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PROVISIONAL INTELLIGENCE REPORT

COBALT IN THE SOVIET BLOC

CIA/RR PR-76

(ORR Project 23.175)

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FOREWORD

Because of the strategic importance of cobalt in the production of military end items, reliable information about the production and use of cobalt in the Soviet Bloc is very scarce. The purpose of this research aid is to present the data that are available, to derive estimates from them, and to formulate conclusions based on the data and the estimates and -- to some extent -- on US analogy.

US analogy has been a useful aid in deriving a quantitative cobalt use pattern in the Soviet Bloc. For that reason, US data are presented in some detail.

Quantitative estimates in this research aid should be considered tentative.

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Summary

The production of cobalt in the Soviet Bloc is limited almost entirely to the USSR. Communist China, North Korea, and East Germany are reported to have produced small quantities, but Satellite production in total has been negligible. Production of cobalt in the USSR in 1953 is estimated at 1,800 metric tons,** a production second only to that of the Belgian Congo. Production in 1954 is estimated at about 2,000 tons, roughly 13 percent of the world's 1954 supply of cobalt.

The reserves of cobalt-bearing ore -- largely nickel -- of the USSR are estimated to be approximately 49,000 tons of metallic cobalt content. Communist China and North Korea have some reserves, but available data do not support a quantitative estimate. At the 1954 production rate of about 2,000 tons of cobalt annually, the reserves of the Soviet Bloc will permit production for a period of about 25 years.

Reliable estimates of trade in cobalt and cobalt-bearing ores cannot be made. Available information indicates that intra-Bloc trade consists primarily of shipments of metallic cobalt from the USSR to the Satellites -- not more than 100 tons in 1953 -- and small shipments of cobalt-bearing ores from Communist China and North Korea to the USSR. East-West trade in cobalt is, of course, proscribed under COCOM agreements, but by clandestine transshipment the Soviet Bloc imported an estimated 200 tons in 1953, largely from West Germany and France.

A quantitative use pattern for cobalt in the Soviet Bloc cannot be firmly established. The application of US analogy to available data, however, permits 1953 quantitative estimates which are significant, if not completely reliable.

* The estimates and conclusions contained in this research aid represent the best judgment of the responsible analyst as of 1 July 1954.

** Throughout this research aid tonnages are given in metric tons, unless otherwise specified.

The aircraft engine industry in the USSR is the largest consumer of cobalt. It is estimated that in 1953 about 400 tons of cobalt were used in the manufacture of vanes and blades for the VK-1A jet engine, and the industry probably consumed some cobalt for other uses. The electrical industry consumed about 130 tons of cobalt in the manufacture of "alnico" magnets. About 80 tons of cobalt were consumed as binder for cemented carbides, which are used in the manufacture of high-speed cutting tools and the like. Other uses consumed some cobalt, but no firm data on those uses are available, and a quantitative estimate based on US analogy would have little significance. Total 1953 consumption of cobalt in the USSR, then, is estimated at about 600 tons. This estimate is definitely a minimum; it does not include cobalt consumed for uses which cannot be identified and for which quantitative estimates cannot be made.

The 1953 consumption of cobalt for all purposes in Communist China and the European Satellites is estimated at not more than 300 tons. In all probability, a major portion of the end products containing this cobalt is returned to the USSR. Of the total 300-ton Satellite requirement the USSR supplied approximately 100 tons; the remainder is balanced by the estimated 200 tons imported by the Bloc from the West and can be eliminated as a factor in the consumption-to-production ratio.

The estimated consumption of 600 tons of cobalt by the USSR plus the 100 tons exported to the Satellites indicates that 700 tons of the 1,800 tons produced in the Soviet Bloc in 1953 were actually used. Even assuming that the 700-ton estimate of consumption by the Bloc is very low, there is still a wide gap between production and consumption. This gap might well indicate an extensive stockpiling program. Although there is no firm evidence of such a program, it is logical to conclude that a metal of the strategic importance of cobalt is definitely being stockpiled. Because there is no available information on the historical background of the stockpiling program, it is impossible to make a quantitative estimate of the present Soviet stockpile.

The capability of the Soviet Bloc to increase long-term production of cobalt is limited by the relatively short-term reserves. Substantial increase of total supply by imports is presently limited by COCOM restrictions. The capability of the cobalt industry of the Soviet Bloc in time of war, however, cannot be firmly evaluated. There is no evidence to indicate that the Bloc could not increase

short-term production within 6 months or a year of any given date, and such an increase coupled with the probable stockpiled reserves might well satisfy the immediate requirements of a wartime economy.

Three additional factors might affect the wartime capability of the Soviet Bloc cobalt industry. (1) Should Soviet scientists develop a satisfactory substitute for cobalt as an alloying metal, a development which is possible but probably not imminent, the demands on the supply of cobalt would be somewhat eased. (2) Soviet efforts to conserve cobalt, demonstrated by the fact that -- contrary to US practice -- no cobalt is used in the manufacture of reciprocating engines for aircraft, might extend the cobalt supply appreciably. (3) In the event of war the USSR might take over the Finnish copper mine at Outokumpu, the ore from which is cobalt bearing, and could augment the present total Soviet Bloc supply by about 25 percent. All three of these factors are affected, in turn, by the fact that increased supplies of cobalt would be partially consumed by additional demands for new uses.

The cobalt industry of the Soviet Bloc is vulnerable only to the extent that production facilities are concentrated in four refineries and to the extent that the Bloc is dependent on imports from the West.

A marked increase in Soviet efforts to purchase cobalt from the West or a substantial expansion of the cobalt production facilities of the Soviet Bloc would be indicators of Soviet military intentions. Considering the known reserves of cobalt-bearing ores in the Soviet Bloc and their possible augmentation by Finnish reserves, and assuming that the USSR has been stockpiling cobalt in considerable quantities since the beginning of Soviet production in 1940, it is probable that cobalt will continue to have high priority on the Soviet list of critical metals.

I. Introduction.

A. General.

Because cobalt is an alloying metal essential in the production of a number of military end items -- notably engines for jet aircraft -- its production, supply, and utilization in the Soviet Bloc are cloaked in military secrecy. It is estimated that about 75 percent of the total Soviet Bloc consumption of cobalt is used in the production of components for military equipment. This estimate is supported, to some extent, by a well-based prediction that in the event of war about 75 percent of the total US supply of cobalt would be channeled into military applications. 1/*

In addition to the virtual absence of Soviet information, there are other factors which complicate the study of cobalt in the Soviet Bloc:

1. Some of the major quantitative uses of cobalt are for products containing the metal as a minor constituent.

2. Cobalt occurs almost always in combination with other metals -- principally copper and nickel -- and generally comprises only a very small percentage of the ores. In the USSR, nickel and cobalt are grouped organizationally under the Chief Directorate of Nickel and Cobalt, Ministry of the Nonferrous Metallurgical Industry, 2/ Director, A. A. Mironov. 3/

3. The extraction and refining of cobalt is a protracted and complex process, and the quantities produced are relatively small in comparison with other alloying metals.

B. Principal Uses of Cobalt.

The uses of cobalt can be classified into two broad categories, metallic and nonmetallic. The metallic category, in turn, can be divided into ferrous, nonferrous, and powder-metallurgy groupings. The metallic uses of cobalt are the most important, technologically as well as quantitatively.

* Footnote references in arabic numerals are to sources listed in Appendix F.

1. Metallic.

a. Ferrous.

Large amounts of cobalt are used in the US for permanent-magnet steels, which have diverse applications in the communications and electrical industries. In the US, production of "alnico" magnets annually consumes more than 900 tons of cobalt. 4/ The USSR also has specifications for alnico-type magnets. 5/ The USSR, as well as the US, is trying to find suitable substitutes using little or no cobalt. 6/ It is not likely that this research would be done unless the Bloc consumption of cobalt for magnets were sufficiently large to support the effort.

b. Nonferrous.

The use of cobalt in cast cobalt-chromium-tungsten-molybdenum alloys (stellites) for high-temperature applications is a large consumer in the US, particularly for jet engines. 7/ In the US, the 44-percent-cobalt alloy, S-816, has been extensively used for jet rotor blades. 8/ The Soviet jet engine, VK-1A, also uses a similar alloy for the same purpose. 9/

c. Powder Metallurgy.

Cobalt is a most satisfactory binder for tungsten and other cemented carbides. Many of these carbides are shaped and made into high-speed cutting tools. The USSR has GOST (All-Union Standard) specifications covering a variety of cemented carbides. 10/

During World War II, cemented carbides were used as cores for armor-piercing shells. 11/ This is one cobalt application which would soar in time of war, unless a suitable substitute were available.

Other important uses of cobalt, though not necessarily in volume, for which there are indications of Soviet or Bloc consumption include alloy welding rods for coating a hard surface on rapidly wearing steel surfaces 12/ and low-expansion alloys used for glass-to-metal seals such as are used in the electronics industry. 13/

2. Nonmetallic.

Most nonmetallic uses of cobalt are of a less critical nature. These include ground-coat frit, which is used for enamels; pigments; and catalysts. Catalytic applications worthy of note include use in the synthesis of fluorcarbons, which aid in the separation of uranium isotopes; use in gas masks; and possible use in the synthetic gasoline industry. 14/ No information is available concerning Soviet nonmetallic use of cobalt for any of these purposes.

II. Supply.

A. USSR.

1. Development of the Industry.

Although cobalt was produced in Tsarist Russia as early as 1884, the USSR first produced cobalt in 1940 -- from the reworked tailings of the Pysma copper mine in the Urals. Production from this source reached several hundred tons annually at peak output, but the quality of the product was uncertain. 15/ In 1946, production of pure cobalt (99 percent) was achieved for the first time in the USSR at the Orsk nickel combine, 16/ which has become a key center of research and production in the Soviet cobalt industry.

In the postwar period the USSR has placed considerable emphasis on geologic prospecting for ores, on research, and on development of new processes for treating complex ores containing cobalt. The greatest progress seems to have been made in extracting cobalt from nickel ores, especially nickel sulphides. Cobalt-bearing nickel ores now serve as the source of 85 percent to 90 percent of total Soviet production of cobalt.

The USSR is the world's second largest producer of cobalt, exceeded only by the Belgian Congo, the source of a major portion of US cobalt supplies. In 1952 the USSR was the source of about 15 percent and the Belgian Congo about 58 percent of the total world production of cobalt. 17/*

* See Table 4, p. 13, below.

2. Reserves.

During the course of the successive Five Year Plans the USSR conducted an extensive program of exploration for cobalt ores in various parts of the country. (Indigenous production prior to World War II was negligible, and the USSR relied almost entirely on imports of cobalt.) This exploration program apparently met with some success, for the USSR has claimed to have the world's largest reserves of cobalt. 18/

The greater part of the cobalt reserves of the USSR occurs with nickel ores, and because of this, the cobalt and nickel industries are closely related. Cobalt also occurs with ores containing iron, manganese, copper, and other elements. These complex polymetallic ores present special difficulties in the extraction of cobalt and are not yet a fully established source of cobalt. There are few deposits in the USSR known to be mined solely for their cobalt content.

The cobalt-bearing nickel ores, which are the primary source of cobalt in the USSR, are located chiefly in the Kola Peninsula (Economic Region* Ia), in the northern area around Noril'sk (Economic Region XI), in the central and southern Urals (Economic Region VIII), and in the Kazakh SSR (Economic Region Xa). A few additional lower grade deposits in other areas were mined during the middle 1940's to help fill essential needs. The complex ores of iron, manganese, and copper which contain cobalt are located mainly in the Urals (Economic Region VIII) and in Siberia (Economic Regions IX and XI). The small percentage of the total reserves contained in ores mined principally for their cobalt content is located primarily in the Transcaucasus (Economic Region V) and in the Urals (Economic Region VIII).

From the references which give the cobalt content of the nickel-ore reserves, it is possible to derive a rough estimate of cobalt reserves. Approximately 80 percent of the cobalt reserves of the USSR are reportedly associated with nickel ores and 18 percent with the complex ores of iron, manganese, and copper. Only 2 percent is found in ores mined principally for their cobalt content. 19/

* The term region in this research aid refers to the economic regions defined and numbered on CIA Map 12048.1, 9-51 (First Revision, 7-52), USSR: Economic Regions.

Table 1* shows estimated reserves of cobalt in the USSR, 1939-54.

3. Production.

Cobalt is produced in the USSR at the present time largely as a byproduct of nickel refining. The four nickel combines in the USSR, located at Monchegorsk (Economic Region Ia), Verkhniy Ufaley (Economic Region VIII), Orsk (Economic Region VIII), and Noril'sk (Economic Region XI), each have facilities for refining cobalt. 20/

Smaller quantities of cobalt are produced from ores which are mined primarily for their cobalt content. Ore from these mines is concentrated locally and shipped to 1 of the 4 nickel combines for refining. The Dashkesan mine, located about 40 kilometers from the city of Kirovabad in Azerbaydzhan (Economic Region V), is probably the largest single producer of this type of ore. This deposit was originally opened in 1884 and operated until about 1915, when it was believed the ore supply had been exhausted. The mine was reopened in 1937, and a new ore concentrating plant was placed under construction, 21/ which would indicate that either new ore reserves had been discovered or that a new process had been developed for treating the remaining low-grade ore.

Small amounts of cobalt have reportedly been produced in the postwar period at Bolshoy Canyon near Seymchan (62°63' N - 152°26' E, Economic Region XII), in the Far East. The ore is concentrated at Seymchan, trucked under heavy military guard to a nearby airfield, and flown to Magadan (Economic Region XII). From Magadan the concentrate is shipped to 1 of the 4 nickel refineries for further processing. The costly transportation and handling involved in this operation indicate the heavy expenditures the USSR is willing to make to obtain cobalt, even in small quantities. 22/

Details regarding production from other cobalt-bearing ore deposits in the USSR, including the remaining polymetallic deposits in the Urals (Economic Region VIII) and in Siberia (Economic Regions IX and XI), are lacking. Production, if any, from these deposits is believed to be small.

* Table 1 follows on p. 9.

Table 1

Estimated Reserves of Cobalt in the USSR
1939-54

Deposit a/*	Location	Type of Ore	Nickel Reserves 1939 Estimate 23/ (Metric Tons)	Ratio of Cobalt to Nickel	Percent (Cobalt of Nickel)	Cobalt Reserve (Metric Tons)
Region Ia						
Northwest						
Monchegorsk	67°55' N - 32°58' E	Nickel-Sulphide	180,000	1:27.4 24/	3.64	6,500
Pechenga	69°20' N - 30°15' E	Nickel-Sulphide	236,000	1:58.5 25/	1.71	4,000
Region VIII						
Urals						
Central Urals						
Verkhniy Ufaley	56°05' N - 60°15' E	Nickel-Silicate	100,000	1:40 26/	2.50	2,500
Rezh	57°25' N - 61°20' E	Nickel-Silicate				
Revda	56°48' N - 59°58' E	Nickel-Silicate				
Southern Urals						
Orsk-Khalilovo	51°25' N - 58°08' E	Nickel-Silicate	300,000	1:20 27/	5.00	15,000
Aydyrlinskiy	51°25' N - 59°00' E	Nickel-Silicate				
Novo-Troitsk	51°15' N - 58°10' E	Nickel-Silicate				
Region Xa						
Kazakh SSR						
Kimpersayskiy	50°50' N - 58°20' E	Nickel-Silicate	120,000	1:20 28/	5.00	6,000
Burnovo Shelekta	50°40' N - 58°10' E	Nickel-Silicate				

* Footnotes for Table 1 follow on p. 10.

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Table 1

Estimated Reserves of Cobalt in the USSR
1939-54
(Continued)

Deposit a/	Location	Type of Ore	Nickel Reserves 1939 Estimate 23/ (Metric Tons)	Ratio of Cobalt to Nickel	Percent (Cobalt of Nickel)	Cobalt Reserve (Metric Tons)
Region XI						
East Siberia						
Noril'sk	69°20' N - 88°06' E	Nickel-Silicate	200,000	1:11 29/	9.10	18,200
Total Cobalt Reserves of Nickel Deposits, 1939						52,200
Cobalt Lost from Nickel Deposits as Result of Nickel Production, 1939-53						13,000 b/
Cobalt Reserves of Nickel Deposits at the Beginning of 1954 (80 Percent of Total)						39,200
Region V						
Transcaucasus						
Dashkesan	40°39' N - 66°04' E	Copper-Cobalt		(2 Percent of Total)		1,000 c/
Others		Polymetallic		(18 Percent of Total)		9,000 d/
Total Cobalt Reserves of the USSR at the Beginning of 1954						49,200 e/

a. See Appendix B for a more complete list of deposits of cobalt-bearing ores in the USSR.
b. From 1939 through 1953 the nickel reserves of the USSR were reduced by 25 percent as a result of nickel production. 30/
c. Includes all deposits worked primarily for their cobalt content.
d. Includes all deposits of complex polymetallic ores containing cobalt.
e. This figure represents cobalt content. Recoverable cobalt would be less.

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Since cobalt is produced in the USSR largely as a byproduct of nickel refining, there is a fairly stable relationship between cobalt production and nickel production. This relationship varies between the various nickel combines, chiefly as a result of the different cobalt contents of their nickel ore supplies. Standard grades of refined nickel in the USSR contain about 1 percent cobalt. 31/ Thus, by adjusting the cobalt-to-nickel ratios given in Table 1 for this 1 percent loss, it is possible to arrive at estimates of cobalt production as a byproduct of nickel production.

Table 2 shows estimated production of cobalt from nickel ores in the USSR, 1953.

Table 2

Estimated Production of Cobalt from Nickel Ores in the USSR
1953

Plant	Production of Nickel 32/ (Metric Tons)	Percentage Factor Representing Recoverable Cobalt	Production of Cobalt (Metric Tons)	Percent of Total
Monchegorsk a/	15,000	1.7	250	16
Verkhniy Ufaley	4,000	1.5	60	4
Orsk	15,000	4.0	600	38
Noril'sk	8,000	8.1	650	42
Total	42,000		1,560	100

a. Includes production from Pechenga ores.

Table 3* shows estimated production of cobalt in the USSR, 1948-55.

Table 4** shows production of cobalt in the USSR as compared with other cobalt-producing countries in 1952.

* Table 3 follows on p. 12.
** Table 4 follows on p. 13.

Table 3

Estimated Production of Cobalt in the USSR
1948-55

Metric Tons

Year	Production of Nickel 33/	Cobalt Produced from Nickel Ores a/	Other Production b/ 34/	Total c/
1948	25,000	930	240	1,170
1949	29,000	1,080	240	1,320
1950	32,000	1,190	240	1,430
1951	35,000	1,300	240	1,540
1952	39,000	1,450	240	1,690
1953	42,000	1,560	240	1,800
1954	45,000	1,670	240	1,910
1955	49,000	1,820	240	2,060

a. Based on the calculations in Table 2. 1953 production of cobalt from nickel ores was 3.71 percent of production of nickel. This same ratio has been applied to the other years.
b. Chiefly Dashkesan, for which a steady rate of production is estimated.
c. Figures are maximum estimates and may be as much as 25 percent high.

B. Satellites.

1. Reserves.

Communist China and North Korea are the only Satellites with cobalt deposits worthy of mention.

a. Communist China.

Cobalt deposits in Communist China are located mainly in Yunnan Province. Fukien Province has several small manganese deposits which contain minor amounts of cobalt. There is not sufficient information available to permit an estimate of Chinese cobalt reserves.

Table 4

Production of Cobalt in the USSR
as Compared with Other Countries a/
1952

Country	Cobalt Production b/ (Metric Tons)	Percent of Total
Belgian Congo	6,831	58
French Morocco	1,000	9
Northern Rhodesia	585	5
Canada	592	5
US	379	3
Other Non-Bloc Countries	613	5
USSR	1,690	15
Total	11,690	100

a. Latest year for which detailed data are available for non-Soviet Bloc countries. Non-Bloc production for 1953 is estimated at 12,000 metric tons by the US Bureau of Mines. Estimated Soviet production in 1953 (Table 3) would thus be about 13 percent of world total.
b. See Table 3 for source of USSR estimate; for other countries, 35/.

Table 5* shows the location of the known cobalt deposits in Communist China.

b. North Korea.

In 1946, US Army technicians estimated North Korea's cobalt reserve at 422,000 tons of ore averaging 0.1 percent to 0.2 percent of cobalt. 36/ It is believed that this estimate does not include the deposit in the vicinity of Tanch'on, which was to have been exploited on a large scale. 37/

* Table 5 follows on p. 14.

Table 5 38/

Cobalt Deposits in Communist China

Deposit	Location
P'ing-i	25°43' N - 104°09' E
Fu-min	25°14' N - 102°30' E
Sung-ming	25°22' N - 103°01' E
Hsun-tien	25°34' N - 103°12' E
Chan-i	25°38' N - 103°38' E
Ch'eng-kung	25°55' N - 102°48' E
Chin-ning	24°44' N - 102°42' E
Hsuan-wei	26°14' N - 104°00' E
Tu-nan	24°46' N - 103°17' E

Table 6 shows the location and type of known cobalt deposits in North Korea.

Table 6 39/

Cobalt Deposits in North Korea

Deposit	Location	Coordinates	Type of Ore
Hoeryong - Cobalt	Hoeryong-gun, Hamyong-pukto	42°25' N - 129°45' E	Smaltite
Unsong - Nickel	Tanch'on-gun, Hyangyong-namdo	40°39' N - 129°01' E	Cobalt, Nickel-bearing Pyrrhotite
Wondong - Gold	Kumhwa-gun, Hwanghae-do	38°16' N - 128°10' E	Cobaltite-Erythrite

2. Production.

a. Communist China.

Communist China produces small quantities of cobalt ores and salts which traditionally have been used in the porcelain industry. In recent years it has exported small quantities of cobalt ores and concentrates to the European Satellites. The quantity of these exports and the level of current production are unknown.

Communist China has no known facilities for the reduction of cobalt metal. Successful experiments in extracting pure cobalt metal from Chinese ores have been announced by the China Academy of Sciences, 40/ and it is possible that cobalt-refining facilities may be established.

b. North Korea.

Prior to 1950, cobalt was produced at the Haeju Smelting Works, National Ore Refinery, Haeju (37°51' N - 125°42' E). Production early in 1950 was at the rate of 1 ton a month, all of which was exported to the USSR. 41/ Haeju was bombed during the recent hostilities. 42/ It is believed that production of cobalt will be restored at the earliest possible date, and that it will be used to compensate the USSR for part of its aid.

c. East Germany.

Although East Germany has no known deposits of cobalt, small amounts have been recovered from other nonferrous metal refining in recent years. Planned production in 1952 was 28.2 tons. 43/ It is not known whether this goal was attained. Plans for 1953 and 1954 did not call for the production of cobalt. 44/

III. Consumption and Requirements.

Only fragmentary estimates are available on consumption of cobalt in the Soviet Bloc. These estimates are given as the best available, even though they may contain substantial errors.

A. USSR.

The use of cobalt for permanent magnets is so important that an estimate of Soviet consumption for this purpose has been made in spite of the involved methodology required. The Bureau of Mines has constructed coefficients for US cobalt consumption in magnets for peacetime and for periods of mobilization. 45/ These coefficients were constructed by relating the cobalt input for magnets to the dollar output of the electrical industry. It was recognized that the peacetime coefficient, 0.2921 (pounds of cobalt per $1,000 of production, 1947 dollars), included many noncritical uses. The mobilization coefficient, 0.1619, based on 1952 conditions, was considered the better one because it included a minimum of non-essential magnet uses. The estimated value of 1953 production of the Soviet electrical industry in terms of 1947 dollars was $1,740,000,000. 46/ The cobalt consumption derived by applying the mobilization coefficient to this figure is as follows:

$$\frac{0.1619 \times 1{,}740{,}000}{2204} = 128 \text{ tons}$$

US consumption for the same year and the same purpose was 1060 tons.

There is only one known use for high-temperature, cobalt-containing alloys by the Soviet aircraft industry: the VK-1A engine.* Consumption for this purpose is estimated as follows 48/:

Year	Metric Tons**
1953	400
1954	850***
1955	1,500
1956	1,800

The production of cemented carbides in the USSR is estimated at 360 tons a year. 49/ The average cobalt content of these carbides is estimated at 22 percent. 50/ Based on these figures, the total

* The Soviet aircraft industry probably does not use cobalt in the manufacture of reciprocating engines. 47/

** This estimate does not include possible use of cobalt in the new Soviet bombers.

*** 1954-56 estimates are based on the VK-1A production at capacity operation.

estimate for this category is 79 tons a year. US consumption for the same purpose was 276 tons in 1952 and 163 tons in 1953.

Consumption data for other uses are totally lacking, and even US analogy would be meaningless. In the US these other varied uses accounted for 25 percent of the total in 1953.

Soviet exports of cobalt to the Satellites are estimated at 100 tons in 1953. The remainder of the 300-ton Satellite requirement is balanced by the estimated 200 tons imported from the West. 51/

Total estimated consumption of cobalt produced by the Bloc in 1953, then, is 707 tons. On the basis of estimated production of 1,800 tons in 1953, the USSR would appear to have much more than enough cobalt for current needs. Every other indication, however, is to the contrary.

It is possible that the estimate of production in 1953 is somewhat high. The average nickel-cobalt ratio given in Table 1* is 21:1, whereas a Soviet book on cobalt lists it as 25-50:1. 52/ It is possible that this Soviet figure failed to take into consideration the Noril'sk deposit (Economic Region XI), where, although the amount of cobalt per ton of ore is small, the cobalt-nickel ratio is much higher than the average for the rest of the USSR. In Table 2** the ratio of nickel to cobalt is 27:1 because of the 1 percent residual in the nickel.

On the other hand, consumption by the Soviet aircraft industry may be higher than indicated. Production of the VK-1A engine covers only one use of cobalt by the aircraft industry, and there may be others. In 1953, US consumption of high-temperature alloys was 2,400 tons, 53/ or 6 times the estimate for the USSR. By 1955, unless adequate substitutes are found, it is estimated that VK-1A production will absorb 75 percent of the Soviet supply of cobalt.

It is also possible that the estimates given for supply and demand are close to the actual figures. In such a case, there is only one conclusion: that the USSR is stockpiling 500 tons to 1,000 tons of cobalt a year, out of a production of approximately 2,000

* P. 9, above.
** P. 11, above.

tons. In comparison, the US consumes only about half of the cobalt it imports each year.

Without a substantial stockpile of cobalt the USSR would be severely handicapped by lack of cobalt by 1956, and before that time in the event of war. During the first year of a war, US consumption would be expected to increase threefold over present consumption. 54/

B. Satellites.

Most information concerning the consumption of cobalt in the Satellites was obtained as secondary information listed in trade documents.

1. East Germany.

The largest use of cobalt in East Germany is in the iron and steel industry. Estimated requirements for 1953 were 25.3 tons. 55/ About one-fifth of this amount is used at Stahl and Walzwerk, Brandenburg, for producing high-speed cutting alloys containing 56 percent cobalt. 56/

Cobalt oxide has been listed as a bottleneck by the chemical industry, 57/ and "Kovar,"* by the electronics industry. 58/ Planned requirement of the East German Secretariat for Chemistry (DHZ) for the second half of 1953 was 12.728 tons of cobalt oxide, equivalent to about 4 or 5 tons of metal.

The 1954 Economic Plan for Liquid Fuels lists a research project for finding a cobalt substitute for use in the Fischer-Tropsch process, which normally uses cobalt as a catalyst in the production of synthetic fuels. 59/

2. Czechoslovakia.

The recently initiated production of jet aircraft by Czechoslovakia will tend to increase its shortage of cobalt. A recent importation of 10 tons of a stellite-type alloy, "Crinite," might possibly be used for this purpose. 60/ Early in 1952 the use of high-speed steels containing cobalt was reserved solely for machining ball bearings. 61/

* A low-expansion iron alloy, 18 percent cobalt, used for glass-to-metal seals.

3. Other Satellites.

Hungary has been reported as importing cobalt for the electrical industry, 62/ and Poland is trying to import cobalt acetate, which is used as a drier by the paint industry. 63/

In 1940, China imported 72.4 tons of cobalt oxide, most of which was used by the porcelain industry, and a small quantity of cobalt was used by the Manchurian steel industry. 64/ In 1950, Chinese requirements for cobalt metal during the first quarter of 1951 were reported as 50 tons. 65/ It is believed that this figure approximates the requirement for an entire year.

On the basis of this sparse information, it is estimated that Satellite requirements for cobalt total not more than 300 tons a year.

C. Conservation.

There are three ways in which the supply of cobalt can be stretched--by substituting other materials, by controlling specifications so that the smallest effective amount of cobalt is used, and by salvaging cobalt from scrap.

A great deal of research has been done on substitutes for alnico magnets. The materials which appear to have the greatest promise are those based on the fact that the coercive force of all magnetic materials increases materially if they are converted into powder of very small particle size. 66/ The Ugine Co., Grenoble, France, 67/ and Philips Laboratories, Holland, produce magnets of this type. In 1952, Dr. Hellerman of Hescho-Hermsdorf, East Germany, was conducting research on "Ferroxdure" (BaO_6 (Fe_2O_3)), a Philips product 68/; and since then production has started on hard magnets made of "Manipern," a corresponding product. All factors considered, the alnico V, which contains cobalt, is still the best permanent magnet. 69/

The superiority of stellites over high-speed steels at temperatures over 1100° F is well established for such applications as turbine blades. Intensive research on such materials as titanium, chromium, molybdenum, and the ceramic metals (the "cermets") is being done with the hope of finding substitute materials.

Titanium -- because of having a higher melting point than iron, nickel, and cobalt -- was thought to have possibilities. Research has found many uses for titanium alloys, but they cannot be subjected to temperatures over 1500° F. 70/

Chromium-base alloys have shown great promise and are forgeable at proper working temperatures, but their room-temperature ductility is not adequate.

Until alloys featuring molybdenum can be made resistant to oxidation, their use at high temperatures is limited.

Cermets possess high strength and resistance to oxidation at high temperatures, but their low resistance to impact makes them a poor substitute. 71/

Nickel can be substituted for cobalt as a binder for tungsten carbides, but it yields an inferior product. 72/ Most Soviet GOST specifications for tungsten and titanium carbides are similar to US specifications and do not indicate any substitution of nickel for cobalt. 73/ Nevertheless, Soviet cemented carbides which were used for ammunition cores in Korea employed nickel in lieu of cobalt as a binder, 74/ indicating a practical approach to the problem of substituting metals.

The following quotation indicates the importance which the Russians place on substitutes for cobalt 75/:

> The saving of cobalt also is of considerable significance in industry, since it is used for the production of alloys in considerable quantity. In the near future, experimental work in the development of new alloys containing little or no cobalt must be carried out.

Soviet industry is conscious of the savings made possible by using the minimum effective amount of cobalt in the specifications. The cobalt content of cathode nickel found in Soviet vacuum tubes was reduced from 0.8 percent in 1946 to 0.001 percent in 1952. 76/ Similarly, conservation through the use of scrap metal is well established in the USSR. Even before the last war, cobalt-bearing tool steels were salvaged for their cobalt content. 77/ The use of scrap, however, is often difficult because of the contamination involved. Stocks of S-816 grindings are held as valuable scrap by US plane manufacturers, but as yet they have been unable to separate the carborundum contamination. 78/

Until now the extensive research on cobalt has produced only partially successful substitutes, and these are usable only for those applications requiring less exacting specifications. Regardless of any success in conserving cobalt, it is such an effective alloying metal that new uses will more than offset any savings.

IV. Trade.

A. Intra-Soviet Bloc Trade.

Cobalt trade within the Soviet Bloc consists largely of exports from the USSR to the European Satellites. It is probable that these exports are limited to satisfying high-priority requirements for armaments and for manufactures destined for export to the USSR.

East Germany imported 29 tons of cobalt in 1952 79/ and 30 tons in 1953. 80/ It is believed that most of it came from the USSR. Hungary imports some 25 tons to 30 tons of cobalt yearly from the USSR. 81/ The amount of cobalt exported by the USSR to the other European Satellites and Communist China is not known, but it is believed that total Soviet exports of cobalt do not exceed 100 tons per year, and are perhaps even less.

Some cobalt ore has been exported from Communist China to the European Satellites in recent years. The amount of these shipments is unknown but is believed to be small. Prior to the outbreak of the Korean War, from 10 tons to 12 tons of refined cobalt were exported from North Korea to the USSR. 82/ Because of war damage to refining facilities, it is believed, no refined cobalt is produced in North Korea at the present time. Cobalt exports, if any, are in the form of ore concentrates.

B. East-West Trade.

That the USSR falls far short of supplying the Satellites with sufficient cobalt to meet their requirements is indicated by the persistent efforts made by these countries to obtain cobalt from the West and by the strict measures taken to conserve the limited supplies available.

The COCOM embargo on cobalt, and a general shortage in the West, have combined to make imports of cobalt by the Soviet Bloc difficult but by no means impossible. By offering high premium prices, ranging up to 400 percent of free market prices, 83/ and by devising various methods of circumventing trade controls, the Bloc has been able to acquire considerable quantities of cobalt from Western sources.

Most of the cobalt illegally imported by the Soviet Bloc is refined in Western Germany and France, and is transshipped to Gdynia, Poland, via Antwerp and Rotterdam. Much of the cobalt purchased and shipped by Polish agents in Western Europe is for the accounts of Bloc countries other than Poland, including the USSR and China. 84/ Smaller amounts of cobalt have been reported transshipped from Italy and Switzerland to Czechoslovakia and the Balkan Satellites.

A compilation of reported shipments reveals that in 1953 the Soviet Bloc imported from the West 93 tons of cobalt metal and 85 tons of cobalt oxide with an estimated 30 tons of contained cobalt. An additional 56 tons of cobalt metal were reported as possibly imported. Thus, the actual and suspected shipments of cobalt from the West to the Soviet Bloc reported in 1953 totaled 179 tons. In the first 5 months of 1954, reported shipments totaled 40 tons. 85/

The reported shipments of cobalt to the Soviet Bloc do not, of course, represent the total actually shipped, nor is there any indication as to what portion of total shipments is covered by the reports. With known and suspected shipments totaling 179 tons in 1953, however, it is quite probable that at least 200 tons were imported by the Bloc in that year. This amount would be equal to about 11 percent of indigenous production of cobalt in the Bloc.

APPENDIX A

COBALT IN FINLAND

Finland, because of its proximity to the USSR, must be considered as a potential source of cobalt for the Soviet Bloc.

The copper deposit at Outokumpu, Finland, contains some 18 million tons of ore with a cobalt content of approximately 18,000 tons, or 0.1 percent. In 1952 about 600,000 tons of ore were produced from this deposit. Between 200,000 and 220,000 tons of pyrite concentrate were produced from the ore. The pyrite concentrate is sold to cellulose and sulphuric acid plants in Finland, where the sulphur is extracted by roasting. The roasting process leaves a residue of pyrite sinter which contains 0.4 percent to 0.5 percent cobalt. Current production of sinter is between 160,000 tons and 180,000 tons. 86/ The entire production of pyrite sinter is exported to Duisburger Kupferhutte at Duisburg, West Germany, from which the Duisburg firm produces an estimated 500 tons of 97 percent to 98 percent pure cobalt yearly. 87/ The agreement between the West German firm and the Finnish producer of pyrite sinter stipulates that 90 percent of the refined cobalt is retained by the Duisburg firm and 10 percent returned to the Finnish account. 88/

Tentative plans have been drawn up by the Finnish firm to construct a plant in Finland capable of processing approximately 200,000 tons of pyrite sinter per year, which, if operated at capacity, would mean a production of approximately 800 tons of refined cobalt. As yet these plans have failed to materialize.

So far as is known, there have been no direct shipments of cobalt from Finland to the Soviet Bloc in recent years, although cobalt from West Germany, refined from Finnish pyrite sinter, has been diverted to the Bloc. 89/ Finland occupies an extremely vulnerable position in relation to the USSR. The Outokumpu copper mine and the site of the proposed cobalt refining plant are only a few miles from the Soviet border. Acquisition of the Finnish industry would increase the cobalt supply of the Soviet Bloc by approximately 25 percent, provided the Soviets were able to master the technical difficulties involved in extracting the cobalt from the pyrite sinter.

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APPENDIX B

COBALT-BEARING MINERAL DEPOSITS IN THE USSR

Deposit	Approximate Coordinates	Type of Ore
Region Ia		
Kola Peninsula		
Pechenga	69°20' N - 30°15' E	nickel sulphide
Monchegorsk	67°55' N - 30°58' E	nickel sulphide
Region V		
Transcaucasus		
Dashkesan	40°39' N - 46°04' E	cobalt, copper
Kabardinskaya	44°30' N - 39°30' E	cobaltiferrous polymetallic
Labinskaya	44°39' N - 40°34' E	cobaltiferrous polymetallic
Region VIII		
Urals		
Bogoslovsk	60°10' N - 59°50' E	cobaltiferrous polymetallic
Nizhniy Tagil	57°54' N - 60°00' E	manganese, cobalt
Pyshma	56°55' N - 60°37' E	copper, cobalt
Rezh	57°25' N - 61°20' E	nickel silicate
Revda	56°48' N - 59°28' E	nickel silicate
Verkhniy Ufaley	56°04' N - 60°14' E	nickel silicate
Uktus	56°47' N - 60°40' E	nickel silicate
Beloretsk	53°58' N - 58°24' E	nickel silicate
Orsk	51°25' N - 58°08' E	nickel silicate
Aydyrlinskiy	51°25' N - 59°00' E	nickel silicate
Novo-Troitsk	51°15' N - 58°10' E	nickel silicate
Baymak	52°36' N - 58°22' E	cobaltiferrous polymetallic

Deposit	Approximate Coordinates	Type of Ore
Region IX		
West Siberia		
Altayskiy	51°58' N - 85°21' E	polymetallic
Salair	54°13' N - 85°47' E	polymetallic
Stalinsk	53°44' N - 87°10' E	iron, copper, gold
Novofirsovi	51°44' N - 82°12' E	iron, manganese
Oirot-Tura	51°58' N - 85°57' E	iron, manganese
Region Xa		
Kazakh SSR		
Kimpersayskiy	50°50' N - 58°20' E	nickel silicate
Burnovo Shelekta	50°40' N - 58°10' E	nickel silicate
Berkutovskiy	55°11' N - 79°59' E	nickel silicate
Region XI		
Transbaikal		
Noril'sk	69°20' N - 88°06' E	nickel sulphide
Petropavlovskiy	54°25' N - 123°30' E	silver, lead
Blagodatsk	51°14' N - 119°33' E	silver, lead
Chalbuchi	52°28' N - 118°38' E	silver, lead
Mikhaylovsk	49°55' N - 128°49' E	silver, lead
Nerchinsk	51°58' N - 116°35' E	silver, lead
Kultuma	52°11' N - 119°07' E	silver, lead
Region XII		
Far East		
Seymchan	62°63' N - 152°26' E	asbolite

APPENDIX C

USES OF COBALT IN THE US

The following table shows the consumption of cobalt in the US. The substantial increases in the total use of cobalt and in high-temperature alloys since the Korean war are noteworthy. Most of the cobalt listed as metallic is used for direct military applications or for supporting national defense, especially the cast cobalt-chromium-tungsten-molybdenum alloys. In the US, although consumption figures for semifinished materials are available, end-use data are difficult to obtain.

Table 7

Consumption of Cobalt in the US, by Uses
1949-53

	Percent of Total				
Use	1949	1950	1951	1952	1953
Metallic					
High-Speed Steel	6.0	2.8	3.19	2.06	2.02
Other Steel	10.0	3.1	0.80	1.07	1.51
Permanent-Magnet Alloys	25.8	34.4	20.66	15.39	21.70
Soft-Magnet Alloys	0.8	0.5	0.60	0.20	
Cast Cobalt-Chromium-Tungsten-Molybdenum Alloys	19.7	26.9	49.32	59.28	49.67
Cemented Carbides	2.5	1.7	5.79	4.67	3.34
Alloy Hard-Facing Rods and Materials	1.7	3.1	2.99	5.64	5.50
Other Metallic	2.5	2.5	2.78	1.23	2.17
Total	69.0	75.0	86.13	89.54	85.91

Table 7

Consumption of Cobalt in the US, by Uses
1949-53
(Continued)

Use	Percent of Total				
	1949	1950	1951	1952	1953
Nonmetallic (Exclusive of Salts and Driers):					
Ground-Coat Frit	9.0	8.3	4.52	2.85	3.48
Pigments	4.0	3.2	0.50	0.76	0.96
Other	1.8	0.5	0.60	0.40	0.80
Total	14.8	12.0	5.62	4.01	5.24
Salts and Driers	16.2	13.0	8.25	6.45	8.85
Grand Total	100.0	100.0	100.00	100.00	100.00
Total Consumption in Metric Tons	2,140	3,760	4,500	4,900	4,870

APPENDIX D

METHODOLOGY

There are no authoritative estimates or published figures, however remote, covering cobalt production in the USSR similar to those for other metals. Even annual percentage increases which could be applied to a base year are lacking. It was necessary, therefore, to construct reserve and production figures on the basis of unofficial reports on the nickel-to-cobalt ratio in the ores of individual nickel deposits. These ratios were applied to the estimates of nickel reserves and production which, in turn, are projections of old data. When such variables as the percent of metal recovery derived from the processing of ores and the amount of cobalt left in the nickel are considered, it becomes apparent that this method of estimating gives rise to wide variations.

Data on consumption are based on estimates covering partial consumption. Estimates were included for those categories where reasonable estimates were available, or where US analogy seemed to present a basis for a fair estimate. The estimated total is therefore incomplete and establishes a minimum figure.

Trade data are based on a recapitulation of those documents which cover the illicit trade in cobalt. The fragmentary nature of this data made it necessary to fill in the gaps covering the illicit trade on which no reports were received.

APPENDIX E

GAPS IN INTELLIGENCE

For a more accurate picture of the cobalt supply in the Soviet Bloc, there is great need for basic information and current intelligence regarding reserves, mines, production, uses, requirements, consumption, stocks, and trade.

The specific gaps in intelligence include the following:

1. Little information is available regarding the deposits of cobalt-bearing ores in Communist China and North Korea, the only Bloc countries other than the USSR known to have exploitable deposits. On the basis of available information, it is not possible to estimate Chinese ore reserves or production.

2. Information on cobalt trade in the Soviet Bloc is fragmentary. Occasional reports of individual shipments permit only approximate estimates of imports and exports.

3. Information on cobalt consumption and requirements in the Soviet Bloc, except for the USSR and East Germany, is virtually nonexistent.

APPENDIX F

SOURCES AND EVALUATION OF SOURCES

1. Evaluation of Sources.

The following studies and texts were useful for establishing the current uses of cobalt in the US and in the Soviet Bloc:

R.S. Young, Cobalt, New York, 1948.
Materials for Product Development, Proceedings of the Basic Materials Conference, 1953.
National Security Resources Board, Materials Survey - Cobalt, 1952.
Interior, US Bureau of Mines, Inter-Industry Analysis Branch Item, No. 25, 1953, A Study of the Demand for Cobalt.
Interior, US Bureau of Mines, Minerals Yearbook, 1950 and subsequent releases.

Translations from the following Russian texts were useful for facts concerning Soviet technology of cobalt but not for economic data:

F.M. Perel'man, A.Ya Zvorykin, N.V. Gudima, Kobal't, Moscow, 1949.
V.I. Smirov, The Metallurgy of Copper and Nickel, 1950.

Factual information from intelligence documents supplied by all segments of the intelligence community was related to the background information in order to glean what intelligence could be obtained.

The FDD translations covering Soviet uses of cobalt as discussed in Soviet trade journals were the most useful for establishing that Soviet uses were similar to ours but did not help in establishing quantitative data. Completed OSI and ORR studies were also helpful.

CIA/RR 35, Input Requirements of the Aircraft Industry of the USSR, 15 Jun 1954. S.
CIA/RR PR-57, Nickel Supply in the Soviet Bloc, 28 Apr 1954. S.
CIA/SI 50-53, Soviet Activities and Potential in Powder Metallurgy, 27 Jul 1953. S.

2. Sources.

Evaluations, following the classification entry and designated "Eval.," have the following significance:

Source of Information	Information
Doc. - Documentary	1 - Confirmed by other sources
A - Completely reliable	2 - Probably true
B - Usually reliable	3 - Possibly true
C - Fairly reliable	4 - Doubtful
D - Not usually reliable	5 - Probably false
E - Not reliable	6 - Cannot be judged
F - Cannot be judged	

"Documentary" refers to original documents of foreign governments and organizations; copies or translations of such documents by a staff officer; or information extracted from such documents by a staff officer, all of which may carry the field evaluation "Documentary."

Evaluations not otherwise designated are those appearing on the cited document; those designated "RR" are by the author of this report. No "RR" evaluation is given when the author agrees with the evaluation on the cited document.

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1. Munitions Board, Method of Developing Estimates for the Cobalt Basic Data Sheet, 17 Sep 1952. U. Eval. RR Doc.-3.
2. CIA FDD, Summary No. 134, 19 Mar 1954, "Organization of the Ministry of Metallurgical Industry USSR." Eval. RR Doc.-3.
3. CIA FDD, U-3092, 18 Mar 1953, Nickel Cobalt Industry in the USSR. Eval. RR Doc.-2.
4. Minerals and Metals Advisory Board Report, The Economic Comparison Between Bismanol and Alnico V, 24 Sep 1952. C. Eval. RR Doc.-1.
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CIA FDD, U-5566, 17 Feb 1954 (info., Dec 1952). U. Eval. Doc.-2.

7. R.S. Young, Cobalt, New York, 1948, p. 101. U. Eval. RR Doc.-1.

8. Minerals and Metals Advisory Board Report, Cobalt, 10 Apr 1952, p. 8. S. Eval. Doc.-1.

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10. [redacted]

11. CIA/SI 50-53, Soviet Activities and Potential in Powder Metallurgy, 27 Jul 1953. S. Eval. Doc.-2.

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13. [redacted]

14. Interior, US Bureau of Mines, A Study of the Demand for Cobalt, Part II, 17 Aug 1953. Eval. RR Doc.-1.

15. D.B. Shimkin, Minerals, A Key to Soviet Power, Cambridge, 1953. U. Eval. RR 3.

16. Trud, Moscow, 27 Apr 1947. U. Eval. RR 2.

17. H.W. Davis and C.R. Buck, "Cobalt," preprint from Minerals Yearbook 1952, Interior, US Bureau of Mines, 1953. U. Eval. RR 2.

18. WDGS, The Industries of the USSR, 20 Jun 1947. C. Eval. RR 3.

19. NIS 26, Section 63, May 1951. C. Eval. RR 3.

20. Trud, Moscow, 11 Jan 1947. U. Eval. RR 2.

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23. CIA/RR PR-57, Nickel Supply in the Soviet Bloc, 28 Apr 1954. S. Eval. RR 3.

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25. Shimkin, op. cit.

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27. Shimkin, op. cit.

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29. Ibid.

30. CIA/RR PR-57, op. cit.

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32. CIA/RR PR-57, op. cit.
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35. Davis and Buck, op. cit.
36. NIS 41, Section 63, Feb 1950. C. Eval. RR 3.
37. JANIS 75, Chapter II, Apr 1945. S. Eval. RR 3.
38. NIS 39, Section 63, Sep 1951. C. Eval. RR 2.

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41. WDGS, Intelligence Report No. TB-708-50, 10 Jul 1950. S. Eval. RR 3.

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50. CIA/RR FM, Memorandum of interview with a former CIA consultant, 13 Aug 1950. S. Eval. RR B-2.
51. CIA estimate.
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54. Munitions Board, Method of Developing Estimates for the Cobalt Basic Data Sheet, 17 Sep 1952. S.

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66. Clapp and Poliak, Inc., Materials for Product Development, 1953, p. 219. Eval. RR Doc.-1.

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70. Materials for Product Development, op. cit.

71. "Super Refractories for Use in Jet Engines," Metal Progress, Dec 1953, p. 67. Eval. Doc.-1.

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72. Young, op. cit.

73. [redacted]

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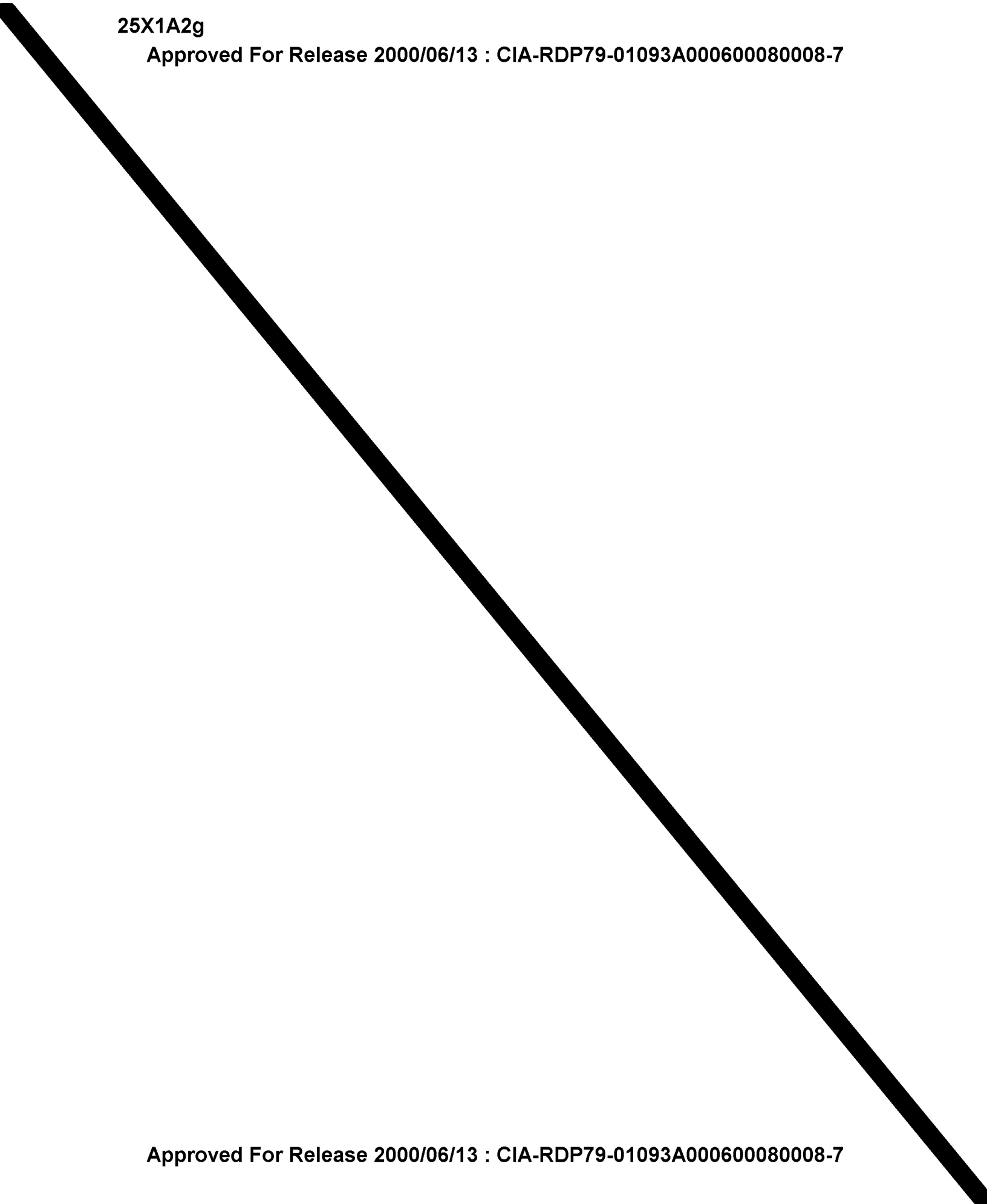

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