2,538.2	3,198.4	3,659.1	4,383.7	4,432.1	4,522.1

*Including shipments not identified by country.

25X1

FIGURE 24. FACILITIES AND PRODUCTION AT PLANTS AND COMBINES OF THE FERROUS METALLURGICAL INDUSTRY, 1968

(Production in thousands of metric tons)

	POLITICAL SUBDIVISION ECONOMIC REGION PLANT AND LOCATION*	FACILITIES**	PRODUCTION OF CRUDE STEEL	FINISHED STEEL PRODUCTS
	R.S.F.S.R.:			
	Northwest:			
1.	Cherepovets Metallurgical Plant (Cherepovets, 59°08′N., 37°54′E.).	CB, BF, OH	4,500	Plate, hot- and cold-rolled sheet, bars, and rods.
	Central:			
2.	Elektrostal' Metallurgical Plant Tereosyana (Elektrostal', 55°47′N., 38°28′E.).	OH, E, ESR	500	Structural shapes, bars, sheet, tool steels, titanium sheet, alloy steels, stainless steels, and high temperature materials.
3.	Serp i Molot Metallurgical Plant (Moscow, 55°47′N., 37°35′E.).	OH, E, ESR	1,000	Structural shapes, bars, rods, sheet, hot- and cold-rolled steels, titanium sheet, tinplate, tool steels, bearing steels, alloy and stainless steels, and Armco iron.
	Central Black Earth:			
4.	Novo Lipetsk Metallurgical Plant (Lipetsk, 52°37′N., 39°35′E.).	CB, BF, E, OC	1,800	Hot- and cold-rolled sheet and steels, transformed steels, and alloy steels.
	Volga:			
5.	Krasnyy Oktyabr' Metallurgical Plant (Volgograd, 48°45′N., 44°25′E.).	OH, E, ESR	2,300	Bars, rods, plate, sheet, strip, wire, and alloy and stainless steels.
	North Caucasus:			
6.	Taganrog Metallurgical Plant imeni Andreyev (Taganrog, 47°12′N., 38°56′E.).	OH, E	1,200	Wheels, plate, sheet, strip, seamless and welded tubes, galvanized pipe, alloy pipe, and drill pipe.
	Urals:			
7.	Magnitogorsk Metallurgical Combine (Magnitogorsk, 53°27′N., 59°04′E.).	CB, BF, OH	11,000	Bars, rods, plate, hot- and cold-rolled sheet, steels, strip, skelp, tinplate, and electrical steel.
8.	Chelyabinsk Metallurgical Plant imeni Bakala (Chelyabinsk, 55°10′N., 61°24′E.).	CB, BF, OH, E	3,200	Bars, rods, small sections, hot-rolled sheet; low alloy, alloy, stainless, and tool and bearing steels.
9.	Zlatoust Metallurgical Plant (Zlatoust, 55°10′N., 59°40′E.).	OH, E, ESR	1,200	Bars, rods, sheets, forgings, bearing, alloy, and stainless steels.
10.	Nizhny Tagil Metallurgical Plant imeni Lenin (Nizhny Tagil, 57°55′N., 59°57′E.).	CB, BF, OH, E, OC	4,000	Rails, structural shapes, bars, plate, sheet, and wheels.
11.	Orsk Khalilovo Metallurgical Plant (Novo Troitsk, 51°12′N., 58°20′E.).	CB, BF, OH, BC	1,800	Plate and sheet and heavy sections.
	West Siberia:			
12	Kuznetsk Metallurgical Combine (Novo Kuznetsk, 53°45′N., 87°06′E.).	CB, BF, OH, E	4,000	Structural shapes, rails, bars, rods, plate, sheet, forgings, castings; low alloy, alloy, stainless, and electrical and bearing steels.
13.	West Siberian Metallurgical Plant (10 miles west of Novo Kuznetsk).	CB, BF, OC	*Negl*	Rods and small sections.
	Ukrainian S.S.R.:			
	Donets-Dnepr:			
1.	Zaporozh'ye Metallurgical Plant (Zaporozh'ye, 47°49′N., 35°11′E.).	CB, BF, OH, E	3,800	Plate, hot- and cold-rolled sheet and strip; tinplate, electrical steels, low alloy steels, welded tube, and cold-formed sections.
2.	Dnepr Special Steels Plant (Zaporozh'ye, 47°49′N., 35°11′E.).	E, ESR	1,700	Low alloy, high alloy, bearing, tool, stainless, and heat-resistant steels; electrical steel, wire, bars, and forgings.
	Donetskaya Oblast':			
3.	Azov Steel Plant (Zhdanov, 47°06′N., 37°33′E.).	CB, BF, OH, E	3,000	Rails, rail accessories, structural shapes, bars, rods, and bearing steels.
4.	Zhdanov Metallurgical Plant imeni Ilyich (Zhdanov).	BF, OH, OC	5,800	Structural shapes, bars, hot- and cold-rolled sheet, plate; seamless, arc weld, and spiral weld tubes; castings, forgings, and alloy and stainless steels.
5.	Makeyevka Metallurgical Plant imeni Kirova (Makeyevka, 48°02′N., 37°58′E.).	BF, OH, E	3,000	Bars, rods, structural shapes, wire, plate, and skelp.
6.	Donetsk Metallurgical Plant (Donetsk, 47°48′N., 37°50′E.).	CB, BF, OH	1,100	Plate sheet, structural shapes, bars, rods, rails, tubes, and alloy steels.
7.	Yenakievo Metallurgical Plant imeni Ordzhonikidze (Yenakievo, 48°14′N., 38°13′E.).	CB, BF, OH, BC, OC	1,700	Structural shapes, bars, rods, wire, plate, sheet, and low alloy steels.

Footnotes at end of table.

FIGURE 24. FACILITIES AND PRODUCTION AT PLANTS AND COMBINES OF THE FERROUS METALLURGICAL INDUSTRY, 1968 (*Continued*)

25X1

POLITICAL SUBDIVISION ECONOMIC REGION PLANT AND LOCATION*	FACILITIES**	PRODUCTION OF CRUDE STEEL	FINISHED STEEL PRODUCTS
Ukrainian S.S.R. (*Continued*):			
Luganskaya Oblast':			
8. Kommunarsk Metallurgical Plant (Kommunarsk, 48°30′N., 38°47′E.).	CB, BF, OH	3,600	Sheet, plate, structural shapes, and low alloy steels.
Dnepropetrovskaya Oblast':			
9. Krivoy Rog Metallurgical Plant imeni Lenina (Krivoy Rog, 47°55′N., 33°21′E.).	CB, BF, OH, OC	6,400	Skelp, bars, rods, wire, small sections, and low alloy steels.
10. Dnepropetrovsk Metallurgical Plant imeni Dzerzhinsk (Dneprodzerzhinsk 48°30′N., 34°37′E.).	BF, OH, BC	4,400	Rails, structural shapes, bars, rods, plate, bent shapes, wire, seamless tubes, and wheels.
11. Dnepropetrovsk Metallurgical Plant imeni Petrovskogo (Dnepropetrovsk, 48°27′N., 34°59′E.).	BF, OH, OC	2,200	Rails, structural shapes, bars, rods, plate, sheet, wire, and low alloy steels.
Georgian S.S.R.:			
1. Rustavi Metallurgical Plant (Rustavi, 41°33′N., 45°02′E.).	CB, BF, OH	1,500	Bars, rods, plate, seamless tube, and wire.
Kazakh S.S.R.:			
1. Karaganda Metallurgical Combine (Temir Tau, 50°05′N., 72°56′E.).	CB, BF, OH	900	Hot-rolled sheet.

*Plant locations are shown on map, Figure 36.

**Basic production facilities: CB—coke batteries, BF—blast furnaces, OH—open hearth furnaces, BC—Bessemer converters, OC—basic oxygen converters, E—electric furnaces, ESR—electroslag remelting furnaces.

FIGURE 25. PRODUCTION OF SELECTED TYPES OF FINISHED STEEL PRODUCTS

25X1

(*Thousands of metric tons*)

	1960	1961	1962	1963	1964	1965	1966	1967	1968
Railroad track material	3,158	3,194	3,404	3,278	3,228	3,245	3,274	3,276	3,370
Heavy sections (80-mm and over)	13,771	14,443	15,155	15,549	16,747	*na*	25,744	28,230	29,983
Light sections (Less than 80-mm)	4,153	4,662	5,305	5,464	5,730	*na*	*	*	*
Wire rods	3,547	3,902	4,072	4,369	4,635	5,172	5,819	6,454	6,589
Flat rolled	14,864	16,786	18,578	20,438	21,915	*na*	25,583	26,833	28,314
Strip and skelp	(2,756)	(3,166)	(3,633)	(4,128)	(4,507)	*na*	(5,984)	(6,468)	(6,901)
Plate (4-mm and over thick)	(6,795)	(7,695)	(8,224)	(8,850)	(9,464)	*na*	**(11,817)	**(12,344)	(12,907)
Sheet (under 4-mm thick)	(5,313)	(5,925)	(6,721)	(7,460)	(7,944)	*na*	***(7,782)	***(8,021)	(8,506)
Selected end products:									
Cold-rolled sheet	1,533	1,703	1,815	2,155	3,031	3,600	3,862	4,081	4,208
Electrical sheet	494	601	661	742	790	*na*	862	893	921
Galvanized sheet	237	244	260	267	303	*na*	332	384	451
Tinplate	312	330	351	368	406	*na*	466	483	497
Pipe and tube	5,805	6,357	6,878	7,521	8,124	9,014	9,905	10,582	11,215
Seamless	(3,266)	(3,394)	(3,537)	(3,751)	(4,102)	(4,275)	(4,409)	(4,608)	(4,803)
Welder	(2,539)	(2,963)	(3,341)	(3,770)	(4,022)	(4,739)	(5,496)	(5,974)	(6,412)

na Data not available.

*Included in heavy sections.

**3-mm thick and over.

***Under 3-mm thick and excluding tonnages subsequently used for production of cold-rolled sheet.

FIGURE 26. EXPORTS OF FINISHED STEEL

25X1

(Thousands of metric tons)

	1960	1961	1962	1963	1964	1965	1966	1967	1968
Communist countries:									
Albania	20.8	17.8	0	0	0	0	0	0	0
Bulgaria	237.1	215.7	269.0	291.8	368.4	374.3	457.6	494.6	739.0
China	201.5	105.7	95.2	88.9	71.0	170.2	61.5	39.7	44.8
Cuba	79.3	189.4	200.2	107.5	120.4	135.0	199.7	189.7	182.9
Czechoslovakia	24.2	88.4	97.2	284.2	294.4	542.2	343.1	375.5	394.2
East Germany	1,283.9	1,400.3	1,555.9	1,459.2	1,747.8	1,864.7	2,099.3	2,108.9	1,943.8
Hungary	78.8	95.7	121.8	115.8	148.1	134.5	166.0	245.3	359.6
Mongolia	15.5	17.5	27.0	21.0	15.6	8.3	7.1	11.4	16.3
North Korea	2.7	8.7	12.8	10.5	9.9	8.2	6.5	10.5	9.4
North Vietnam	15.4	24.6	29.8	24.7	15.5	21.8	12.3	61.7	46.0
Poland	57.1	29.4	39.8	52.1	50.2	66.4	349.0	400.2	428.1
Romania	537.4	625.3	768.7	720.6	852.2	832.4	862.4	730.1	596.5
Yugoslavia	16.9	19.5	32.5	60.5	106.2	88.9	97.0	121.5	156.2
Subtotal	2,570.6	2,838.0	3,249.9	3,236.8	3,799.7	4,246.9	4,661.5	4,789.1	4,916.8
Non-Communist countries:									
Finland	136.1	188.1	161.3	154.0	172.9	112.2	150.2	125.6	106.1
Italy	23.0	54.1	66.0	72.4	92.0	112.7	7.5	3.0	0.2
United Kingdom	0	4.1	29.3	3.9	30.8	17.1	44.6	74.9	140.9
India	66.3	40.4	147.2	50.3	51.2	33.1	33.7	18.1	24.3
Iraq	15.0	28.4	43.2	34.8	36.2	46.5	53.5	48.7	89.6
Turkey	8.0	3.5	9.6	46.5	56.1	73.4	113.0	84.5	87.3
U.A.R.	24.6	21.5	15.9	16.2	30.3	32.8	30.9	61.5	29.5
Other	140.9	140.4	137.8	210.9	239.3	252.3	320.3	330.5	477.7
Subtotal	413.9	480.5	610.3	589.0	708.8	680.1	753.7	746.8	955.6
Total exports	2,996.4	3,343.7	3,892.0	3,864.1	4,530.2	4,948.7	5,440.2	5,579.7	5,909.7
Including those not identified by countries	11.9	25.2	31.8	38.3	21.7	21.7	25.0	43.8	37.3

FIGURE 27. IMPORTS OF FINISHED STEEL

25X1

(*Thousands of metric tons*)

	1960	1961	1962	1963	1964	1965	1966	1967	1968
Communist countries:									
Bulgaria	...	...	...	...	...	...	5.1	58.4	138.3
Czechoslovakia	133.2	187.4	227.4	273.1	323.0	323.5	201.1	*176.5	264.3
Hungary	5.2	7.5	7.9	1.0	...	2.9	0.2	0.7	...
North Korea	25.5	35.3	56.9	64.9	66.9	66.5	59.8	80.4	83.9
Poland	116.9	127.0	122.3	118.1	112.2	147.6	61.2	86.0	136.2
Romania	146.1	264.9	336.4	312.7	376.8	419.7	418.8	300.1	381.8
Yugoslavia	34.3	32.6	23.1	27.9	29.6	25.9	30.0	40.5	33.4
Subtotal	461.2	654.7	774.0	797.7	908.5	986.1	776.2	742.6	1,037.9
Non-Communist countries:									
Austria	105.9	105.4	110.4	108.6	107.2	107.7	98.5	112.6	97.8
Belgium	90.4	71.6	37.1	15.3	6.3	18.0	6.9	4.7	5.5
France	170.7	146.1	68.4	18.6	9.4	16.8	20.3	50.9	139.7
Italy	187.2	138.2	197.8	62.1	9.8	48.3	6.6	0.3	1.0
Japan	58.9	46.8	202.5	334.4	86.1	200.0	152.8	74.4	139.2
Netherlands	3.5	24.3	0.9	...	...	...	...	45.9	20.5
Norway	9.6	15.3	9.1	3.1	8.5	...	...	...	...
Sweden	11.6	4.7	11.2	66.0	54.8	48.6	42.3	43.1	81.9
United Kingdom	25.7	45.0	65.8	41.6	0.7	30.5	...	15.6	1.8
West Germany	332.1	291.3	462.7	110.0	56.8	93.9	51.3	368.1	281.4
Canada	1.0	0.1	...	...	...	...	...	...	...
United States	63.4	8.4	...	...	...	...	0.5	...	...
India	...	...	...	...	...	...	...	38.9	219.9
Subtotal	1,060.0	897.2	1,165.9	759.7	339.6	563.8	379.2	754.5	988.7
Total imports	1,530.7	1,559.0	2,023.3	1,590.3	1,248.6	1,561.6	1,157.8	1,513.7	2,175.0
Including those not identified by country	9.5	7.1	83.4	32.9	0.5	11.7	2.4	16.6	148.4

... Not pertinent.

*Estimated.

FIGURE 28. PRINCIPAL MANGANESE ORE DEPOSITS AND MINES

REGION DEPOSIT OR MINE LOCATION*	TYPE OF ORE	MANGANESE CONTENT	MANGANESE ORE RESERVES PROVEN $(A+B+C_1)$**
		Percent	*Millions of tons*
Ukraine:			
Nikopol' 47°34'N., 34°24'E.	Pyrolusite, psilomelane, and bog	*28–33*	***980
Bol'shoy Tokmak 47°14'N., 35°44'E.	Carbonate	*na*	***851
Transcaucasus:			
Chiatura 42°19'N., 43°18'E.	Pyrolusite, psilomelane, braunite, wad, and manganite.	*25–47*	***105
Urals:			
Northern Group (Urkinsk, Loz'va, Berezovskiy, Yuzhno-Berezovskiy, Indel', Polunochnoye, Tyninsk, Marsyaty).	Pyrolusite, psilomelane, and wad carbonate	*26–32*	50
Southern Group (Baymak, Akkermanovka, Uchaly, Kul'minskiy, Beloretsk).	Pyrolusite, psilomelane, and carbonate	*30*	Very small—probably less than 10 million tons.
West Siberia:			
Usa 54°03'N., 88°45'E.	Carbonate	*20*	98
Kazakhstan:			
Dzhezdy Group (Dzhezdy, Nayzatash, Shointas, Karazhal, Ktay, Klych).	Braunite with some psilomelane and pyrolusite.	*na*	45
Mangyshlak Poluostrov (Peninsula) 44°18'N., 51°00'E.	Psilomelane and pyrolusite	*22*	33
East Siberia:			
Mazul' 56°15'N., 90°27'E.	Psilomelane, pyrolusite, manganite, and carbonate.	*18*	*na*
Far East:			
Malyy Khingan	Braunite with carbonate	Low grade	11

na Data not available.

*Most coordinates are approximate or are the coordinates of the nearest principal town.

**Measured reserves (A+B) and indicated reserves (C_1).

***1 January 1958.

FIGURE 29. PRINCIPAL DEPOSITS OF TUNGSTEN AND MOLYBDENUM 25X1

REGION DEPOSIT LOCATION	DESCRIPTION OF DEPOSITS	REMARKS
	MOLYBDENUM-TUNGSTEN	
North Caucasus:		
Tyrnyauz 43°25′N., 42°55′E.	Ore in steeply dipping veins more than 2,600 feet above sea level. Skarn ore bodies contain 0.045%–0.22% molybdenum, and 0.22%–0.25% WO_3.	One of main tungsten and molybdenum producers. Began operations in 1940. Facilities destroyed by Germans in 1942, rebuilt after war. Hydrometallurgical plant commissioned at Nal'chik in 1962. Sixth section under construction in 1967.
East Siberia:		
Dzhida 50°18′N., 103°18′E.	One of largest tungsten-molybdenum deposits in the world. Primary ore mineral is hubnerite, but scheelite, molybdenite, galena, and sphalerite are also present.	Tungsten-molybdenum combine in existence here since 1934. Ores are processed at concentrating plant in Gorodok. Second beneficiation plant to be built during 1966–70.
	COPPER-MOLYBDENUM	
Transcaucasus:		
Agarak 39°13′N., 46°33′E.	Chalcopyrite and molybdenite in secondary quartzite. Ore contains 0.04%–0.1% molybdenum. To be mined by open pit method.	Second section of copper-molybdenum combine completed in 1963.
Dastakert 39°23′N., 46°02′E.	Chalcopyrite and molybdenite in secondary quartzite.	
Kadzharan 39°10′N., 46°08′E.	Chalcopyrite and molybdenite in secondary quartzite. Ores are mined by open pit method, contain about 0.1% molybdenum.	
Kazakh S.S.R.:		
Kounrad 46°59′N., 75°00′E.	Large copper-porphyry deposit averaging 9.5% molybdenite. Molybdenum: copper ratio ranges from 1:146 to 1:100.	Molybdenum recovered at mill at Balkhash. New technology for processing molybdenum concentrates introduced in 1962.
Vostochno-Khoundrad 46°00′N., 74°00′E.	Copper-molybdenum ore contains 0.8% molybdenum.	Ores processed at Balkhash.
Bozshakul' 51°50′N., 74°20′E.	Low-grade copper ores averaging 0.6% molybdenum.	Ore-concentrating plant was to be constructed by the end of 1965, but apparently is still under construction.
Uzbek S.S.R.:		
Almalyk 40°50′N., 69°35′E.	Large reserves of hard-to-concentrate oxide and mixed ores, containing copper and 0.6% to 2.4% molybdenum.	Copper-molybdenum combine began operating in 1962.
Far East:		
Vostok 46°00′N., 136°00′E. (approximate location).	Ores contain a high percentage of copper, gold, and bismuth.	Construction began in 1967. First phase of combine to be completed in 1971.
	MOLYBDENUM	
East Siberia:		
Sora (Dzerzhinskiy) 54°01′N., 90°12′E.	Pyrite-molybdenite ores in secondary quartzite. Ores are lean and worked by open pit method.	One of U.S.S.R.'s main producers of molybdenum concentrates. Concentrating plant was expanded in 1964.
	TUNGSTEN	
Uzbek S.S.R.:		
Ingichka 39°32′N., 66°34′E.	Largest tungsten deposit in the U.S.S.R. Ore mined in 1956 contained 0.3%–0.6% WO_3 in scheelite.	Capacity of mines was increased and concentrating plant built, 1959–65.
	TIN-TUNGSTEN	
Far East:		
Iul'tin 67°50′N., 178°48′E.	Wolframite and cassiterite	Deposits discovered in 1937; plans for development delayed by World War II. Mine and concentrating plant commissioned in 1959. Modernization undertaken in 1967.

FIGURE 30. PRINCIPAL NICKEL AND COBALT DEPOSITS AND NICKEL-COBALT SMELTERS AND REFINERIES, 1968

25X1

REGION DEPOSIT LOCATION	DESCRIPTION OF DEPOSITS	SMELTING AND REFINING FACILITIES
Northwest:		
Zhdanovsk Approx. 69°20′N., 31°30′E.	Sulfide copper-nickel ore, probably contains cobalt. Alla River diverted to uncover deposits, which are reported to be very rich.	First stage of ore-concentrating plant at Zapolyarnyy was completed in 1965.
Pechenga 69°33′N., 31°12′E.	Sulfide copper-nickel ore containing cobalt. Basic mineralization consists of disseminated ore in ultrabasic rock, containing 0.6%–1.0% nickel, 0.017%–0.055% cobalt.	Electric smelter at Nikel' processes concentrates of local ores to matte which is sent to Monchegorsk for further refining.
Monchegorsk 67°56′N., 32°58′E.	Sulfide copper-nickel ore containing 0.23%–0.39% nickel, 0.010%–0.016% cobalt.	Facilities include electric furnaces for smelting concentrates produced on Kola peninsula, 2 nickel electrolysis shops, and an electric furnace for production of cobalt.
Urals:		
Ufaley Group 56°04′N., 60°14′E.	Laterite ore containing nickel and cobalt. Average nickel content of dry ore is 1.24%; cobalt content is 0.039%. Fourteen deposits associated with the Ufaley serpentinite massif constitute the main Central Ural nickel reserves and the raw material base for the Ufaley Nickel Plant.	Facilities at Verkhniy Ufaley include smelter and refinery with designed capacity of 3,000 metric tons of nickel per year. Processes local ores and matte from Rezh. Cobalt recovered as byproduct.
Rezh 57°23′N., 61°24′E.	Ore contains 0.8%–2.5% nickel, 0.02%–0.06% cobalt.	Matte produced from local ore is refined at Verkhniy Ufaley.
Orsk-Khalilovo 51°20′N., 58°25′E.	Laterite ore containing 0.39%–1.8% nickel, 0.015%–0.07% cobalt.	Yuzhuralnikel' Combine at Orsk is the center of the South Urals nickel industry. Cobalt oxide and metallic cobalt produced as byproduct of nickel production.
Buruktal 50°50′N., 60°46′E.	Largest nickel laterite ore deposit in U.S.S.R. Dry ores have average nickel content of 0.83%–0.98%, 0.09% cobalt. Seventy percent of the ores are ferruginous, containing 46.5% Fe_2O_3. Large mines were put into operation 1959–65.	Plans exist for establishment of large nickel combine, probably to produce ferronickel. Until combine is operating, ores probably will be sent to Orsk for processing.
Kazakhstan:		
Aktyubinsk Group (Kimpersay) 50°36′N., 58°15′E.	Laterite ore containing nickel and cobalt. Average nickel content of dry ore is 1.21%; cobalt content is 0.05%. More than 50 deposits occurring in an area of 1,200 square kilometers constitute the raw material base for the Yuzhuralnikel' Combine at Orsk.	No known smelting or refining facilities. Ores are sent to Orsk for processing.
East Siberia:		
Noril'sk 69°20′N., 88°06′E.	Disseminated copper-nickel sulfide ore containing 0.31% nickel and 0.012% cobalt represents 98% of nickel reserves of this region. Some rich vein ore contains 5.16% nickel, 0.12% cobalt. Five deposits are located in a 772-square-mile area in Noril'sk and Syverma Plateau region.	Electric smelter and refinery process local ores. Cobalt recovered as byproduct. New deposits opened at Tal'nakh in 1964.

25X1

FIGURE 31. ELECTRIC FURNACE FERROALLOY PLANTS

LOCATION	FERROALLOY PRODUCTION	REMARKS
Ukraine:		
Almaznaya 48°31'N., 38°35'E.	Ferrosilicon	Put into operation in 1962.
Nikopol' 47°34'N., 34°24'E.	Ferromanganese	Put into operation in 1964. Construction continuing. A major supplier of manganese alloys. To be largest ferroalloy plant in U.S.S.R.
Zaporozh'ye 47°49'N., 34°11'E.	Ferrosilicon, ferrochrome, and ferromanganese	Put into operation in 1933, plant equipment was evacuated to Stalinsk (now Novokutzetsk) during World War II. Ferroalloy production was resumed at Zaporozh'ye in 1948.
Transcaucasus:		
Zestafoni 42°07'N., 43°03'E.	*do*	Plant began operation in 1933, is now being expanded and modernized.
Central:		
Lipetsk 52°37'N., 39°35'E.	Ferrotitanium* ferrotungsten, ferrosilicon, and ferroboron.	At least partially built before World War II. Reported to serve as experimental plant for Central Scientific Research Institute for Ferrous Metallurgy. Produces about 50% of total Soviet ferrotitanium output.
Urals:		
Chusovoy 58°17'N., 57°49'E.	Ferrovanadium*	Vanadium shop, established as part of Chusovoy Metallurgical Plant in 1935, had become separate plant by 1946.
Klyuchevsk 57°07'N., 60°56'E.	Ferrotitanium and ferrochrome	Very little information available. Probably built just before or during World War II.
Chelyabinsk 55°10'N., 61°24'E.	Ferrosilicon, ferrochrome, ferrotungsten, and ferromolybdenum.	First Soviet ferroalloy plant, began operation in 1931. Now undergoing expansion and modernization.
Serov 59°36'N., 60°35'E.	Ferrochrome and ferrosilicon	First unit reported to have begun operation in 1958; two shops were completed as of December 1962.
West Siberia:		
Novokuznetsk 53°45'N., 87°06'E.	Ferrosilicon*	Began operation in 1944 with equipment from Zaporozh'ye. Plant being expanded.
Kazakhstan:		
Aktyubinsk 50°17'N., 57°10'E.	Ferrochrome,* ferrosilicon, ferronickel, ferrotitanium, and ferrotungsten.	Built during World War II, plant began operation in 1943. Plant being expanded, processes being automated.
Yermak 52°02'N., 76°55'E.	Ferrochrome, ferromanganese, ferrovanadium, ferrotungsten, ferromolybdenum, ferrosilicon, and ferrotitanium.	Put into operation in 1965. Construction continuing.

*Indicated plant is U.S.S.R.'s major producer of starred product.

Approved For Release 2008/09/08 : CIA-RDP08S01350R000100080001-8

FIGURE 32. ALUMINUM REDUCTION PLANTS

REGION POLITICAL SUBDIVISION LOCATION	ESTIMATED CAPACITY 1 JANUARY 1969 *Thousands of metric tons*	REMARKS
Northwest:		
Murmanskaya Oblast' Kandalaksha (67°09′N., 32°25′E.)	75	Completed soon after World War II. Operates on hydroelectric power. Receives alumina from Pikalavo.
Karel'skaya A.S.S.R Nadvoitsy (63°52′N., 34°19′E.)	65	Produced first aluminum in 1954. Fourth potroom was added in 1965. Receives power from Ondskaya Hydroelectric plant and alumina from Pikalavo.
Leningradskaya Oblast' Volkhov (59°55′N., 32°21′E.)	20	Oldest aluminum plant in the U.S.S.R., built by Alcoa in 1931. Alumina is supplied by local plant, power by the Volkhov Hydroelectric power station.
Ukraine:		
Zaporozhskaya Oblast' Dnepr (47°48′N., 35°11′E.)	90	Second oldest Soviet aluminum plant was dismantled during World War II and reconstructed afterwards. Alumina and hydroelectric power are available locally.
Transcaucasus:		
Azerbaijan S.S.R Sumgait (40°36′N., 49°38′E.)	60	Began operations in 1955. Receives alumina from the Urals and Kirovabad. Will discontinue use of alumina from the Urals when output expands at Kirovabad. Hydroelectric power is available locally.
Armenian S.S.R. Kanaker (40°11′N., 44°30′E.)	35	Plant produced first aluminum in 1950. Receives alumina from the Urals, will use Razdan alumina when it is available.
Volga:		
Volgogradskaya Oblast' Volgograd (48°42′N., 44°30′E.)	160	Began operations in 1959 and reached present capacity in 1965. Uses alumina from the Urals and possibly imported alumina. Eventually may obtain alumina from Kirovabad. Power is supplied by Volzskaya Hydroelectric power station.
Urals:		
Sverdlovskaya Oblast' Urals plant (56°25′N., 61°54′E.)	90	Important World War II plant, modernized and automated in recent years. Alumina and thermoelectric power are available locally.
Bogoslovskiy plant (59°46′N., 60°12′E.)	100	Began operations during World War II and was enlarged to present capacity during 1952–53. Alumina and power are available locally.
West Siberia:		
Kemerovskaya Oblast' Novokuznetsk (53°45′N., 87°06′E.)	290	Largest Soviet reduction plant. Began operations in World War II. Twelve potrooms, the last of which was added in 1966. Alumina is obtained from the Urals and thermoelectric power is available locally. Plant is being reconstructed and modernized.
East Siberia:		
Irkutskaya Oblast' Shelekhovo (52°14′N., 104°08′E.)	160	Began production in 1962, now has 6 potrooms operating. Two more potrooms to be added in future. Alumina is obtained from the Urals and Pavlodar, will come from Achinsk when available. Power is supplied from a nearby dam and the Siberian power network.
Bratsk (56°05′N., 101°48′E.)	180	Began production in 1966; now has 6 potrooms operating, 2 of which started in 1968. Will be the largest Soviet plant when completed in the 1970's. Alumina is now supplied by Pavlodar. Power is obtained from the Bratsk Hydroelectric station.
Krasnoyarskiy Kray Krasnoyarsk (56°08′N., 93°07′E.)	180	Began production in 1964. Eventual capacity to be about double present size. Alumina is obtained from Pavlodar, will come from Achinsk when available.

FIGURE 33. PRINCIPAL TIN MINES AND CONCENTRATING PLANTS

25X1

GEOGRAPHIC AREA LOCATION	INSTALLATIONS	REMARKS
East Siberia:		
Chitinskaya Oblast':		
Khapcheranga (49°42′N., 112°24′E.)	Khapcheranginskiy Tin Combine	First large tin enterprise established in U.S.S.R.; includes many mines and several concentrating plants.
Olovyannaya (50°56′N., 115°35′E.)	Ononskoye Mining Administration	Administration is composed of at least four mines and concentrating plants.
Sherlovaya Gora (50°34′N., 116°15′E.)	Sherlovogorskiy Mining and Concentrating Combine.	Combine is based on one of biggest tin deposits in the U.S.S.R.
Yakutskaya A.S.S.R.:		
Deputatskiy (69°18′N., 139°54′E.)	Deputatskoye Mining Administration	Administration is largest tin enterprise in Yakutsk A.S.S.R. It reportedly is one of the lower cost producers.
Ege-Khaya (67°31′N., 134°40′E.)	Ege-Khaya Ore Mining Combine	One of the largest tin-mining combines in Yakutsk A.S.S.R.
Far East:		
Khabarovskiy Kray:		
Obluch'ye (49°00′N., 131°05′E.)	Khingan Tin Combine	Combine has at least two mines and concentrating plants.
Solnechnyy (approximately 50°40′N., 136°25′E.)	Solnechnyy Mining and Concentrating Combine.	This is the largest tin-producing enterprise in Khabarovsk Kray and one of the two largest in the U.S.S.R.
Magadanskaya Oblast':		
Galimyy (62°20′N., 155°59′E.)	Omsukchanskiy Tin Mining Combine	Combine includes several mines and concentrating plants.
Iul'tin (67°50′N., 178°48′E.)	Iul'tinskiy Ore Mining Combine	Combine produces tin and tungsten concentrates and is the largest mining enterprise in the northeastern part of the Far East.
Pevek (69°42′N., 170°17′E.)	Chaun-Chukotskiy Ore Mining Combine.	Combine includes several mines and one-concentrating plant.
Primorskiy Kray:		
Dal'niy (43°00′N., 132°57′E.)	Dal'olovo Tin Combine	Combine includes many mines and several concentrating plants.
Kavalerovo (44°16′N., 135°51′E.)	Khrustal'nyy Mining and Concentrating Combine.	Combine is one of the two largest in the U.S.S.R. and is one of the lower cost tin producers in the U.S.S.R.
Tetyukhe (44°25′N., 135°55′E.)	Sikhote-Alinskiy Polymetallic Combine.	Combine includes lead smelter and several mines and concentrating plants producing tin, lead, and zinc concentrates.

Approved For Release 2008/09/08 : CIA-RDP08S01350R000100080001-8

FIGURE 34. CEMENT PLANTS

MAP REF. NO.*	PLANT NAME AND LOCATION**	ESTIMATED ANNUAL CAPACITY	ESTIMATED PRODUCTION 1967	PRODUCTS	REMARKS
		--- *Metric*	*tons* ---		
1	Kunda, Estonian S.S.R.	1,200,000	941,000	Portland cement, including grade 700. Special purpose cement.	Three 4 x 150-m. rotary kilns; shaft kilns. Wet process. Mechanized quarry and plant.
2	Slantsy, Leningradskaya Oblast' (Obl.)	800,000	720,000	Portland cement	Two 4 x 60-m. rotary kilns; three shaft kilns. Dry process.
3	Broceni Construction Materials Combine, Broceni, Latvian S.S.R.	*na*	555,000	Portland cement, grade 500; and slate	One 3.6 x 150-m. rotary kiln; three other kilns.
4	Riga, Latvian S.S.R.	*na*	250,000	.....	Three rotary kilns: one 3 x 88.5 m., two 2 x 40 m. Seven crushers, one grinder, ball mills. Cement mainly below grade 500.
5	Akmene, Lithuanian S.S.R.	950,000	836,000	Portland cement, grade 500 hydrophobic portland cement, portland-pozzolan cement, slate, asbestos cement pipe.	Two 4 x 150-m. rotary kilns; two other kilns. Currently undergoing expansion; two 5 x 185-m. rotary kilns to be built in 1969 and 1970. High-quality limestone quarries nearby. Experimental shop.
6	Pobeda, Volkovysk, Grodnenskaya Obl	750,000	680,000	Portland cement and rapid-hardening cement.	Two 4.5/5.0 x 135-m. rotary kilns; three other kilns. Wet process. Coal fuel.
7	Kiev, Kievskaya Obl	*na*	220,200	Portland cement	Clinker grinding mills. A grinding plant; clinker from Zdolbunov Cement Combine.
8	Zdolbunov Cement Combine, Zdolbunov, Rovenskaya Obl.	2,550,000	2,400,000	Portland cement, grades 700–900; rapid-hardening cement and slate.	Seven rotary kilns: three 3.3 x 118 m., four 4.5 x 170 m. Slate plant. Wet process. Coal fuel. Utilizes hydraulic transport of raw materials from the quarry to the plant. Combine includes two cement plants and a slate plant.
9	Nikolayev, L'vovskaya Obl	2,100,000	1,890,000	Portland cement, grades 700–800; and rapid-hardening cement.	Six 4 x 150-m. rotary kilns. Several cement mills. Wet process. Gas fuel.
10	Grigor'yevka, Nikolayveskaya Obl	1,250,000	336,000 (1968)	Portland cement, asbestos-cement pipe and asbestos tile.	Two 5 x 185-m. rotary kilns; other kilns. Tile and asbestos pipe plant. Wet process. Two 5 x 185-m. rotary kilns put in operation in 1968; third kiln planned.
10A	Odessa, Odesskaya Obl	350,000	297,000	Portland cement	
11	Kamenets-Podol'skiy, Khmel'nitskaya Obl.	*na*	*na*	.....	Under construction; first technological line with rotary kiln to be completed in 1970.
12	Rybnitsa, Moldavian S.S.R.	900,000	622,000	Portland cement, asbestos cement pipe and slate.	Three rotary kilns 4 x 60 m. Asbestos cement and slate shops. Dry process. Plant being expanded; fourth rotary kiln is planned. Cableway 4 km. long, over Dniester River, for transporting limestone to the plant.
13	Vorovskiy, Leningrad, Leningradskaya Obl.	*na*	396,000	Portland-pozzolan cement and waterproof cement.	Three rotary kilns.
14	Volkhov Aluminum Combine, Volkhov, Leningradskaya Obl.	*na*	790,000	.....	Four rotary kilns: two 3.6 x 127 m., two 3.3 x 118 m. Wet process. Cement made from waste byproducts of aluminum combine.
15	Savinskiy, Archangel'skaya Obl	700,000	530,000	Portland cement	Two 4 x 150-m. rotary kilns. Wet process. Coal fuel.
16	Pikalevo, Leningradskaya Obl	2,300,000	2,080,000	Portland cement and slate	Five rotary kilns: three 4.5 x 170 m., two 3.6 x 60 m. Grinding mills. Slate shops. Expansion planned.

17	Podol'sk, Moskovskaya Obl	*na*	800,000	Portland cement	Four 60- to 70-m. rotary kilns. Four grinding mills. Wet process.
18	Gigant, Voskresensk, Moskovskaya Obl	2,300,000	2,150,000	Portland cement, grades 500, 600, and 700	Six rotary kilns: three 4 x 150 m., two 3.3 x 118 m., one 4.5/5.0 x 135 m. Huge quarry nearby. This plant is a major supplier of cement in Moscow area.
19	Krasnyy Stroitel', Voskresensk, Moskovskaya Obl.	*na*	432,000	Asbestos cement and slate	
20	Shchurovo, Moskovskaya Obl	*na*	520,000	Portland cement, and white and colored cements.	Two rotary kilns, 3 x 80 m. each; other kilns. Expansion planned.
21	Staryy Oskol, Belgorodskaya Obl	*na*	*na*		Plant under construction including one 5 x 185-m. rotary kiln, 600,000-ton rated annual capacity. To be put in operation in 1969.
22	Kosaya Gora, Tulla, Tul'skaya Obl	*na*	484,000	Slag-portland cement	Two 3.6 x 70-m. rotary kilns. Dry process.
23	Spartak Oktyabr'skiy Cement Combine, Mikhaylov, Ryazanskaya Obl.	1,900,000	1,754,000	Portland cement, grades 500 and 600	Six rotary kilns: three 4.5 x 170 m., three 3.6 x 70 m. Shaft kilns. Expansion planned.
24	Cement and Tile Combine, Krichev, Magilevskaya Obl.	1,400,000	1,200,000	Cement and slate	Two 4.5 x 170-m. rotary kilns; two other kilns. Wet process. Tile shops.
25	Bryansk, Bryanskaya Obl	2,000,000	1,797,000	Portland cement, including grade 700. Sulfate-resistant portland cement and portland-pozzolan cement. Slate and asbestos cement products.	Nine rotary kilns: five 3.6 x 150 m. and four smaller old kilns. Wet process. Slate and asbestos cement plant. Expansion planned including two 5 x 185-m. kilns.
26	Orel, Orlovskaya Obl	200,000	170,000	Cement	Four shaft kilns.
27	Lipetsk, Lipetskaya Obl	1,100,000	970,000	Portland cement	Four rotary kilns 4 x 60 m. Dry process. Plant to be considerably expanded.
28	Belgorod, Belgorodskaya Obl	2,500,000	2,213,000	Portland cement. Asbestos-cement products and slate.	Seven rotary kilns: five 3.6 x 150 m., two 4.5 x 170 m. Five cement mills 2.6 x 13 m.; other mills 3 x 14 m. Wet process. Gas fuel. Equipment and five 150-m. kilns from West Germany firm of Krupp. Kilns to be reconstructed. 1,100 workers.
29	Kommunar, Podgorenskiy, Voronezhskaya Obl.	*na*	672,000	Portland cement	Old plant, expansion planned.
30	Khar'kov, Khar'kovskaya Obl	*na*	250,000	Slag-portland and rapid-hardening cement.	One large shaft kiln. Partly a clinker grinding plant.
31	Balakleya, Khar'kovskaya Obl	2,400,000	2,280,000	Portland cement	Four 5 x 185-m. rotary kilns. An experimental rotary kiln, 7 x 232 m., under construction. Wet process. Gas fuel. One of the largest cement plants in the U.S.S.R. Annual capacity to expand to 3,400,000 tons when construction of huge experimental 7 x 232-m. rotary kiln is completed, possibly in 1970.
32	Kramatorsk, Donetskaya Obl	*na*	700,000	Slag-portland cement and rapid-hardening cement. Heavy cement used for strengthening oil wells and boreholes.	Five rotary kilns: two 3.3 x 55.2 m., two 3.6 x 68 m., one other kiln. Two cement mills.
33	Dneprodzerzhinsk, Dnepropetrovskaya Obl.	1,300,000	1,200,000	Fast-hardening cement and slag-portland cement.	Four short rotary kilns. Four granulators. Dry process. Natural gas.
34	Dnepropetrovsk, Dnepropetrovskaya Obl	*na*	370,000	Slag-portland cement	
35	Makeyevka, Donetskaya Obl	*na*	300,000	....*do*	Two Dietsch double-floor shaft kilns. Partly a grinding plant.
36	Yenakiyevo, Donetskaya Obl	*na*	750,000	....*do*	Several rotary kilns.
37	Krivoy Rog, Dnepropetrovskaya Obl	950,000	850,000	Portland cement and slag-portland cement.	Two Lepol rotary kilns, 4 x 60 m., other kilns. Dry process.

Footnotes at end of table.

FIGURE 34. CEMENT PLANTS [redacted] *Continued)*

MAP REF. NO.*	PLANT NAME AND LOCATION**	ESTIMATED ANNUAL CAPACITY	ESTIMATED PRODUCTION 1967	PRODUCTS	REMARKS
		--- *Metric*	*tons* ---		
38	Amvrosiyevka Cement Combine, Amvrosiyevka, Donetskaya Obl.	3,400,000	3,050,000	Portland cement and asbestos cement pipes.	Eight rotary kilns: two 5 x 185 m., six 3.6 x 150 m. Wet process. Largest combine, incorporates all cement plants in urban area.
39	Yamnitsa, Ivano-Frankovskaya Obl......	*na*	140,000	Sulfate-resistant portland cement.........	
40	Bakhchisaray, Krymskaya Obl...........	*na*	355,000	Portland cement.......................	One rotary kiln 3 x 100 m.; other kilns.
41	Proletariy, Novorossiysk, Krasnodarskiy Kray.	2,200,000	1,730,000	Portland cement and hydrophobic portland cement.	Nine rotary kilns: four 3.3 x 85 m., two 3.6 x 104 m., one 3.3 x 118 m., two 5 x 185 m. Six raw materials mills; four clinker mills. Wet process. Numerous cement silos. This is the chief plant in the combine. It has a unified production plan and disbursement office. Other cement plants in Novorossiysk are subsidiary. The combine has 38 raw materials and clinker mills.
42	Oktyabr', Novorossiysk, Krasnodarskiy Kray.	1,250,000	1,100,000	Portland cement.......................	Four rotary kilns: three 3.6 x 150 m., one 4 x 150 m. Wet process. Gas fuel.
43	Pervomayskiy, Novorossiysk, Krasnodarskiy Kray.	1,000,000	800,000	....*do*...............................	Five rotary kilns: two 4 x 60 m., two Lepol 3.7 x 34 m., one 3.654 m. Dry process.
44	Pobeda Oktyabrya, Novorossiysk, Krasnodarskiy Kray.	*na*	420,000	....*do*...............................	Several shaft kilns.
45	Alekseyevka, Komsomol'skiy, Mordovskaya A.S.S.R.	*na*	1,056,000	Portland cement and asbestos cement products.	Three 3.6 x 150-m. rotary kilns. Natural gas fuel. Plant being expanded, two 5 x 185-m. rotary kilns to be put in operation in 1969–70.
46	Ul'yanovsk, Ul'yanovskaya Obl..........	1,800,000	1,580,000	Portland cement.......................	Four 4.5 x 170-m. rotary kilns. Wet process. Natural gas fuel. Production is being expanded.
47	Sengiley, Ul'yanovskaya Obl.............	*na*	140,000	....*do*...............................	Several 50-m. kilns. Wet process.
48	Zhigulevsk, Kuybyshevskaya Obl........	1,750,000	1,600,000	....*do*...............................	Three 4.5/5.0 x 155-m. rotary kilns; other kilns. Wet process.
49	Bol'shevik, Vol'sk, Saratovskaya Obl.....	2,400,000	1,936,000	Portland cement, average grade 562; and slate.	Eleven rotary kilns: two 5 x 185 m., two 4.5/5.0 x 135 m., one 4.5 x 170 m., two 3.6 x 43 m., two 3.6 x 70 m., two 2.5 x 43 m. This is the chief plant of the combine which includes other cement plants in Vol'sk.
50	Krasnyy Oktyabr' Vol'sk, Saratovskaya Obl.	*na*	634,000	Portland-pozzolan cement...............	Three 3.6 x 70-m. rotary kilns; other kilns. Gas fuel. Reconstruction of one kiln planned in 1966–70 period.
51	Komsomolets, Vol'sk, Saratovskaya Obl...	*na*	314,000	Plasticized and sulfate-resistant cement...	Rotary kilns.
52	Kommunar Vol'sk, Saratovskaya Obl.....	*na*	300,000	Portland-pozzolan cement, grade 500......	Two rotary kilns.
53	Sebryakovskiy Mikhaylovka, Volgogradskaya Obl.	2,700,000	2,215,000	Portland cement, plastic cement, and slag-portland cement. Asbestos-cement products, slate.	Seven rotary kilns: one 5 x 185 m., two 4.5 x 170 m., four 3.6 x 150 m. Wet process. Gas fuel. Computer system production management control. Factory equipped with closed-circuit TV. Another 5 x 185-m. rotary kiln under construction.
54	Kaspi, Georgian S.S.R..................	950,000	850,000	Portland-pozzolan cement, fast-setting cement, sulfate-resistant portland cement. Slate and asbestos-cement panels.	Four 3.6 x 127-m. rotary kilns. Slate plant. Natural gas fuel. Wet process. Large asbestos-cement plant under construction.
55	Rustavi, Georgian S.S.R................	760,000	630,000	Slag-portland cement and rapid-hardening cement.	Three 3.6 x 127-m. rotary kilns. Wet process. Slag and limestone are basic raw materials. Shops for production of cement and sand tiles, and fibrolite panels.

56	Tauz, Azerbaijan S.S.R.	*na*	55,000	White and colored portland cement	Two production lines. Plant being expanded, cement production to increase to 263,000 tons in 1970.
57	Chir-Yurt, Checheno-Ingushskaya A.S.S.R.	*na*	*na*	*na*	Under construction. Planned annual capacity 600,000 tons.
57A	Razdan, Armenian S.S.R.	*na*	*na*	*na*	Under construction including two 5 x 185-m. kilns, 600,000-ton annual capacity each.
58	Ararat, Armenian S.S.R.	750,000	672,000	Portland cement, rapid-hardening cement, and slate.	Four rotary kilns: one 3.3 x 118 m., one 3.6 x 150 m., two 3.6 x 80 m. Asbestos-cement pipe and slate shops. Wet process. Natural as fuel.
59	Azerbaijan Cement and Gypsum Combine Karadag, Azerbaijan S.S.R.	1,650,000	1,385,000	White and colored portland cement, asbestos-cement products, and slate.	Four 3.6 x 150-m. rotary kilns and one 4.5 x 170-m. kiln. Gas fuel.
60	Novopashiyskiy Gornozavodsk, Permskaya Obl.	1,950,000	1,566,000	Portland cement, gypsum, and expanding waterproof cement.	Seven rotary kilns: two 5 x 170 m., two 3.6 x 150 m., three 3.6 x 127 m., other kilns. Liquid fuel. Wet process. Includes two plants. One 5 x 185-m. rotary kiln, 600,000-ton rated annual capacity under construction; another such kiln planned.
61	Nizhnyaya Salda, Sverdlovskaya Obl.	*na*	265,000	Slag-portland cement	Grinding mills. A grinding plant; clinker from Sukhoy Log cement plant.
62	Nizhniy Tagil, Sverdlovskaya Obl.	1,000,000	850,000	Slag-portland cement and slate	Four rotary kilns: one 3.6 x 150 m., two 3.6 x 127 m., one other kiln. Gas fuel. Reconstruction and lengthening of two kilns to 150 m. planned.
63	Nev'yansk, Sverdlovskaya Obl	1,000,000	850,000	Portland cement	Rotary 3.6 x 60-m. and shaft kilns. Grinding mills.
64	Katav-Ivanovsk, Chelyabinskaya Obl.	900,000	790,000	Slag-portland cement	Three rotary kilns, including one 3.6 x 80 m.; other kilns. One kiln, 300,000-ton annual capacity, planned. Includes old and new plant.
65	Sterlitamak, Bashkirskaya A.S.S.R.	1,250,000	1,004,000	Slag-portland cement and slate	Four rotary kilns: one 4.5 x 170 m., three probably 3.6 x 127 m. Natural gas fuel.
66	Magnitogorsk, Chelyabinskaya Obl	1,250,000	1,130,000	Portland cement	Three 3.6 x 150-m. rotary kilns; two other rotary kilns. Gas fuel.
67	Novotroitsk, Orenburgskaya Obl.	1,200,000	1,103,000	Slag-portland cement	Three rotary kilns: two 3.6 x 127 m., one 3.3 x 118 m. Wet process. Reconstruction and lengthening of kilns to 3.6 x 150 m. planned.
68	Bezmein, Turkmen S.S.R.	450,000	407,000	Cement, roofing slate, and asbestos cement pipe.	Two rotary kilns. Dry process. Slate and asbestos cement shops.
69	Vorkuta, Komi A.S.S.R.	*na*	255,000	Portland cement	Four small rotary kilns. Expansion planned.
70	Sukhoy Log, Sverdlovskaya Obl.	620,000	540,000	Plasticized portland cement, rapid-hardening cement, special-purpose cement for radiation shielding.	Five rotary kilns: two 2.8 x 65 m., three 3.6 x 70 m. Wet process. Two rotary kilns 5 x 185 m. planned.
71	Yemanzhelinsk, Chelyabinskaya Obl.	2,450,000	2,283,000	Slag-portland cement, asbestos-cement products, and slate.	Six rotary kilns: four 3.6 x 150 m., two 4.5 x 170 m. Natural gas. Wet process.
72	Lenin Chimkent, Chimkentskaya Obl.	2,000,000	1,720,000	Portland cement, hydrophobic cement, asbestos-cement products, and slate.	Six rotary kilns: two 3.6 x 150 m., four 4 x 150 m. Natural gas. Wet process.
72A	Sastobe, Chimkentskaya Obl.	200,000	180,000	Portland and colored cement	Two 3.6 x 70-m. rotary kilns. Wet process. Plant being expanded.
73	Akhangaran, Tashkentskaya Obl.	1,400,000	1,200,000	Portland cement and slate	Three 4.5 x 170-m. rotary kilns. Gas fuel. Wet process. Belt conveyor, 6.3 km. long to transport raw material from quarry. Another 170-m. rotary kiln planned.
74	Angren, Tashkentskaya Obl.	400,000	320,000	Slag-portland cement	Three rotary kilns: one 50 m. long, one 62 m. long, one 3.6 x 150 m. Wet process. Liquid fuel.
75	Khilkovo, Bekabad, Ferganskaya Obl.	600,000	450,000	Portland cement and sulfate-resistant cement.	Three rotary kilns: two 3.3 x 118 m., one 3.6 x 150 m. Natural gas. Wet process.
76	Dushanbe, Tadzhik S.S.R.	1,100,000	821,000	Portland cement, slate, and asbestos-cement pipes.	Six rotary kilns: four 4.0/3.5 x 128 m., two others; three shaft kilns. Asbestos-cement and slate plants.
77	Karaganda, Karagandinskaya Obl.	1,650,000	1,337,000	Portland cement, porcelain cement, slag-portland cement, and quick-setting portland cement.	Five rotary kilns: four 3.6 x 150 m., one 4.5 x 170 m. Natural gas fuel. Asbestos-cement and slate shops. Wet process. Expansion planned.

Footnotes at end of table.

FIGURE 34. CEMENT PLANTS (*Continued*)

MAP REF. NO.*	PLANT NAME AND LOCATION**	ESTIMATED ANNUAL CAPACITY	ESTIMATED PRODUCTION 1967	PRODUCTS	REMARKS
		--- *Metric tons* ---			
78	Chu, Dzhambul'skaya Obl	170,000	140,000	Cement and slate	Three shaft kilns.
79	Kant Cement-Slate Combine Kant, Kirgiz S.S.R.	950,000	856,000	Portland cement, slate, and asbestos cement pipe.	Five rotary kilns 4/3.5 x 128 m. Large slate and asbestos cement pipe shops. Cement plant built in 1962–67 period. All rotary kilns imported from Czechoslovakia.
80	Kurmenty, Kirgiz S.S.R	*na*	62,000	Cement and slate	Two small kilns. Slate shop.
81	Kuvasay, Ferganskaya Obl	850,000	755,000	Portland cement, sulfate-resistant cement, and slate.	Four rotary kilns: two 2.7 x 84.8 m., two 3.6 x 150 m. Gas fuel.
82	Noril'sk, Krasnoyarskiy Kray	*na*	84,000	Slag-portland cement	Two 50-m. rotary kilns. Part of a metallurgical combine.
83	Yashkino, Kemerovskaya Obl	700,000	543,000	Cement and slate	Three rotary kilns: one 2.7 x 118 m., two 30 m. long, two others; four shaft kilns. Plant connected to limestone and clay quarries by 7 km. cableway.
84	Topki, Kemerovskaya Obl	1,200,000	1,000,000	Portland cement and slate	Two 5 x 185-m. rotary kilns. Wet process. Third rotary kiln 5 x 185 m. to be built in 1970; fourth such kiln is planned.
85	Chernorechenskiy, Iskitim, Novosibirskaya Obl.	2,500,000	2,357,000	Portland cement, placticized portland cement, and slate.	Eight rotary kilns: four 4.5 x 170 m., two 3.6 x 127 m., two 3.6 x 65 m. Coal fuel. Wet process. Slate plant.
86	Novokuznetsk, Kemerovskaya Obl	1,200,000	1,050,000	Slag-portland cement	Four rotary kilns: one 3.6/3 x 65 m., one 3.6/3.3 x 70 m., two 3.6 x 150 m.; other kilns. Expansion planned.
87	Asbestos-Cement Plant, Semipalatinsk, Semipalatinskaya Obl.	1,350,000	1,100,000	Slag-portland cement, asbestos cement articles, and slate.	Four rotary kilns: one 4.5 x 170 m., three 3.6 x 150 m. Wet process. Asbestos from Dzhetygara.
88	Oktyabr'skiy Ust'-Kamenogorsk, Vostochno-Kazakhstanskaya Obl.	800,000	180,000	Portland cement	Three rotary kilns: one 5 x 185 m., two 3 x 100 m. Wet process. One 5 x 185-m. kiln, 600,000-ton rated annual capacity, put in operation in December of 1968; another such kiln planned.
89	Alumina Plant, Achinsk, Krasnoyarskiy Kray.	1,300,000	1,172,000	....*do*	Two 5.8/4.8/5.3 x 175-m. rotary kilns of French manufacture. Wet process. Three additional 175-m. kilns planned, 560,000-ton rated annual capacity each, to be constructed in 1971 and 1972.
90	Krasnoyarsk, Krasnoyarskiy Kray	1,100,000	920,000	Portland cement, slag-portland cement, asbestos-cement products, and slate.	Seven rotary kilns: three 3.6 x 60 m., two 3.3 x 118 m., two 3.6 x 150 m. Coal fuel. Wet process. Reconstruction of old kilns planned.
91	Angarsk, Irkutskaya Obl	1,200,000	895,000	Portland cement including grade 600	Four 3.5 x 150-m. rotary kilns. Liquid fuel. Wet process.
92	Temlyuy, Buryatskaya A.S.S.R	600,000	537,000	Portland cement, siliceous cement, and slate.	Two 3.6 x 150-m. rotary kilns. Asbestos-cement products shop.
93	Bestyakh, Yakutskaya A.S.S.R	*na*	*na*	....	Under construction. Planned capacity for 1970, 100,000 tons of cement.
94	Teploozersk, Khabarovskiy Kray	990,000	679,000	Portland cement, rapid-hardening cement, and portland-pozzolan cement.	Six rotary kilns: two 80 m., four 3.6 x 127 m.
95	Spassk-Dal'niy, Primorskiy Kray	1,500,000	1,337,000	Portland cement, lime meal, asbestos-cement pipe, and slate.	Five rotary kilns: four 3.6 x 51 m., one 3.6 x 58.9 m. Dry process. Exports cement to Southeast Asia. Plant reconstructed and modernized in 1959–65. Construction planned for a new plant nearby with two 5 x 185-m. rotary kilns.
96	Poronaysk, Sakhalinskaya Obl	*na*	83,000	....	Shaft kilns.

na Data not available.
*Identifying reference number on Figure 38, map.
**Plant name not given where same as town name.

25X1

FIGURE 35. MAJOR CONSTRUCTION GLASS PLANTS

MAP REF. NO.*	PLANT NAME** TOWN ADM. DIV.	ESTIMATED WINDOW-GLASS PRODUCTION, 1967	REMARKS
		Millions of square meters	
1	Jarvakandi Estonian S.S.R.	2.0	Other products: electric insulators and technical glass.
5	Sarkandaugava Riga Latvian S.S.R.	2.6	
7	Radvilishkis Lithuanian S.S.R.	1.5	
8	Panevezys Lithuanian S.S.R.	1.8	Other products: plate glass, glass blocks, and electric insulators. Shop with a production capacity of 3.2 million glass blocks per year is in operation.
9	Polotsk Vitebskaya Oblast' (Obl.)	*na*	Largest fiberglass plant in the Soviet Union. Pilot plant in U.S.S.R. for the production of glass concrete fittings.
18	L'vov L'vovskaya Obl.	2.1	Other products: electric insulators, technical glass, and glassware.
23	Chagoda Vologodskaya Obl.	13.6	Third largest U.S.S.R. window-glass plant. Also produces foam glass.
31	Velikiy Oktyabr' Firovo Kalininskaya Obl.	5.5	Also produces glass pipes.
34	Leninskiy Moscow Moskovskaya Obl.	3.0	
38	Pioner Misheronskiy Moskovskaya Obl.	5.3	Also produces plate glass.
39	Kaluga Kaluzhskaya Obl.	*na*	Produces construction glass.
42	Bytosh Bryanskaya Obl.	3.3	*Do.*
43	Ivot Bryanskaya Obl.	4.7	*Do.*
48	Skopin Ryazanskaya Obl.	*na*	Produces glass blocks.
49	Lomonosov Kostyukovka Gomel'skaya Obl.	14.0	Fourth largest U.S.S.R. window-glass plant. Pilot plant for the production of foam glass and glass pipes. Other products: plate glass and hardened glass. Plans to produce glass blocks. 3,200 workers.
55	Proletariy Lisichansk Luganskaya Obl.	23.3	Largest U.S.S.R. window-glass plant. Other products: plate glass, automobile glass, glass blocks, glass tiles, plastic glass, and glass wool. Planned to produce 3.4 million glass blocks in 1967. Polished glass production capacity of 400,000 square meters per year to be attained in near future. Avtosteklo Glass Plant, also in Lisichansk, is the pilot plant for the production of automobile glass. Other products: window glass, polished glass, triplex laminated safety glass, technical glass, and optical glass. Expansion planned by 1970.
58	Oktyabr'skaya Revolyutsiya Konstantinovka Donetskaya Obl.	20.5	Second largest U.S.S.R. window-glass plant. Also produces construction glass, glass pipes, silicate tiles, and packing glass.
63	Krasnodar Krasnodarskiy Kray	1.2	
66	Bor Gor'kovskaya Obl.	6.2	Other products: plate glass, profile glass, automobile glass, and technical glass.
74	Dzerzhinskiy Gus'-Khrustal'nyy Vladimirskaya Obl.	6.0	Other products: plate glass, polished glass, profile glass, automobile glass, triplex laminated safety glass, hardened glass, technical glass, and packing glass. Expansion planned by 1970. Glass research institute at plant.
79	Kurlovskiy Vladimirskaya Obl.	1.2	Also produces plate glass and colored glass.

Footnotes at end of table.

FIGURE 35. MAJOR CONSTRUCTION GLASS PLANTS (*Continued*)

25X1

MAP REF. NO.*	PLANT NAME** TOWN ADM. DIV.	ESTIMATED WINDOW-GLASS PRODUCTION, 1967	REMARKS
		Millions of square meters	
86	Saratov Saratovskaya Obl.	4.2	Largest construction and technical glass plant, produces 15% of total glass output in the U.S.S.R. Principal producer of polished glass, shopwindow glass, and electrical insulators. Other products: plate glass, automobile glass, glass blocks, and plastic glass. 6,000 workers. Glass research institute at plant.
93	Dagestanskiye Ogni Dagestanskaya A.S.S.R.	8.8	Also produces glass tiles and foam glass.
95	Sumgait Azerbaijan S.S.R.	5.7	Other products: plate glass, automobile glass, and bottles.
96A	Sylva Permskaya Obl.	2.0	Also produces electrical insulators, technical glass, and glassware.
102	Krasnousol'skiy Bashkirskaya A.S.S.R.	5.0	
103	Magnitogorsk Chelyabinskaya Obl.	3.5	
104	Salavat Bashkirskaya A.S.S.R.	11.0	Fifth largest U.S.S.R. window-glass plant. Other products: plate glass, automobile glass, triplex laminated safety glass, glass blocks, and technical glass. The plate glass shop has a production capacity of 3 million square meters per year.
105	Ashkhabad Turkmen S.S.R.	6.0	Other products: electric insulators, packing glass, and glassware.
106	Irbit Sverdlovskaya Obl.	2.4	
111	Chirchik Tashkentskaya Obl.	2.7	Also produces plate glass.
115	Anzhero-Sudzhensk Kemerovskaya Obl.	7.4	*Do.*
119	Tulun Irkutskaya Obl.	2.5	Other products: glass blocks and packing glass.
120	Ulan-Ude Buryatskaya A.S.S.R.	12.3	Also produces plate glass. Plans to produce technical glass, glass blocks, and glass wool.
122	Raychikhinsk Amurskaya Obl.	6.0	Other products: foam glass and bottles.
124	Stekol'nyy Magadanskaya Obl.	0.3	
125	Khabarovsk Khabarovskiy Kray	*na*	Produces glass wool and other fiberglass products.

na Data not available.
*Identifying reference number on Figure 39, map.
**Plant name not given where same as town name.

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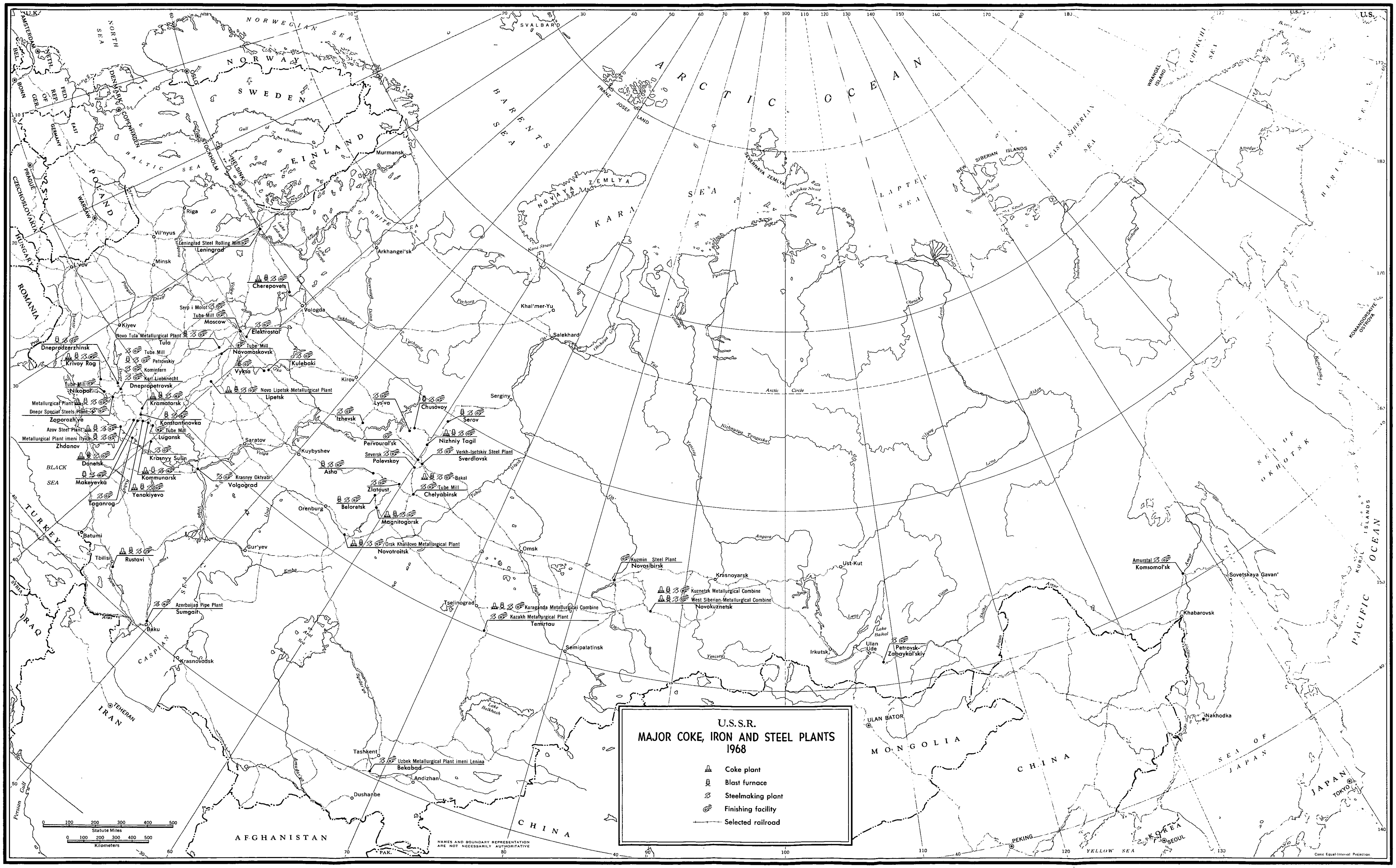

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Coke, Iron, and Steel Plants Figure 36

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