

COBALT

A Materials Survey

By Joseph H. Bilbrey, Jr.

★ ★ ★ ★ ★ ★ ★ ★ ★ ★ information circular 8103



UNITED STATES DEPARTMENT OF THE INTERIOR
Stewart L. Udall, Secretary

BUREAU OF MINES
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OFFICE OF THE DIRECTOR



UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF MINES
WASHINGTON 25, D. C.

Hon. Frank B. Ellis
Director
Office of Emergency Planning
Washington 25, D. C.

Dear Mr. Ellis:

In accordance with the agreement of April 15, 1955, between the Department of the Interior and the Office of Civil and Defense Mobilization, which assigned responsibility to Interior for preparation and revision of Surveys covering 45 mineral commodities, the Bureau of Mines has prepared and herewith transmits to you the revision of COBALT, A Materials Survey.

Sincerely yours,

Marling J. Ankney

Director

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COBALT¹

A Materials Survey

By

Joseph H. Bilbrey, Jr.²

INTRODUCTION AND SUMMARY

COBALT is a silvery gray metal which closely resembles nickel in appearance and properties although it is somewhat harder and more brittle. It is rather widely disseminated and is estimated to make up about 0.001 percent of the earth's crust as compared to 0.020 percent for nickel. Cobalt, one of the four ferromagnetic elements, is used for many magnetic applications. It is oxidation resistant, a property which when coupled with its moderately high melting point of 1,495° C., makes it useful in high-temperature applications.

Although cobalt had been used by man as a coloring agent for glass and other ceramic products for 4,000 years, it was not isolated as a metal until 1742 and not established as an element until some 40 years later. Early in the 20th century, cobalt began to be used in alloys, and soon these applications displaced ceramics as the major consumer of cobalt. The use of cobalt in alloys gave considerable stimulus to production, and the world output of cobalt increased rapidly, rising from 400 tons in 1920 to 1,400 tons in 1930 and 5,500 tons in 1940. With the advent of the jet plane in the mid 1940's and the consequent increased need for cobalt-bearing high-temperature alloys, cobalt production again increased, reaching 7,900 tons in 1950. The increased demand for cobalt during the Korean war coupled with a large demand for stockpiling caused world production to more than double within the next 10 years, reaching a peak of 17,300 tons in 1959.

In 1960, the major uses for cobalt were in permanent-magnet alloys, high-temperature alloys, hard-facing alloys, tool steels, driers for paints, and ground-coat frit for enameling. A relatively minor amount of cobalt continued to be used to color ceramics, but strangely enough, one of its major uses in the ceramic industry was as a decolorizer—the blue imparted by the cobalt serves to neutralize the yellow tint caused by iron and other impurities.

Cobalt-bearing deposits are fairly widely distributed, but cobalt ores are usually found in association with ores of other metals, seldom alone. Cobalt occurs in minor amounts in many copper and nickel ores throughout the world. Nearly all laterites contain some cobalt, and it is also found in lead-zinc, silver, and iron ores in many places. But deposits containing cobalt values high enough to warrant working them for cobalt alone are scarce. The rich ores of Saxony and Bohemia have been depleted; the high-grade cobalt deposits of New Caledonia and Canada have been nearly worked out. Of the only two deposits worked primarily for cobalt in recent times, one, the Calera deposit in Idaho, was forced to close because of economic pressure from byproduct cobalt, although a substantial reserve remained; the other, at Bou Azzer in Morocco, was still operating in 1960, but reportedly at a loss.

By far the largest share of the world's cobalt now comes from central Africa as a byproduct of copper mining in the Congo and Northern Rhodesia. The ore reserves of central Africa are immense and contain at least 1 million

¹ Work on manuscript completed November 1961.

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tons of recoverable cobalt in the known copper-cobalt deposits of Katanga and Northern Rhodesia plus an unknown amount in similar deposits in nearby Uganda. Except for Canada, which has cobalt reserves of about 190,000 tons, mainly nickel-copper ores, most of the other cobalt reserves of the world are contained in the laterite deposits of Cuba, New Caledonia, the Philippines, and other tropical or semitropical areas. These laterites contain substantially more cobalt than the central African reserves, but in a less available form.

The major reserves of the United States are in a group of deposits in the Blackbird district of Idaho. Calera Mining Co. in 1959 estimated its cobalt reserves in this district at 15 million pounds in blocked-out ore plus 225 million pounds in indicated and inferred ores, a total of 240 million pounds or 120,000 tons. Smaller reserves exist in the Cornwall iron ore deposit of Pennsylvania and in the lead-zinc ores of southeastern Missouri.

The United States depends on imports, mainly from Africa, for its cobalt, since domestic productive capacity has always been well under the level of consumption. Since the largest U.S. producer, the Calera Mining Co., closed in 1959, domestic productive capacity has been less than 20 percent of the normal level of consumption.

CHAPTER 1. FORMS AND USES

Forms

METAL

Most of the cobalt consumed by industry is in the form of metal. Cobalt metal is produced as briquettes, granules, squares, broken cathodes, rondelles, fines, and powder. Briquettes are made by compacting cobalt powder with a small amount of organic binder and sintering the resultant green briquettes to give them physical strength. Squares are made by cutting cathodes into squares of 1, 2, or 4 inches on a side. Broken cathodes are produced by feeding the cathodes through toothed rolls. Rondelles are made by converting compacted pellets of cobalt oxide to metal, using carbon as the reductant. Fines are a relatively impure form of cobalt produced as an intermediate product in certain operations. Powder is the end product of the hydrogen-reduction method of producing cobalt and is also made by reducing oxides, grinding rondelles, or decomposing salts, such as the oxalate, precipitated from special solutions. Raney cobalt, an active form of cobalt powder for catalytic uses, is produced by dissolving the aluminum from a finely divided aluminum-cobalt alloy powder in a caustic soda solution. Table 1 gives typical analyses of cobalt metal from the leading commercial suppliers.

OXIDE

Cobalt forms three stable oxides,³ cobaltous oxide (CoO), cobaltic oxide (Co₂O₃), and cobaltosic oxide (Co₃O₄), but only two of these are used commercially: Gray oxide, mainly CoO (theoretical cobalt content, 78.65 percent), and black oxide, mainly Co₃O₄ (theoretical cobalt content, 73.43 percent).

SALT

The primary producers of cobalt salts generally offer six cobalt salts to their customers. The Union Minière and Mond lists of products contain only the following salts:

Salt:	Percent cobalt	
	Union Minière	Mond
Cobalt acetate.....	23-24	23.5
Cobalt carbonate.....	45-47	45
Cobalt chloride.....	24-25	24.5
Cobalt nitrate.....	20-21	20
Cobalt sulfate.....	21	20.5

Many other salts used by industry are made by secondary producers from purchased cobalt metal or one of the salts listed above. Table 2 contains a partial listing of the cobalt salts used by industry. Nearly all of the cobalt salts used are in the cobaltous state.

³ A fourth oxide, cobalt dioxide (CoO₂), has been reported in the literature, but its existence has not been verified.

TABLE 1.—Nominal analyses of commercial cobalt metal

	Cobalt	Nickel	Iron	Copper	Sulfur	Carbon
Falconbridge: Broken cathodes.....	99.60	0.33	0.003	0.004	0.002	0.015
Inco: Electrolytic squares.....	99.5+	.45	.005	.005	.001	.01-.02
National Lead:						
Briquettes.....	¹ 99.3	² .5	² .05	² .02	² .01	² .03
Powder (grades S, C, and M).....	98.6	.4	.10	.02	.04	.09
Powder (grade F).....	98.0	.4	.10	.02	.05	.09
Sherritt Gordon:						
Briquettes.....	99.8	.10	.01	.005	.005	.01
Powder.....	99.8	.10	.01	.005	.03	.05
Union Minière:						
Granules.....	99.60	.18	.10	.01	.01	.01
Rondelles.....	99.25	.30	.04	.001	.006	.007
Powder (100, 300, and 400 mesh).....	99.50	.08	.09	.001	.015	.030
Powder (400 mesh low C).....	99.60	.08	.09	.001	.010	.015
Powder (extra fine).....	99.88	.012	.015	.001	.005	.030

¹ Minimum. ² Maximum.

TABLE 2.—Common commercially available cobalt salts

Name	Formula	Theoretical cobalt content, percent	Uses
Cobaltous:			
Acetate.....	$\text{Co}(\text{C}_2\text{H}_3\text{O}_2) \cdot 4\text{H}_2\text{O}$	23. 6	Driers, catalysts.
Ammonium Sulfate.....	$\text{CoSO}_4(\text{NH}_4)_2\text{SO}_4 \cdot 6\text{H}_2\text{O}$	14. 9	Catalysts.
(ortho) arsenate (erythrite).....	$\text{Co}_3(\text{AsO}_4)_2 \cdot 8\text{H}_2\text{O}$	29. 4	Ceramics.
Bromide.....	$\text{CoBr}_2 \cdot 6\text{H}_2\text{O}$	18. 0	
Carbonate.....	CoCO_3	49. 5	Pigments, ceramics, animal feed.
Chloride.....	$\text{CoCl}_2 \cdot 6\text{H}_2\text{O}$	24. 7	Dyes, catalysts.
Chromate.....	CoCrO_4	33. 6	Ceramics.
Fluoride.....	$\text{CoF}_2 \cdot 2\text{H}_2\text{O}$	44. 3	Fluorinating agent.
Hydroxide.....	$\text{Co}(\text{OH})_2$	63. 4	Base for manufacture of other cobalt compounds.
Linoleate.....	$\text{Co}(\text{C}_{18}\text{H}_{31}\text{O}_2)_2$	9. 5	Driers.
Nitrate.....	$\text{Co}(\text{NO}_3)_2 \cdot 6\text{H}_2\text{O}$	20. 2	Pigments, ceramics, catalysts.
Octoate.....	$\text{Co}(\text{C}_{18}\text{H}_{33}\text{O}_2)_2^{(1)}$	(¹)	Driers.
Oleate.....	$\text{Co}(\text{C}_{18}\text{H}_{33}\text{O}_2)_2^{(1)}$	(¹) 9. 4	Do.
Resinate.....	$\text{CoSiO}_4^{(1)}$	(¹) 56. 0	Do.
(ortho) silicate.....	$\text{CoSiO}_4^{(1)}$	(¹)	Ceramics.
Stearate.....	$\text{CoSO}_4 \cdot 7\text{H}_2\text{O}^{(1)}$	(¹) 20. 9	Driers.
Sulfate.....	$\text{CoSO}_4 \cdot 7\text{H}_2\text{O}^{(1)}$	(¹)	Ceramics, catalysts, animal feed.
Tallate.....	$\text{CoSO}_4 \cdot 7\text{H}_2\text{O}^{(1)}$	(¹)	Driers.

¹ Not available.

Uses

ALLOYS

The use of cobalt in the manufacture of alloys dates back to the experiments of Elwood Haynes in 1899. In 1907, Haynes received a patent (1)⁴ covering a series of cobalt-chromium alloys, which he called Stellites. Within a few years the amount of cobalt used in alloys had exceeded that used in ceramics and dyes, formerly the major cobalt-consuming industries.

During the 1950's over 75 percent of the cobalt consumed annually in the United States went into the manufacture of various types of alloys. Of this amount, over 70 percent went into just two types—high-temperature alloys and permanent-magnet alloys.

High Temperature Alloys

The Stellite alloys produced by Haynes were the forerunners of today's high-temperature alloys, although they were originally used for cutlery, tableware, and surgical instruments. In 1913, Haynes (3) published the results of experiments on a series of cobalt-chromium-tungsten alloys for use as cutting tools. Within a short time after Haynes' discoveries, the manufacture of Stellites constituted the major use for cobalt. World War I provided a considerable impetus for the use of cobalt in alloys, and in 1918, 250,000 pounds of cobalt was consumed in the manufacture of Stellites.

⁴ Italicized figures in parentheses refer to items in the bibliography.

During World War I, the remarkable non-oxidizing properties of Stellite and its resistance to change under heat were discovered by army surgeons in France. Following advancing lines and attending wounded men close to the front where they could not carry liquid antiseptics, the surgeons sterilized their knives by putting them in a candle or other flame, without harm to the edges or smooth polish. Steel knives would have been destroyed by such treatment.

Following World War I, the use of cobalt in heat-resistant alloys continued to increase slowly until again stimulated by the needs of the aircraft industry for high-temperature alloys for exhaust-driven superchargers of high-performance engines. Turbosupercharger buckets of cobalt-base alloy were first made in 1941. The alloy used was a modification of Vitallium (65 percent cobalt, 30 percent chromium, and 5 percent molybdenum), an alloy developed in 1936 for dental and surgical work. As an example of the extremely rapid growth of the use of high-temperature alloys at this time, the Haynes Stellite Co. alone made 25 million turbosupercharger buckets of Vitallium in 1944 (11).

With the development of the jet engine and the consequent requirements for alloys of ever higher strength at high temperatures, research on the development of super alloys, as they came to be known, increased rapidly, and a large number of new alloys were developed. Table 3 gives a list of the principal cobalt-base and cobalt-bearing high-temperature alloys now in use.

TABLE 3. Typical cobalt-bearing high-temperature alloys

Alloy	Nominal composition							Other
	Co	Ni	Cr	Mo	W	Fe	C	
Cobalt-base:								
Haynes Stellite 21---	(1)	1.5-3.5	25.0-30.0	4.5-6.5	-----	2.0	0.20-0.35	B, 2.007
Haynes Stellite 25---	46.0-53.0	9.0-11.0	19.0-21.0	-----	14.0-16.0	3.0	.05-.15	Mn, 1.0-2.0
Haynes Stellite 30---	(1)	15.0	26.0	6.0	-----	2.0	.2-.50	Mn, 2.10; Si, 2.10
Haynes Stellite 31---	(1)	9.5-11.5	24.5-26.5	-----	7.0-8.0	2.0	.45-.55	B, .01-.05
Haynes Stellite 36---	(1)	9.0-11.0	17.5-19.5	-----	14.0-16.0	2.0	.35-.45	B, .04
HE-1049-----	(1)	10.0	26.5	-----	15.0	3.0	.40	Ti, 4.3
J-1570-----	37.5	28.0	20.0	-----	6.0	1.4	.20	Ta, 2.0; Ti, 3.8
J-1650-----	(1)	27.0	19.0	-----	12.0	-----	.20	-----
S-590-----	19.0-21.0	19.0-21.0	19.0-21.0	3.5-4.5	3.5-4.5	(1)	.38-.47	-----
S-816-----	40.0-44.0	19.0-21.0	19.0-21.0	3.5-4.5	3.5-5.0	2.0	.32-.42	-----
Unitemp L-605	(1)	9.0-11.0	19.0-21.0	-----	14.0-16.0	3.0	.65-.15	-----
WI-52-----	68.0	1.0	19.5	-----	11.0	.5	.4	B, .09; Cb, 1.5
Cobalt-bearing:								
Inco 700-----	30.0	44.0	15.0	3.0	-----	1.5	.14	Al, 3.1; Ti, 2.35; Zr, .05
Inco 717C-----	8.0	(1)	11.0	4.5	-----	-----	.12	Al, 7.5; Cb, 2.0; Ti, 1.0
J-1500-----	10.0	(1)	20.0	10.0	-----	-----	.15	Al, 1.0; Ti, 3.0
J-1530-----	13.5	57.0	19.5	4.3	-----	-----	.08	Al, 1.3; Ti, 3.1
J-1600-----	19.0	(1)	19.0	4.0	-----	-----	.10	Al, 3.0; Ti, 3.0
J-1610 (René 41)	11.0	(1)	19.0	10.0	-----	-----	.09	Al, 1.5; Ti, 3.1
M-252-----	9.0-11.0	(1)	18.0-20.0	9.0-10.5	-----	2.0	.10-.20	Al, 7.5-1.25; Ti, 2.25-2.75
Multimet (N-155)	18.5-21.0	19.0-21.0	20.0-22.5	2.5-3.5	2.0-3.0	(1)	.08-.16	Mn, 1.0-2.0; Cb, .75-1.25
Nicrotung-----	10.0	(1)	12.0	-----	8.0	-----	.10	Al, 4.0; B, .05; Ti, 4.0; Zr, .05
Nimonic 90-----	15.0-21.0	(1)	18.0-21.0	-----	-----	2.0	.10	Al, 3.0-1.80; Ti, 1.80-2.70
Nimonic 100-----	20.0	50.0	19.0	5.0	-----	-----	.10	Al, 2.0; Ti, 3.0
Nimonic 105-----	18.0-22.0	(1)	13.5-16.0	4.5-5.5	-----	-----	.20	Al, 4.2-5.5; Ti, .9-1.5
Refractaloy 26-----	18.0-22.0	35.0-39.0	16.0-20.0	2.5-3.5	-----	(1)	.08	Al, 2.25; Ti, 2.3-2.9
Refractaloy 70-----	28.5-31.5	19.0-21.0	19.0-21.0	7.5-8.5	3.5-4.5	(1)	.20	Al, 2.25; Mn, 1.75-2.25
Refractaloy 80-----	28.5-31.5	19.0-21.0	19.0-21.0	9.0-11.0	4.5-5.5	2.0	.20	-----
Udimet 500-----	13.0-20.0	(1)	15.0-20.0	3.0-5.0	-----	2.0	.15	Al, 2.5-3.25; Ti, 2.5-3.25
Udimet 600-----	13.0-20.0	(1)	15.0-20.0	3.0-5.0	-----	2.0	.10	Al, 3.8-4.6; Ti, 2.5-3.25
Udimet 700-----	17.0-20.0	(1)	13.0-17.0	4.5-5.75	-----	2.0	.15	Al, 3.75-4.75; Ti, 3.0-4.0; B, 2.10
Waspalloy-----	12.0-15.0	(1)	18.0-21.0	3.0-5.0	-----	2.0	.10	Al, 1.0-1.5; Ti, 2.75-3.25; B, .005

1 Balance. 2 Maximum.

Permanent Magnets

Because so much cobalt is used for the manufacture of permanent magnets, it is worthwhile to dwell briefly on the subject of magnetism. The purpose of a magnet is to provide a magnetic flux. The so-called permanent magnets provide this flux without an external power source. Permanent-magnet materials are able to perform this function because of their relatively great magnetic hysteresis. Magnetic hysteresis can be briefly defined as the lagging of magnetism behind the changes of the field that produces it. This can be illustrated by means of a diagram known as a hysteresis loop, such as that shown in figure 1.

If a ring made from an alloy having a hysteresis loop as shown in figure 1 is subjected to a magnetic field, H , the values of the flux density, B , will be shown by the line OB . When the field is decreased to zero, the flux does not return to zero, but follows the curve $B_s B_r$. B_r is known as the residual induction. To get the flux to return to zero, a magnetizing force of opposite sign with intensity H_c must be applied. H_c is known as the coercive force. In service, a magnet is always operating at some point along the curve between H_c and B_r , as demagnetizing conditions are always present. This portion of the curve is referred to as the demagnetization curve for the material. In figure 1 the point $(BH)_{\max}$ designates the point

at which the magnet is delivering its maximum available energy. This point can be approximately located on the demagnetization curve by the intersection of the diagonal OA of the rectangle $OH_c AB_r$ with the curve.

Originally, permanent magnets were made of high-carbon steel, which possesses a reasonably high residual induction but a very low coercive force. These magnets needed to be quite large and, owing to the low coercive force, were very sensitive to demagnetizing conditions. The addition of tungsten to steel was found to increase both the residual induction and the coercive force, and tungsten steels were widely used as magnets until the price of tungsten rose during World War I. It was then found that chromium could be substituted for tungsten with only a slight loss in magnetic properties.

The use of cobalt for magnet alloys dates back to the work of Honda and Saito (8), who in 1920 published a report on the magnetic properties of steels with high (30 to 40 percent) cobalt contents. In 1930 Mishima discovered that alloys of iron, aluminum, and nickel had remarkable permanent magnet properties. It was later found that adding cobalt to these alloys greatly improved magnetic properties.

Cobalt possesses unique magnetic properties, some of which may be briefly summarized as follows:

- (1) Because of its hexagonal close-packed

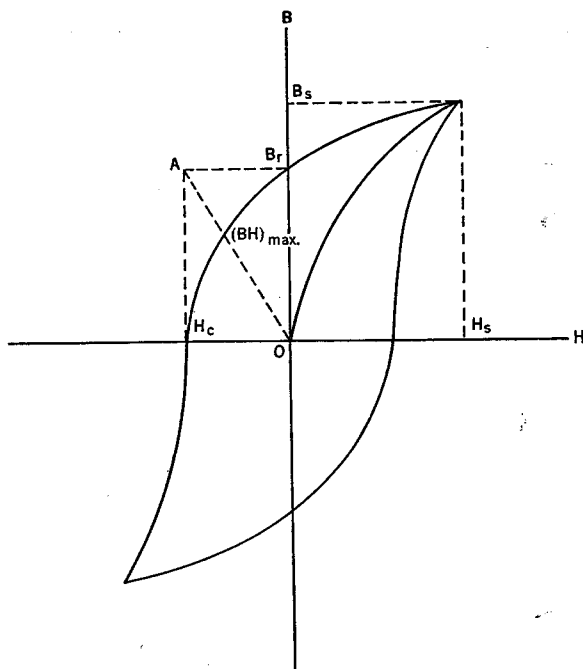


FIGURE 1.—Typical Hysteresis Loop of Permanent-Magnet Alloy.

crystal structure, cobalt has a crystal anisotropy 35 times as great as that of iron (body-centered cubic) and 300 times as great as that of nickel (face-centered cubic). This property leads to high coercivity values for cobalt-alloy magnets.

(2) Cobalt is the only element which increases the saturation magnetization of iron.

(3) Cobalt has a much higher Curie temperature (1,121° C.) than iron (768° C.) or nickel (353° C.), making it possible to heat-treat high-cobalt alloys in a magnetic field to provide superior properties.

In 1936 the General Electric Co. announced the development of the first of the Alnico series of permanent-magnet alloys. Actually the first alloy of the Alnico group to be developed was an alloy with 25 percent nickel and 12 percent aluminum which contained no cobalt. This alloy was originally known as Alnic, but was later renamed Alnico III after two cobalt-containing varieties had been developed.

The first of the cobalt-containing alloys, Alnico I, had the same composition as the original Alnico III, except that 5 percent of the nickel was replaced by cobalt. The cobalt addition made practically no change in the magnetic properties of the alloy, but it improved its response to heat treatment and thus resulted in a more dependable alloy. It was later found that the coercive force could be improved without lowering the residual induction by increasing the cobalt content of the alloy to 12.5

percent and by adding 6 percent copper. Alnico IV was developed to meet the demand for a lower cost alloy with a high coercive force. In this alloy, the cobalt content was decreased to 5 percent and the copper omitted while the nickel content was increased. The discovery that residual induction could be greatly increased by heat treatment of certain types of alloys in a magnetic field resulted in the production of Alnico V. As shown in figure 2, this alloy has nearly twice the residual induction of the previously developed types. Alnico types VI and XII are high-cobalt types with titanium added. The addition of titanium greatly increases coercivity through the formation of titanides (Fe_2Ti , Co_2Ti , and Ni_3Ti). Table 4 gives the chemical composition of the principal Alnico alloys.

TABLE 4.—Nominal composition of Alnico magnets, percent

Type	Composition					
	Al	Ni	Co	Cu	Ti	Fe
I.....	12	20	5	-----	-----	(1)
II.....	10	17	12.5	6	-----	(1)
III.....	12	25	-----	-----	-----	(1)
IV.....	12	28	5	-----	-----	(1)
V.....	8	14	24	3	-----	(1)
VI.....	8	14	24	3	1	(1)
XII.....	6	18	35	-----	8	(1)

¹ Balance.

Most Alnico magnets are produced by casting, since the alloys cannot be forged except under very special conditions. Any necessary finishing is accomplished by grinding, the alloys being too hard and brittle to be machined. Alnico magnets may also be produced by powder metallurgical techniques, in which the finished magnets are formed by pressing and sintering metallic powders. The magnetic properties of sintered magnets are slightly inferior to those of cast magnets, but the process has advantages in that it produces magnets of uniform composition with consistent magnetic properties and a good surface finish, which obviates the need for finish grinding.

Permanent magnets have many uses. Probably the largest single use for Alnico magnets is in the construction of loudspeakers. High-fidelity recording created a need for high quality speakers, and these often contain Alnico magnets weighing several pounds.

Automobile speedometers are a good example of a major use of permanent magnets. In a speedometer, a magnet rotated by the speedometer drive near a conductive disk or cup gen-

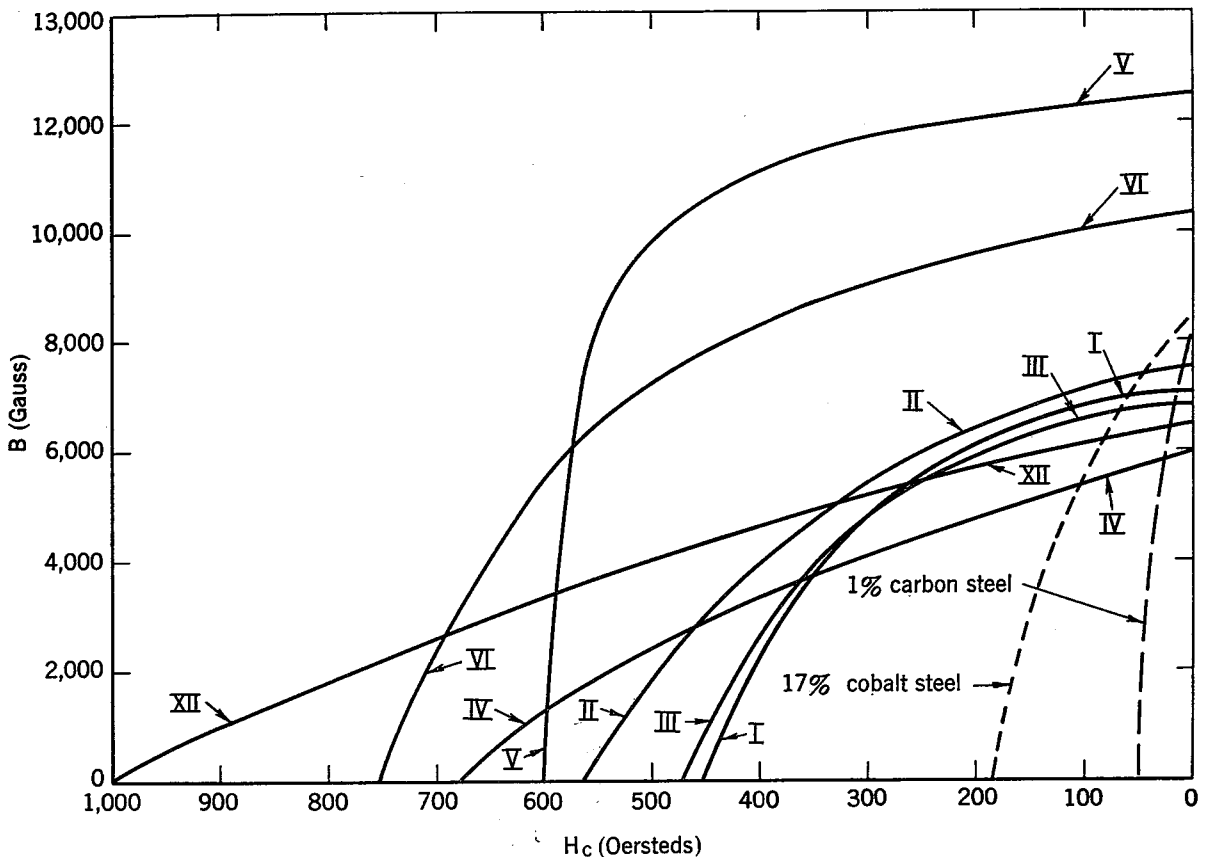


FIGURE 2.—Demagnetization Curves of Principal Alnico Alloys.

erates eddy currents which create a reaction to the magnetic field and apply a torque to the disk or cup to which the indicator pointer is connected. The torque is balanced by a hair-spring, thus allowing the needle to indicate the speed. Magnetic tachometers also operate on this principle.

Permanent magnets are also used in meters, motors, magnetic chucks and holding plates, television receivers, telephones, and hundreds of other applications.

Tool Steels

The major use of cobalt in tool steel is in high-speed steel. Cobalt is added to improve the red hardness of the alloy. The addition of cobalt allows tools to be used at higher rates of speed and for deeper cuts than would be possible with tools of a similar alloy lacking cobalt. Cobalt alloys have several disadvantages that tend to prevent their wider use in tool steels: The higher price of cobalt-bearing steels, reduced toughness and forgeability, and need for higher hardening temperatures. The

low toughness of tools made from cobalt steels means that they need to be well supported in use and not subjected to excessive shock or chattering. Cobalt high-speed steels do not flow as readily in forging; slightly higher forging temperatures and more care in forging are required to prevent cracking or checking. Since cobalt high-speed steels need to be hardened at higher temperatures than the ordinary 18-4-1 type in order to develop maximum cutting quality, they are more susceptible to decarburization than noncobalt varieties, and tools made from them may need to be ground all over to remove the soft skin or decarburized layer. Grinding must be performed with care since cobalt high-speed steels are more susceptible to checking than ordinary varieties.

The American Iron and Steel Institute (AISI) set up a type-classification system which covers most of the alloys in general use (19). The commonly used tool steels were divided into six major groups, and each subgroup of steels under each group was assigned an alphabetical letter symbol. The classification symbols give information on the appli-

TABLE 5.—*AISI tool steel classification*

Type of steel	Symbol	Other information
Water hardening tool steels.....	W	Oil hardening types. Medium alloy air hardening types. High carbon-high chromium types. (H1 to H19 inclusive chromium base types, H20 to H39 inclusive tungsten base types, H40 to H59 inclusive molybdenum base types.)
Shock resisting tool steels.....	S	
Cold work tool steels.....	O	
	A	
	D	
Hot work tool steels.....	H	Tungsten base types. Molybdenum base types. Low alloy types. Carbon tungsten types. Mold steels. (P1 to P19 inclusive low carbon types, P20 to P39 inclusive other types.)
	T	
High-speed tool steels.....	M	
	L	
Special purpose tool steels.....	F	
	P	

Source: Steel Products Manual, Tool Steels, American Iron and Steel Institute, New York 17, N.Y., April 1955.

TABLE 6.—*Identification and type classification of tool steel*

AISI type	C	Mn	Si	Cr	Ni	V	W	Mo	Co	Cb
COLD WORK TOOL STEELS Symbol D, High Carbon—High Chromium Types										
D1.....	1.00	-----	-----	12.00	-----	-----	-----	1.00	-----	-----
D2.....	1.50	-----	-----	12.00	-----	-----	-----	1.00	-----	-----
D3.....	2.25	-----	-----	12.00	-----	-----	-----	-----	-----	-----
D4.....	2.25	-----	-----	12.00	-----	-----	-----	1.00	-----	-----
D5.....	1.50	-----	-----	12.00	-----	-----	-----	1.00	3.00	-----
D6.....	2.25	-----	1.00	12.00	-----	-----	1.00	-----	-----	-----
D7.....	2.35	-----	-----	12.00	-----	4.00	-----	1.00	-----	-----
HIGH-SPEED TOOL STEELS Symbol T, Tungsten Base Types										
T1.....	0.70	-----	-----	4.00	-----	1.00	18.00	-----	-----	-----
T2.....	.80	-----	-----	4.00	-----	2.00	18.00	-----	-----	-----
T3.....	1.05	-----	-----	4.00	-----	3.00	18.00	-----	-----	-----
T4.....	.75	-----	-----	4.00	-----	1.00	18.00	-----	5.00	-----
T5.....	.80	-----	-----	4.00	-----	2.00	18.00	-----	8.00	-----
T6.....	.80	-----	-----	4.50	-----	1.50	20.00	-----	12.00	-----
T7.....	.75	-----	-----	4.00	-----	2.00	14.00	-----	-----	-----
T8.....	.75	-----	-----	4.00	-----	2.00	14.00	-----	5.00	-----
T9.....	1.20	-----	-----	4.00	-----	4.00	18.00	-----	-----	-----
T15.....	1.50	-----	-----	4.00	-----	5.00	12.00	-----	5.00	-----
Symbol M, Molybdenum Base Types										
M1.....	0.80	-----	-----	4.00	-----	1.00	1.50	8.00	-----	-----
M2.....	.80	-----	-----	4.00	-----	2.00	6.00	5.00	-----	-----
M3.....	1.00	-----	-----	4.00	-----	2.70	6.00	5.00	-----	-----
M4.....	1.30	-----	-----	4.00	-----	4.00	5.50	4.50	-----	-----
M6.....	.80	-----	-----	4.00	-----	1.50	4.00	5.00	12.00	-----
M7.....	1.00	-----	-----	4.00	-----	2.00	1.75	8.75	-----	-----
M8.....	.80	-----	-----	4.00	-----	1.50	5.00	5.00	-----	1.25
M10.....	.85	-----	-----	4.00	-----	2.00	-----	8.00	-----	-----
M15.....	1.50	-----	-----	4.00	-----	5.00	6.50	3.50	5.00	-----
M30.....	.80	-----	-----	4.00	-----	1.25	2.00	8.00	5.00	-----
M33.....	.90	-----	-----	3.75	-----	1.15	1.50	9.50	8.00	-----
M34.....	.90	-----	-----	4.00	-----	2.00	2.00	8.00	8.00	-----
M35.....	.80	-----	-----	4.00	-----	2.00	6.00	5.00	5.00	-----
M36.....	.80	-----	-----	4.00	-----	2.00	6.00	5.00	8.00	-----

Source: Steel Products Manual, Tool Steels, American Iron and Steel Institute, New York 17, N.Y., April 1955.

cation of the steel and the method of quenching. The major groups and subgroups together with the identifying symbols are shown in table 5.

Cobalt is used in only a few of the subgroups (mainly in T and M, the high-speed tool steels), although small amounts are used in other classes. Cobalt is also a constituent of many specialty tool steels which do not fall within the AISI classification. Table 6 reproduces part of the AISI table which lists the types of steel against an approximate analysis. The

analyses shown are for identification purposes only and do not represent a mean of the composition range of the various elements. Steels of the same type produced by different manufacturers may differ in mean analysis from the values given and may contain elements not listed. Only those groups which have types containing cobalt are included in table 6.

A list of commercial grades of cobalt-bearing tool steels is given in table 7, together with nominal analyses and names of manufacturers.

TABLE 7.—Commercial cobalt-bearing tool steels

Trade name	C	Mn	Si	Cr	Ni	V	W	Mo	Co	Ob
D-5										
Cobalt Chrome FM.	1.50	0.25	0.50	12.25				0.85	3.10	
Double Seven.	1.35	(1)	(1)	12.50				.60	3.00	
EK-81.	1.35	.30	.25	12.75				.80	3.00	
Allegheeny Ludlum Steel Corp.	1.50	.40	.40	12.00		.50		.90	3.25	
H & R No. 61.	1.35	.25	.50	12.12				.64	3.04	
Houghton & Richards Inc.	1.40	.30	.60	13.00	.50			.60	3.30	
Darwin & Milner Inc.	1.40	.30		13.00	.40	.50		1.15	3.25	
PRK 33.	1.55	.30	(1)	13.00		.50		1.15	3.25	
Jessop Steel Co.	1.55			13.00	.40	.50		1.15	3.25	
3-C Special.										
do.										
3-C Special-Cast-to-Shape.										
T-4										
Acmite.	.73	(1)	(1)	4.00		1.15	18.00	(1)	5.00	
B-7.	.72	.30	.35	4.00		1.15	18.00	.50	5.00	
Cobalt High Speed.	.72	.30	(1)	4.00		1.00	18.00	.75	5.00	
Comokut.	.74	(1)	(1)	4.50		2.00	18.25	.65	5.75	
D-6-Co.	.75	.25	.20	4.00						
Darwin 505.	.70	.30	.25	4.00		1.15	18.00	.60	5.00	
GW Super-kut.	.72	.30	.33	4.00		1.05	17.25	.50	4.50	
H & R Cobalt.	.78	(1)	(1)	4.00		1.00	18.00	(1)	5.00	
Houghton & Richards Inc.	.72	.20	.33	4.00		1.05	17.25	.50	4.50	
HSC Cobalt 5.	.75	.25	.25	4.00		1.00	19.00	(1)	5.00	
Allegheeny Ludlum Steel Corp.	.75	.25	.25	4.00		1.00	19.00	(1)	5.00	
Panther Special.	.75	.25	.30	4.00		1.10	18.50	2.50	5.00	
Powhatan.	.75	.28	(1)	4.20		1.10	18.00	.75	5.00	
Atlas Steels Ltd.	.74	(1)	(1)	4.00		1.08	18.25	.65	4.75	
Jessop Steel Co.	.75	.30	.30	4.25		1.15	18.00	.75	5.00	
Firth Sterling Inc.	.73	.30	.30	4.00		1.00	18.00	(1)	5.00	
Red Chip.	.73	.30	.30	4.00		1.15	18.00	.65	5.00	
Vanadium-Alloys Steel Co.	.73	.30	.30	4.00		1.00	18.25	.75	5.00	
Crucible Steel Co. of America.	.75	(1)	(1)	4.00		1.15	18.00	(1)	5.00	
Simonds Saw & Steel Co.	.75	(1)	(1)	4.00		1.00	18.25	.60	5.25	
H. K. Porter Co., Inc.	.72	.30	.30	4.00		1.15	18.25			
Wolfram Cobalt.										
T-5										
B-10.	.78	.30	.35	4.50		2.00	18.50	1.00	9.00	
Bonded Carbide Jr.	.77	.25	.25	4.50		1.95	18.50	.75	7.60	
Circle C.	.77	(1)	(1)	4.50		2.00	18.50	1.00	9.00	
Cobite.	.78	(1)	(1)	4.25		1.88	18.50	(1)	9.00	
Universal-Cyclops Steel Corp.	.80	.30	.25	4.00		2.00	18.00	.80	8.00	
Firth Sterling Inc.	.80	.30	(1)	4.00		2.15	18.75	.80	9.00	
Darwin & Milner Inc.	.85	(1)	(1)	4.10		1.75	18.50	.80	7.50	
Electricite Super Cobalt.	.80	(1)	(1)	4.50		1.50	21.50	.50	13.00	
H & R No. 4.	(1)	(1)	(1)	4.50		2.00	19.00	.80	8.00	
Houghton & Richards Inc.	(1)	(1)	(1)	4.00		1.95	18.50	.75	7.90	
A. Milne & Co.	.78	.25	.30	4.20		1.85	18.00	.75	8.75	
Atlas Steels Ltd.	.78	.28	.30	4.25		2.00	18.50	.65	8.00	
Jessop Steel Co.	.78	.25	.30	4.00		2.00	18.00	(1)	5.00	
Nipigon.	.78	.25	.30	4.00		2.00	19.00	.75	7.00	
Purple Label Extra.	.78	.25	.30	4.25		2.00	18.50	.65	8.00	
Red Cut Cobalt B.	.80	.30	.30	4.00		2.00	18.00	(1)	5.00	
Vanadium-Alloys Steel Co.	.80	.30	.30	4.00		2.00	18.00	.75	8.00	
Crucible Steel Co. of America.	.80	(1)	(1)	4.00		2.00	18.00	(1)	5.00	
Super Cobalt.	.80	.25	.25	4.00		2.00	19.00	.75	7.00	
Simonds Saw & Steel Co.	.80	.25	.25	4.00		2.00	19.00	.75	7.00	
Allegheeny Ludlum Steel Corp.										
T-6										
Bonded Carbide.	.70	.25	.25	4.50		1.50	18.50	.70	12.00	
Darwin 1366.	.80	.30	.30	4.00		2.00	18.00	.80	13.00	
Gray Cut Cobalt.	.80	.25	(1)	4.25		1.60	20.50	.60	12.50	
Vanadium-Alloys Steel Co.	.80	.25	.32	4.25		1.35	20.50	.60	12.50	
H & R Super Cobalt.	.78	.30	(1)	4.25		1.75	19.60	.75	11.50	
King Cobalt.	.78	.25	(1)	4.20		1.60	18.00	.75	11.50	
Jessop Steel Co.	.70	.25	.25	4.50		1.50	18.00	.75	11.50	
Lehigh SS.	.83	.25	.27	4.50		2.00	22.00	1.00	10.00	
Macco Enormous.	.83	.25	.27	4.50		2.00	22.00	1.00	10.00	
F. F. McDonald & Co.	.80	.30	.30	4.00		2.00	19.50	.60	12.00	
Crucible Steel Co. of America.										

See footnotes at end of table.

TABLE 7.—*Commerical cobalt-bearing tool steels—Continued*

Trade name	Manufacturer	C	Mn	Si	Cr	Ni	V	W	Mo	Co	Cb
T-8											
B-8.....	Universal-Cyclops Steel Corp.....	.78	.30	.35	4.25	-----	2.25	14.00	.50	5.00	-----
FS 2-5.....	Firth Sterling, Inc.....	.80	(¹)	(¹)	4.00	-----	2.00	14.00	.75	5.00	-----
Gold Star.....	Carpenter Steel Co.....	.77	(¹)	(¹)	3.75	-----	2.00	13.75	(¹)	5.00	-----
Maxite.....	Columbia Tool Steel Co.....	.73	.25	.30	4.00	-----	2.15	14.00	² 1.00	4.75	-----
Rex 95.....	Crucible Steel Co. of America.....	.80	.30	.30	4.00	-----	2.00	14.00	.75	5.25	-----
T-8 High Speed.....	Jessop Steel Co.....	.79	.30	(¹)	4.00	-----	2.00	14.00	.75	5.00	-----
T-15											
Electrite Dynavan XL.....	Latrobe Steel Co.....	1.50	(¹)	(¹)	4.50	-----	4.75	13.50	.50	5.00	-----
H & R No. 445.....	Houghton & Richards Inc.....	1.50	(¹)	(¹)	4.50	-----	4.75	13.50	.50	5.00	-----
Panther 5.....	Allegheny Ludlum Steel Corp.....	1.50	(¹)	(¹)	4.75	-----	5.00	12.50	(¹)	5.00	-----
Vasco Supreme.....	Vanadium-Alloys Steel Co.....	1.75	.25	.25	4.75	-----	5.00	12.50	(¹)	5.00	-----
M-6											
Congo.....	Braeburn Alloy Steel Corp.....	.78	.25	.25	4.00	-----	1.40	4.00	5.00	12.00	-----
M-15											
Super Unicut.....	Universal-Cyclops Steel Corp.....	1.50	.30	.35	4.00	-----	4.75	6.25	3.25	5.00	-----
Vasco Supreme A.....	Vanadium-Alloys Steel Co.....	1.75	.25	.25	4.75	-----	5.00	6.50	3.00	5.00	-----
M-30											
Como.....	Braeburn Alloy Steel Corp.....	.77	.25	.25	4.00	-----	1.20	1.55	8.50	5.00	-----
H & R No. 48.....	Houghton & Richards Inc.....	.81	.30	.30	4.10	-----	1.25	1.70	8.30	5.00	-----
H & R Super Molybi.....	do.....	.82	.25	.32	4.00	-----	1.25	1.50	8.50	5.00	-----
Super Motung.....	Universal-Cyclops Steel Corp.....	.82	.30	.35	4.00	-----	1.25	1.50	8.25	5.00	-----
M-34											
Armstrong.....	Armstrong Bros. Tool Co.....	(¹)	(¹)	(¹)	(¹)	-----	(¹)	(¹)	(¹)	(¹)	-----
Atlas M-34.....	Atlas Steels Ltd.....	.90	.30	.25	3.75	-----	2.05	1.45	8.70	8.25	-----
M-35											
Rex M2-5.....	Crucible Steel Co. of America.....	.85	.30	.30	4.15	-----	1.95	6.40	5.00	5.00	-----
M-36											
Circle M.....	Firth Sterling Inc.....	.85	(¹)	(¹)	4.00	-----	2.00	6.00	5.00	9.00	-----
H & R Cobalt Moly.....	Houghton & Richards Inc.....	.88	.25	.25	4.10	-----	1.90	6.00	6.00	9.00	-----
MMCO.....	A Milne & Co.....	(¹)	(¹)	(¹)	4.00	-----	2.00	5.80	5.20	9.00	-----
Super DBL.....	Allegheny Ludlum Steel Corp.....	.80	.40	.40	4.00	-----	1.75	5.50	4.25	7.75	-----

¹ Not available. ² Maximum.

Carbides and Hard-Facing Alloys

An important industrial use for cobalt is in the manufacture of cemented carbides, particularly tungsten carbide. The cemented carbides consist of small particles of one or more metal carbides held together by a metal binder. In order to form a strong, coherent material, the metal used as the binder must wet the carbide particles completely. Cobalt fulfills this condition best for tungsten carbides and mixed carbides composed mainly of tungsten with tantalum, columbium, or titanium.

The cemented carbides are extremely hard and resistant to wear at relatively high temperatures, properties which make them desirable as cutting materials. Some of the major

uses for cemented tungsten carbides in addition to the manufacture of cutting tools of all sorts are drawing and swaging dies, masonry and rock drills, and special wear-resistant applications such as lathe centers, sandblast nozzles, and thread and wire guides. Other applications include the use of cobalt-bonded tungsten carbide as a matrix for mounting diamonds in special cutting tools and as bullet and shell cores for armor-piercing ammunition.

The amount of cobalt used in making a cemented carbide depends on the final use of the product. In cutting tools, cobalt content ranges from about 3 to 13 percent, and cobalt contents of up to 30 percent are used in the manufacture of tungsten carbide dies. Hardness and wear resistance decrease with increas-

ing cobalt content, whereas toughness and shock resistance increase.

Cemented tungsten carbides are made by pressing and sintering mixtures of tungsten carbide powder and cobalt powder which have previously been ball-milled for as much as 5 days to obtain proper mixing. In the sintering operation a eutectic phase is formed between the cobalt and carbide particles which wets and flows around each carbide particle forming a hard, coherent mass. The sintered compact is then finished by grinding if necessary.

A fairly recent development in carbide technology is the so-called flame-plating process, in which a thin layer of cobalt-bonded tungsten carbide is sprayed on a base metal. Since the body of the base metal need not be heated above 400° F. in the operation, low-melting-point metals can be plated by this method. The coating has a Rockwell A hardness of over 89 and is extremely wear resistant. Typical applications are gages, pump rods, tappets, valve lifters, shafts, and knives. Kitchen and hunting knives with flame-plated edges were first marketed in 1959.

Another type of hard, wear-resistant material is used in hard facing, a welding process by which a hard alloy is deposited on a softer metal base. Hard facing is widely employed in the manufacture and repair of parts subjected to abrasive conditions in service, such as ballmill liners, hammers and knives of crushing and comminuting equipment, dipper teeth, seats of valves in steam and abrasive slurry lines, engine valves and valve seats, and many others. There are five general classes of hard-facing materials: Iron-base low alloy, iron-base high alloy, cobalt-base nonferrous alloys, nickel-base nonferrous alloys, and carbides. Cobalt is used

to some extent in the second type and to a greater extent in the third type, which is the most common.

Other Specialty Alloys

Cobalt is used for a number of special alloys not mentioned in the foregoing sections. Some of the main specialty alloys are those used for metal-to-glass seals and those which exhibit a constant length over a wide temperature range. Table 8 lists a number of these alloys with their compositions and major uses.

Cobalt is also common as a constituent of alloys used for dental and surgical applications. The most widely used alloy of this type is Vitallium (65 percent cobalt, 30 percent chromium, and 5 percent molybdenum).

PIGMENTS AND DYES

Cobalt pigments are not used in ordinary paints, but are used to a limited extent in the manufacture of artist's oil paints. Cobalt pigments are not used in water colors. Examples of the compounds commonly used for pigments are cobalt blue (cobalt aluminate), ceruleum blue (cobalt stannate), and cobalt violet (cobalt phosphate).

Cobalt is a constituent of some dyes used for dyeing cloth and coloring lacquers. It is used in some of the metal complex compounds of azo dyes, stable diazonium salts, metallized azomethine dyes, nitroso dyes, and anthraquinone alizarin mordant dyes.

CERAMICS

Cobalt is widely used in the ceramic industry as a decolorizer and to impart a blue color to pottery, glazes, enamels, and glass.

TABLE 8.—Cobalt-bearing specialty alloys and their uses

Trade name	Manufacturer	Analysis (nominal)							Typical uses
		Co	Cr	Fe	Mn	Mo	Ni	V	
Ceramiseal.....	Wilbur B. Driver Co.....	25.0	—	48.0	—	—	27.0	—	Metal-to-ceramic seals. Springs, pen nibs, diaphragms, pivots, reeds scales, draft bands, corrosion resistant applications.
Cobenium.....	do.....	40.0	20.0	(1)	2.0	7.0	15.0	—	
Dynavar.....	Precision Metals Division.....	(1)	20.0	16.0	2.0	7.0	15.0	—	Core material for motors, genera- tors, and transformers. Hysteresis motors. Core material for motors, genera- tors, and transformers. Metal-to-glass seals.
Elgiloy.....	Elgin National Watch Co.....	(1)	20.0	16.0	2.0	7.0	15.0	—	
Ferrovac 49-2V.....	Crucible Steel Co. of America.....	49.0	—	49.0	—	—	—	2.0	
G-E Alloy P-6.....	General Electric Co.....	45.0	—	45.0	—	—	—	4.0	
Hiperco.....	Westinghouse Electric Corp.....	35.0	1.0	64.0	—	—	—	—	Do. Do. Core material for motors, genera- tors, and transformers. Metal-to-glass seals. Permanent magnets. Magnetostrictive uses.
Kovar "A".....	do.....	17.0	—	(1)	.3	—	29.0	—	
Nilo K.....	Stupakoff Ceramic and Manu- facturing Co.....	17.0	—	(1)	—	—	29.0	—	
Rodar.....	Henry Wiggin & Co., Ltd.....	17.0	—	(1)	.3	—	29.0	—	
Supermendur.....	Wilbur B. Driver Co.....	49.0	—	49.0	—	—	—	2.0	Do. Do. Core material for motors, genera- tors, and transformers. Metal-to-glass seals. Permanent magnets. Magnetostrictive uses.
Therlo.....	Westinghouse Electric Corp.....	17.0	—	(1)	.3	—	29.0	—	
Vicalloy.....	Driver-Harris Co.....	(1)	—	33.0	.7	—	—	9.0	
204.....	Vanadium-Alloys Steel Co.....	4.3	—	—	—	—	(1)	—	
	International Nickel Co.....	—	—	—	—	—	—	—	

¹ Balance. ² Maximum.

Glaze Stain.—Cobalt oxide alone or in combination with other metallic oxides or salts is mixed either raw or as a soft frit with the glaze material which is applied to the fired ceramic body to give a wide range of blue shades.

Underglaze Stain.—The base color is finely ground, mixed with a vehicle such as water, and applied to the fired ceramic body. The body is then covered with a transparent glaze and refired.

Overglaze Stain.—The base color is prepared by fine grinding, mixed with a vehicle, applied to the glazed ceramic body, and fired.

Body Stain.—Nearly all clays used in ceramic manufacture contain traces of iron which would impart a yellow color to the article on firing. When a dead-white article is desired, cobalt is added to produce a blue color which neutralizes the yellow. Black cobalt oxide, cobalt sulfate, or cobalt chloride is added to the dry pottery mix in a ratio of about 1 pound per ton. Cobalt is also used in larger quantities to give a blue color to the pottery body.

Enamels.—Cobalt oxide is used in the production of white enamels to neutralize the yellow caused by the presence of iron. Smalt, a potash-silica glass colored with cobalt, is used in the production of blue enamels; cobalt oxide, in the production of black enamels; and cobalt sulfate, in the production of gray enamels. The major use for cobalt in the enamel industry, however, is not to color enamel but to increase its adherence to iron or steel. Relatively small quantities (0.15 to 0.5 percent) of cobalt oxide in an enamel greatly increase its adherence. No universally accepted theory has yet been discovered for this action, but in a recent study by Battelle Memorial Institute (23) it was concluded that good adherence of enamel to iron was the result of metal-to-metal bonding between atoms of iron in the base metal and iron ions in the enamel under certain conditions, and that cobalt oxide merely helped to establish and maintain the proper conditions for good adherence without contributing directly to the bond itself.

Since the cobalt ground coat is blue, a second coat of enamel is necessary to give the desired color to the object. The development of a "one-coat" enamel process, which would eliminate the need for the cobalt-bearing ground-coat, is periodically announced in the literature. As of 1960, however, about 500,000 pounds per year of cobalt continued to be used to manufacture ground-coat frit, about the same quantity as had been used in each of the previous 15 years.

Glass.—Cobalt oxide is a component of many mixtures used in the manufacture of glass. In very small amounts (1 ounce or less per ton of mixture) cobalt acts as a decolorizer of plate

and sheet glass by neutralizing the yellow color caused by iron. In amounts of about $\frac{1}{4}$ to $\frac{1}{2}$ pounds per ton of mix, cobalt oxide imparts a light blue shade to glass, whereas 1 pound or more per ton gives a dark blue glass. For structural glasses and special optical filters, 5 to 10 pounds of cobalt oxide per ton of mix may be used.

DRIERS

Driers are substances which are used to accelerate the rate of drying of paints, varnishes, and inks. They act by speeding the oxidation rate of the oils contained in these materials, by catalyzing the polymerization of the oils, or both. All driers are metallic compounds—mainly of cobalt, manganese, and lead. Cobalt is the strongest and most effective of the metals used to make driers, and as a consequence, it is widely used, either alone or in combination with other metals.

Cobalt acts primarily as an oxidation catalyst and has such a rapid action that it can cause the formation of a hard skin over the paint which inhibits drying or causes wrinkling. Therefore, cobalt is often used in combination with a polymerization catalyst type of drier. The skin-forming action of cobalt is used to advantage in the production of wrinkle finishes, where a relatively large amount of cobalt drier is deliberately used to cause extensive wrinkling of the paint film.

Originally, salts such as acetates were cooked into the varnish during its manufacture to act as driers. This method was unsatisfactory, however, since only that part of the metal which formed a soluble soap was retained in the finished product, while the remainder formed a sludge which had to be removed by filtering. The variable amounts of driers thus introduced into the finished product by this method resulted in nonuniform drying behavior. Later, more dependable driers were formed by reacting the metal salt and oil acid separately to form the metal soap which was then added to the varnish. A typical material of this type is fused cobalt resinate which is formed by adding cobalt hydroxide to melted rosin and mixing at an elevated temperature. Fused driers are somewhat variable in composition and have been widely supplanted by better materials, but they are still in limited use.

Precipitated driers are the type most widely used at the present time. They contain more drier metal than the fused type and are more uniform in composition. They are formed by mixing a soluble salt of the drier metal with a soluble salt of the desired oil acid and precipitating the drier thus formed. An example of this type is the precipitated form of cobalt

resinate which is prepared by dissolving rosin in sodium hydroxide solution, precipitating a sodium resinate, dissolving the resinate in hot water, and adding cobaltous chloride solution to precipitate the desired cobalt resinate. Cobalt resinate formed by this method contains about 7.5 percent cobalt as against approximately 4 percent cobalt for the fused product.

The most widely used precipitated driers are probably the naphthenates, since they are high in metal content and are more stable than the resinates. Cobalt naphthenate, the cobalt salt of naphthenic acid (essentially cyclohexanecarboxylic acid), ordinarily contains about 12 to 16 percent cobalt.

A relatively new series of driers, the use of which has been growing rapidly since World War II, is replacing the naphthenates for many applications. These are the octoates, metallic soaps prepared from 2-ethylhexanoic acid. Although the octoates are more expensive than the corresponding naphthenates, they have certain advantages that make them desirable for many applications. Octoates are more stable than naphthenates, and they have virtually no odor, an important factor in the manufacture of modern odorless paints. Cobalt octoate stains less in white finishes than cobalt naphthenate.

Other cobalt compounds used for driers are cobalt linoleate and cobalt tallate (prepared from the fatty acids of tall oil).

CATALYSTS

In addition to its catalytic activity as a drier, cobalt in the form of metal, oxide, and salts is used as a catalytic material for many types of reactions. Cobalt, alone or in combination with other metals, can be used as a catalyst in the following types of reactions: Synthesis, hydrogenation, hydration, desulfurization, oxidation, and reduction.

From 1937 to 1944, the standard catalyst used in German plants for preparing synthetic liquid fuels by the Fischer-Tropsch process was composed of cobalt supported on diatomaceous earth (kieselguhr) with small additions of thorium and magnesium oxides. Since then, cobalt has been largely supplanted by iron for this use. Cobalt is used in hydrogenation reactions such as converting oils to edible products, but only on a small scale as compared to nickel, which is the most widely used catalyst for this type of reaction.

A relatively new application for cobalt is as a catalyst in the oxo reaction, which involves the catalytic addition of carbon monoxide and hydrogen to olefins to form aldehydes containing one more carbon atom than the original olefin.

The fact that cobalt oxides are effective oxidation catalysts has led to extensive investigation of their efficiency in antismog devices to insure complete combustion of automotive exhaust gases. Catalysts of CoO and Co_3O_4 on various supporting materials have been found which, in laboratory tests, will convert nearly 100 percent of the carbon monoxide and unburned hydrocarbons in exhaust gases to carbon dioxide and water.

Other catalytic applications for cobalt are in preparation of hydrogen from hydrocarbons and water vapor, oxidation of ammonia to nitrogen oxide, and desulfurization of petroleum compounds.

ANIMAL NUTRITION

Cobalt has been found to be a necessary item of diet for ruminants. For many years, it was known that cattle and sheep (especially the latter) raised in certain locations often suffered from a mysterious wasting disease. This disease was especially prevalent in many areas of Australia and New Zealand, where it was known as bush sickness or coast disease; in the United Kingdom, where it was known as pinning; and in Florida and the coastal areas of Georgia and South Carolina, where a similar malady was known as salt sickness.

In Australia and New Zealand, it was at first believed that the disease was caused by iron deficiency, and during the 1920's and early 1930's, treatment with limonite was successfully adopted for combatting it. In 1934, however, it was discovered that it was the small amount of cobalt present in the limonite which was the active agent, and within a few years, research had confirmed that cobalt deficiency was the cause of the previously mentioned diseases in sheep and cattle.

Later research established that vitamin B_{12} could also be used in the treatment of cobalt-deficiency disease, and it was finally established that vitamin B_{12} was synthesized by microorganisms in the rumen, and that cobalt played a necessary, although still not fully understood, part in the synthesis.

Cobalt is also used in the treatment of a condition in sheep and cattle known as the phalaris staggers. This apparently occurs only in Australia in animals grazed in pastures containing the grass *Phalaris tuberosa*. It is not known exactly how the addition of cobalt to the animal's diet prevents this disease.

Occurrence of cobalt-deficiency diseases in ruminants can be prevented in several ways. The amount of cobalt needed to protect an animal is extremely small; for sheep, 0.07 to 0.08 milligram of cobalt per day is all that is necessary. Translated into terms of cobalt

content of pasturage, this means that as little as 0.08 parts per million of cobalt (dry basis) in the pasturage is sufficient to protect sheep. The requirement for cattle is even lower—0.07 parts per million. These small requirements can be met either by increasing the cobalt content of the pastures or by direct administration to the animal.

The addition of cobalt compounds such as the sulfate or carbonate to fertilizer or some carrier material which is spread on the pasture land can result in an increase in the cobalt content of the pasturage sufficient to prevent cobalt deficiency in animals fed on it. When this method is used, about 1 to 2 pounds of cobalt salt per acre is necessary, and the treatment must be repeated every few years. A more economical method is to add cobalt to a special food supplement which is administered to the animals at regular intervals. The most convenient method is one widely used by Australian sheep raisers. Cobalt oxide is mixed with a clay binder and formed into a hard pellet (commonly referred to as a cobalt bullet) which is administered to the animal. The bullet is retained in the reticulum for long periods of time and slowly releases sufficient cobalt to prevent any deficiency. Dosing in this manner need only be carried out at annual intervals.

RADIOACTIVE COBALT

When certain metals are subjected to bombardment by thermal neutrons, some of the neutrons are captured by the nuclei of the metal atoms, and a radioactive isotope of the metal is formed. The extra energy carried by the neutron is dissipated in the form of gamma rays, which are a form of electromagnetic radiation similar to X-rays but of shorter wave length. Gamma radiation is very penetrating and will pass through considerable thicknesses of solid matter. For this reason, gamma radiography has supplanted the use of X-rays for many applications. Cobalt 60, the radioactive isotope of cobalt, is one of the principal sources of gamma radiation for industrial and medical use. It has a relatively long half life, 5.25 years, and emits gamma radiation of fairly high energy, 1.17 and 1.33 million electron volts.

One of the major industrial uses for a cobalt 60 source is in the examination of metal castings and forgings for flaws. In iron, a thickness of slightly over 0.7 inch is necessary to stop one-half of the gamma radiation emitted by cobalt 60, and a thickness of slightly under 2.3 inches is required to stop nine-tenths of the radiation.

In use, the cobalt source is placed at a predetermined distance from the piece being examined, and a sensitized film is placed immedi-

ately behind the piece. Part of the gamma radiation from the source will penetrate the piece, and part will be absorbed. The greater the amount of radiation reaching the film, the darker the image formed. The thick sections of the metal will absorb more radiation than the thin ones and will therefore show up as light areas. Any voids or flaws in the metal will show up as dark spots against the lighter area of homogeneous metal. By selecting a suitable source and proper exposure time, iron or steel castings and forgings up to 9.5 inches thick may be examined.

Cobalt 60 can be used in treatment of certain types of cancer and glandular disorders. The U.S. Army has experimented with the use of a small cobalt 60 source in a portable housing for radiographic examination of injuries at forward areas where X-ray equipment is not available.

Small cobalt 60 sources have also been used as level indicators in sealed tanks or bins and in experiments on the rate of erosion of blast-furnace linings.

Radiation from cobalt 60 sources has been used experimentally in tests on retarding the spoilage of foods and preventing the fermentation of wine. Experiments have also been carried out on the use of cobalt 60 sources in granaries to prevent infestation of the stored grain by insects. High-intensity cobalt 60 sources have been used in experiments on polymerization of plastics and in refining of petroleum.

Except for its radioactivity, the chemical and physical properties of cobalt 60 are very similar or identical to those of the naturally occurring nonradioactive form of cobalt. For this reason, cobalt 60 has found wide application in tracer work. In this type of research, small amounts of cobalt 60 are added to the normal isotope, and the course of the movement or reaction under study is followed by means of a radioactivity-detection device. Research of this type has included studies on the effect of cobalt on plant and animal nutrition, distribution of cobalt between metal and slag in metallurgical reactions, distribution of cobalt in alloy phases, segregation and diffusion of cobalt in alloys, and many others. Cobalt 60 has been extensively used in chemical analysis as a means of checking the effectiveness of both new and standard techniques and as a means of measuring small percentages of cobalt in other materials where ordinary chemical methods could not be used.

An important industrial application of cobalt 60 is in studies of wear of metals. By incorporating a small amount of cobalt 60 in the metal part under study, small amounts of wear impossible to measure by other methods can

be detected. Some examples of this type of use are in the study of the wear of wire-drawing dies, cutting tools, and piston rings, gears, or other engine parts. In studies on the wear of wire-drawing dies, the amount of cobalt 60 appearing on the finished wire is used to calculate the total amount of die material removed by wear. In cutting-tool studies, the wear is determined by measuring the radioactivity of the chips or turnings produced, whereas in engine-wear studies, the radioactivity of the oil is used to measure the rate at which the cobalt 60-tagged metal is wearing away.

MISCELLANEOUS

Cobalt salts are widely used as humidity and moisture indicators. Paper which has been dipped in cobaltous chloride and dried is pink when the humidity is high and blue when it is low, with a series of lilac intermediate colors. The series of color changes occurs when the red cobaltous chloride, $\text{CoCl}_2 \cdot 6\text{H}_2\text{O}$, becomes dehydrated at low humidities. With the use of

a color chart, relative humidity may be estimated to within 2 percent in the range of 40 to 70 percent by means of cobalt chloride paper. Papers more suitable for measuring higher humidities can be prepared with cobalt thiocyanate as the indicator.

A possible large-scale future use for cobalt is in the production of oxygen for large-scale industrial uses. Several types of cobalt chelates have the property of taking up oxygen from the air at ordinary temperatures and releasing it at higher temperatures. During World War II, the Navy carried out a number of tests using the cobalt compound salcomine (bis-salicylaldehyde ethylenediimine-cobalt). In actual use tests aboard a destroyer tender, a salcomine unit operated for several months and produced oxygen at a cost not exceeding that of cylinder oxygen. A major obstacle to the commercial use of salcomine for oxygen production is that it tends to deteriorate on prolonged use owing to the gradual loss of water attached to the molecule and subsequent nonreversible oxidation.

CHAPTER 2. HISTORY

Earliest Known Uses

The earliest known application of cobalt by man was about 4,500 years ago when the Egyptians used naturally occurring cobalt compounds to color glass. For over 4,400 years thereafter, coloring was the only use for cobalt. The ancient Egyptians, Persians, and Babylonians, and later the Chinese, Romans, and Venetians all used cobalt compounds as coloring agents for glass, pottery, and enamel.

Early Mines and Plants

The modern history of cobalt began in the latter half of the 15th century with the mining of silver-cobalt ores in Saxony and Bohemia. These ores contained a considerable quantity of arsenic which caused ulceration of the hands and feet of the miners and resulted in the evolution of poisonous fumes when the ores were smelted. The workers thought their troubles were caused by mischievous spirits called kobolds. This gradually evolved into the name cobalt.

Bruchmueller (2), in his history of the cobalt industry in Saxony, stated that the first discovery of silver ore at Schneeberg was in 1470, and that by 1474 there were 176 producing mines in the area. Although cobalt occurred in the deposits, mining was done mainly for silver. In 1492 silver-cobalt veins were discovered in the Annaberg region of Saxony, and by 1496 six mines were paying dividends.

The development of the cobalt industry in Saxony is rather obscure, but the first plant is generally believed to have been started by Peter Weidenhammer, who settled in Schneeberg in 1520 and made blue color, known as safflor or saffre, for sale to the Venetians. This was a crude cobalt oxide made by crushing and roasting the hand-cobbed cobalt-arsenic-bismuth ore. Some time later Christian Schuerer, who had a glassworks at Neudeck, made an improved blue color, called smalt, by fusing the ore with potassium carbonate and silica.

In 1568 Christopher Stahl erected a smelting works at Schneeberg to make blue pigments for artists. This was a small-scale operation, and the plant was swept away by a flood in 1573. In 1575 the Prince of Saxony granted a

monopoly on the production of blue color to Hans Harrer and Hans Jenitz. In spite of the monopoly, their undertaking was not successful, mainly because of competition from illegal color works in Saxony, and competition from Bohemian cobalt. From 1589, when the concession of Harrer and Jenitz expired, until 1641, the ministry in Saxony made a number of changes in management and in laws governing the operations.

In 1649 there were four color works in Saxony, three privately owned and one belonging to the state. These operated separately for nearly 200 years until 1845, when the three privately owned works were amalgamated into one company at Niederpfannenstiel. The state-owned works remained at Oberschlema.

By the late 1800's the character of the ore had begun to change. Bismuth became the most important metal taken from the deposits and although some cobalt was still mined, the richest deposits were nearly worked out. By the end of the 19th century, the cobalt industries of Saxony and Bohemia were almost defunct and only small pockets of ore continued to be mined. About this time, the newly discovered rich cobalt ores of New Caledonia became the world source of cobalt.

Development of the Mining Industry

EUROPE

Aside from the early development of the cobalt industry in Saxony and Bohemia already discussed, there has been no real development of a cobalt mining industry in Europe. Small amounts of cobalt-bearing materials have been mined in nearly every European country at some time over the past 150 years, but with one exception there has been no sustained mining of large amounts of cobalt ores in any of them. The exception is Finland, where cobalt-bearing cupriferous pyrite has been mined continuously since 1913 for the production of copper, iron, and cobalt. The cobalt content of this ore is relatively low, about 0.2 percent.

NEW CALEDONIA

The cobalt mining industry in New Caledonia began in early 1880's and soon replaced that of Saxony as the world source of cobalt. New Caledonia was virtually the only producer of cobalt in the world until its position as leader was challenged by Canada in 1905. The New Caledonian cobalt industry declined

rapidly after Canada entered the picture, and by 1911 cobalt mining had ceased. It resumed to a small extent during World War I and ended again in 1925. No further cobalt mining was carried out after that until 1958, when a relatively small amount of ore was mined for experimental purposes. The fluctuations of the cobalt mining industry in New Caledonia are shown in table 9.

TABLE 9.—Cobalt ore and matte produced and shipped in New Caledonia, 1883–1927¹

Year	Ore				Matte	
	Production		Shipments		Shipments	
	Gross weight (short tons)	Cobalt con- tent (percent)	Gross weight (short tons)	Cobalt con- tent (percent)	Gross weight (short tons)	Cobalt con- tent (percent)
1883	(2)	(2)	2,750	(2)		
1884	(2)	(2)	2,750	(2)	(2)	(2)
1885	(2)	(2)	2,750	(2)		
1886	(2)	(2)	2,750	(2)		
1887	(2)	(2)	2,750	(2)		
1888	(2)	(2)	2,750	(2)		
1889	(2)	(2)	2,750	(2)		
1890	(2)	(2)	4,123	(2)	220	20
1891	(2)	(2)	1,486	(2)		
1892	(2)	(2)	2,124	(2)		
1893	(2)	(2)	573	(2)		
1894	(2)	(2)	4,581	(2)		
1895	(2)	(2)	5,844	(2)		
1896	(2)	(2)	6,068	(2)		
1897	(2)	(2)	5,039	(2)		
1898	(2)	(2)	2,616	(2)		
1899	(2)	(2)	3,631	(2)		
1900	1,033	(2)	2,687	(2)		
1901	3,803	(2)	3,442	(2)		
1902	11,231	(2)	8,280	(2)		
1903	11,868	(2)	9,140	(2)		
1904	10,322	(2)	9,892	(2)		
1905	6,703	(2)	8,730	5.25		
1906	2,897	(2)	2,741	4.95		
1907	4,190	(2)	4,211	4.98		
1908	2,599	(2)	3,663	4.83		
1909	604	(2)	1,079	4.83		
1910	60	(2)				
1911						
1912						
1913						
1914	491	4.89	1,014	(2)	27	(2)
1915	154	5.75				
1916	340	5.69				
1917	106	6.50				
1918	53	5.30				
1919	34	(2)				
1920	14	(2)			72	(2)
1921	119	5.95				
1922	71	4.40			3	(2)
1923	67	4.76	71	4.76	228	18
1924	17	4.50				
1925						
1926						
1927			87	4.46		
Total	(2)	(2)	110,414	³ 5	550	³ 19

¹ Source: La Chronique des Mines d'Outre-Mer, Special Number 242, August 1956.

² Not available.

³ Approximately.

CANADA

The first cobalt-bearing materials to be mined in Canada were the rich silver-cobalt ores near the district now known as Cobalt. The ore bodies in this area were accidentally discovered in the spring of 1903 by workmen engaged in building the Temiskaming and Northern Ontario Railway. By November 1903, four rich veins had been discovered (4), and mining had begun. In 1904, relatively little interest was displayed in the deposits, but in the summer of 1905 there was a rush of miners and prospectors to the area, and mine production expanded rapidly. The ensuing rapid development in mining is indicated by figure 3. However, the

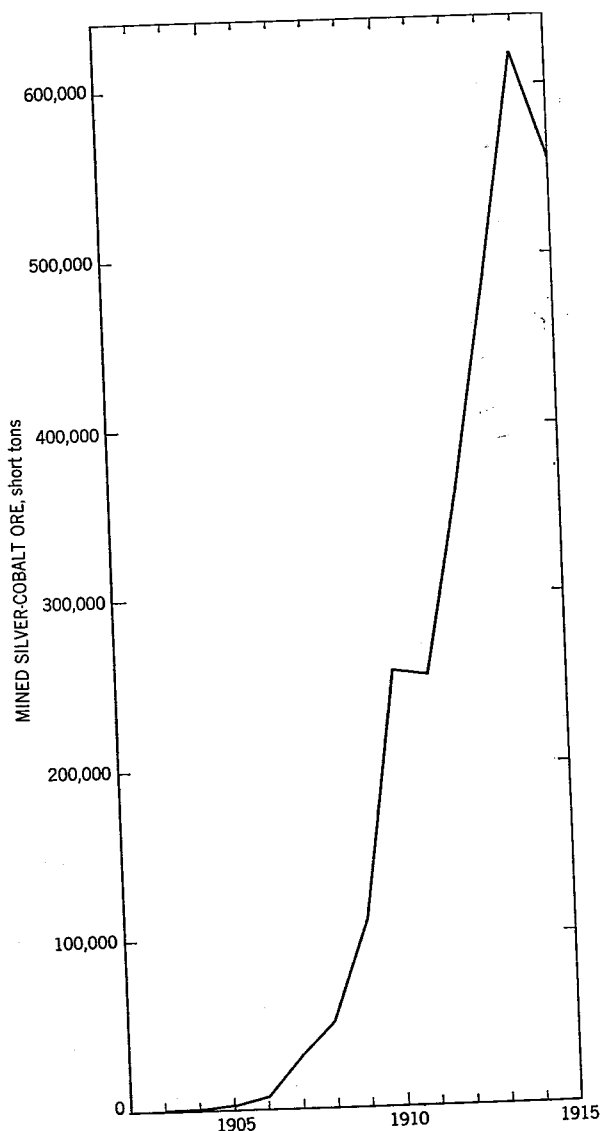


FIGURE 3.—Silver-Cobalt Ore Mined in Cobalt Area, 1903-15.

extremely rapid increase in mining was largely due to the silver content of the ore rather than to its cobalt content, as the value of the silver ranged from ten to several hundred times that of the cobalt.

Regardless of the reasons for development, shipments of cobalt concentrate from the Cobalt area rose from zero in 1903 to over 1 million pounds (cobalt content) in each of 1908 and 1909.

Shortly after the deposits at Cobalt were developed, a group of new silver-cobalt deposits was found in 1908 in the area of Gowgand Lake, about 60 miles northwest of Cobalt. These deposits were similar in nature to those at Cobalt, but much smaller. Ore production was started in 1910 and has continued up to the present time. Table 10 shows production of ore from both the Cobalt and Gowgand areas since the start of Canadian cobalt mining in 1904.

The Ontario government gave a boost to the cobalt industry when it established the Temiskaming Testing Laboratories. This facility served as a weighing, sampling, assaying, and shipping plant for all of the producers in the area. Table 11 gives figures for the ores and concentrates shipped via the Temiskaming Testing Laboratory from 1940 through 1949. These figures are probably a more accurate indication of the cobalt output during World War II than those in table 10, since table 10 counts the cobalt content of ores and concentrates reported as production for the year of export, not the year of mining. (The classification of ores as cobalt ores or silver ores is arbitrary and merely indicates the classification under which the mine operator gets the greater return under the smelter rates prevailing at the time of sale. Usually, an ore or concentrate containing more than 10 percent cobalt is classified as a cobalt ore and one under 10 percent as a silver ore.)

In 1940, The International Nickel Company of Canada, Ltd. (Inco), started recovering cobalt at its refinery at Clydach, Wales, from nickel matte made from nickel-copper ores mined in the Sudbury district, Canada. In 1947, it began to recover an impure cobalt oxide at Port Colborne, Ontario, and to ship it to Clydach for refining into pure oxide salts. In October 1954, Inco completed its refinery at Port Colborne and began commercial production of electrolytic cobalt metal from Sudbury nickel-copper ores.

In July 1952, a second company, Falconbridge Nickel Mines Limited, began commercial production of electrolytic cobalt at its refinery at Kristiansand S., Norway, from matte produced by its smelter in Falconbridge, Ontario. A third cobalt producer, Sherritt Gordon

TABLE 10.—Ore raised and cobalt content of ore and concentrates shipped from Cobalt and Gowganda areas, 1904-60¹

Year	Cobalt area		Gowganda area		Year	Cobalt area		Gowganda area	
	Ore raised (short tons)	Cobalt content of shipments (pounds)	Ore raised (short tons)	Cobalt content of shipments (pounds)		Ore raised (short tons)	Cobalt content of shipments (pounds)	Ore raised (short tons)	Cobalt content of shipments (pounds)
1904	475	32,500	---	---	1923	23,293	121,182	30,932	40,729
1905	2,598	326,300	---	---	1924	32,545	255,898	21,680	32,273
1906	7,708	448,964	---	---	1925	30,959	498,273	21,402	20,818
1907	32,180	364,975	---	---	1926	34,174	583,815	22,532	24,724
1908	52,310	1,083,874	---	---	1927	34,215	227,217	21,519	20,848
1909	109,147	1,030,788	---	---	1928	31,799	194,521	25,665	16,778
1910	257,218	1,616,279	---	---	1929	33,995	330,519	20,877	19,433
1911	254,935	---	855	5,592	1930	15,414	558,159	1	207
1912	361,275	---	5,923	---	1931	11,299	437,278	0	0
1913	489,700	2,900	9,923	---	1932	6,173	403,338	69	7,194
1914	618,014	33,380	3,620	---	1933	2,750	411,963	70	5,205
1915	555,643	13,428	9,730	---	1934	2,857	174,472	105	9,000
1916	467,884	647,712	9,891	---	1935	24,965	130,884	75	1,185
1917	---	914,046	---	---	1936	29,939	76,537	0	0
1918	---	877,163	---	---	1937	13,464	181,853	95	(2)
1919	---	322,211	---	---	1938	5,837	142,282	3,068	(2)
1920	---	811,170	---	---	1939	16,778	91,708	20,714	6,000
1921	342,922	138,881	11,703	---	1940	37,719	78,136	18,470	18,470
1922	243,852	322,407	11,922	---	1941	87,960	276,811	32,542	38,009
1923	401,215	506,898	1,447	---	1942	67,441	613,698	60,931	36,557
1924	363,775	500,685	19,845	---	1943	188,725	1,137,280	51,076	48,698
1925	261,851	418,041	18,148	---	1944	99,943	1,419,437	43,551	50,495
1926	248,723	369,463	31,087	---	1945	98,754	1,397,158	45,955	49,860
1927	208,066	354,576	48,105	---	1946	95,900	1,720,946	29,253	48,398
1928	180,003	354,440	62,821	---	1947	156,239	511,866	33,870	40,309
1929	151,424	384,440	66,855	---	1948	116,540	345,832	73,483	58,795
1930	139,168	689,206	43,407	---	1949	116,540	247,949	80,246	64,686
1931	114,434	---	28,452	---	1950	165,752	199,747	86,953	61,400
1932	38,941	1,130,711	30,130	---					

¹Source: Ontario Department of Mines. * Not available.TABLE 11.—Shipments from Cobalt and Gowganda areas via Temiskaming Testing Laboratories, 1940-60¹

Year	Cobalt ore, pounds		Silver ore, pounds		Total cobalt, pounds
	Gross weight	Cobalt content	Gross weight	Cobalt content	
1940	4,344,406	445,324	610,867	13,465	458,780
1941	4,037,340	411,328	607,715	34,934	446,262
1942	3,816,767	384,652	464,417	24,844	409,496
1943	1,620,872	161,992	176,203	11,933	173,925
1944	1,499,920	173,928	339,683	17,302	191,230
1945	353,310	106,935	398,468	21,683	128,618
1946	657,787	73,900	193,134	5,946	79,846
1947	1,873,424	188,247	416,162	5,730	193,977
1948	1,230,021	139,024	1,526,480	10,096	149,120
1949	718,918	73,031	1,701,695	19,476	92,507
1950	583,912	92,360	4,955,177	105,820	198,180
1951	935,203	88,674	3,661,440	213,447	302,121
1952	4,382,820	484,185	3,167,474	171,708	655,893
1953	10,392,143	1,167,987	2,066,274	132,316	1,300,303
1954	12,153,662	1,254,425	2,643,114	172,110	1,426,535
1955	12,299,442	1,293,500	2,229,736	135,938	1,429,438
1956	5,846,037	571,224	2,914,391	209,857	781,081
1957	1,283,668	161,149	4,572,395	380,001	541,150
1958	718,608	77,234	3,059,682	248,087	325,321
1959	0	0	3,339,002	222,054	222,054
1960	0	0	2,760,036	175,525	175,525

¹Source: Department of Mines and Technical Surveys, Canada.

Limited, began production of cobalt metal in June 1955 at Fort Saskatchewan, Alberta, from concentrate produced at its plant at Lynn Lake, Manitoba.

KATANGA

Mining of cobalt-bearing copper ores was started in Katanga Province in the former Belgian Congo about 1910 by Union Minière du Haut Katanga. The first mine was the Star of the Congo, a short distance from Elizabethville. At that time, the sole interest was in the recovery of copper. In June 1911, the first blast furnace was put into operation at the Lubumbashi plant for the production of crude copper. Although the ore contained an appreciable amount of cobalt, much of which appeared in the blister copper, Union Minière made no attempt to recover it. Some cobalt was, however, recovered from the blister copper which was electrolytically refined in Germany.

In 1924, Union Minière constructed three electric furnaces at Panda and commenced the recovery of cobalt as white alloy, a crude alloy containing about 42 percent cobalt, 16 percent copper, and 35 percent iron. The white alloy was shipped to Belgium for refining by the Société Générale Métallurgique de Hoboken, a Union Minière subsidiary. Within a few years, the Belgian Congo had become the world's largest producer of cobalt, and after the depression of 1931-1936, production expanded rapidly.

In 1945, production of electrolytic cobalt began at the refinery at Shituru, and most of the additional expansion in productive capacity following that time was in the electrolytic facilities. In 1958, Union Minière reported (21) that its electric smelting facilities had a capacity of 4,000 metric tons of cobalt per year, and that its electrolysis plant had a capacity of 6,600 metric tons of cobalt per year.

Production capacity was expanded again in 1960 when a new metallurgical plant was opened. The new plant, on the Luilu River a few miles from Kolwezi, contained electrolytic refining facilities with a capacity of 1,750 tons of cobalt per year. Provision was made for doubling this capacity at a later date. The opening of this plant brought the announced capacity of the Union Minière plants in 1960 to 12,350 metric tons of cobalt per year, but this figure is on the conservative side, and a higher production rate could be achieved if it became necessary.

NORTHERN RHODESIA

The cobalt industry in Northern Rhodesia was started in 1933, when the Rhokana Corp. began recovering cobalt as a byproduct of

copper from its mine at Nkana. Production increased rapidly, and within 2 years the Rhokana Corp. had become the second largest cobalt producer in the world. From 1933 until 1952, production was in the form of a crude alloy produced by matte smelting a cobalt-rich concentrate to recover the copper and to concentrate the cobalt values in the converter slag, which was then reduced with coke in an electric furnace. The composition of the alloy produced was about 15 percent copper, 45 percent iron, and 40 percent cobalt. The alloy was exported for refining until 1953. In 1939, a third electric furnace was added, increasing converter-slag treatment capacity by 50 percent. By 1945, Rhokana was experiencing difficulties in its cobalt production facilities due to changes in the ore. According to the annual report of the Rhokana Corp. for 1945, the smelter practice in cobalt production required some changes because of the steady increase in the iron content of the ore with greater depth in mining. The increased iron content made it impossible to meet the specifications for alloy to be shipped for refining, and it became necessary to retreat considerable quantities of alloy in the converters. Although shipments were maintained by these means, losses and costs were increased.

These difficulties led to the construction of a gravity separation plant which produced a concentrate with a higher cobalt and a lower iron content. This plant was put into operation in 1947.

In 1949, work began on the construction of electrolytic refining facilities with a designed capacity of 1,500 short tons of metal per year. In August 1952, the plant went into production, but because of technical difficulties continuous production was not achieved until February 1953. Production of crude alloy was continued, but at a reduced rate.

In 1952, construction was started on a plant to produce cobalt carbonate, and in 1954 the plant was put into operation.

A new producer entered the industry in 1955 when Chibuluma Mines Ltd., began mining a cobalt-bearing copper ore at its mine a few miles west of Nkana. On May 6, 1956, Chibuluma began operating a concentrator near Ndola, and in 1957, production of cobalt matte was started. Matte was exported for refining. The company announced that it was considering plans for the construction of a refinery on the plant site, but as of 1960 this had not been started.

MOROCCO

The cobalt-bearing desposits of Bou Azzer district of French Morocco were discovered in 1930, and in 1931, the Société Minière de Bou

Azzer et du Graara was formed to exploit them. Production has been continuous since 1932, although with wide variations in output. In 1954, a modernization campaign was started to improve mining and concentrating procedures. The main expenditure was for a new washing plant to improve the capacity and efficiency of the concentration process. The new washing plant went into operation in 1958, and production of cobalt concentrate was more than double that of the previous year.

Concentrate is the only cobalt product made in Morocco. All concentrate produced by Bou Azzer is refined abroad, mainly in France and partly in Belgium. No plans have been announced to refine cobalt in Morocco, and it is probable that none will be as long as the price of cobalt remains low.

It was reported in 1959 (24) that the Bou Azzer operations were losing money, and because the price of cobalt has dropped since then, it is possible that the company may be experiencing difficulties in maintaining operations. It should be noted that the modernization campaign, which involved relatively heavy expenditures, was started in 1954 when the price of cobalt was \$2.60 a pound, a much more attractive price for producers than the 1960 price of \$1.50 a pound.

UGANDA

The copper-cobalt deposit in Uganda was discovered by Tanganyika Concessions, Ltd., in 1927, but its license to exploit the district was given up in 1940.

In 1947, Frobisher Limited obtained a special exclusive prospecting license covering the deposits known at that time and in 1950 caused the incorporation of Kilembe Mines Limited to take over their exploration. Subsequently it was decided that Kilembe Mines Limited should proceed with the development of the deposits, and by 1954 financial arrangements were concluded by Kilembe, which is 70-percent owned by Kilembe Copper Cobalt, Ltd., which is 77.4-percent owned by Ventures Ltd. A concentrating plant was erected in Kilembe in mid-1956, and a smelter at Jinja, 270 miles distant, in November 1956.

In 1959 additional facilities were installed to increase the copper-concentrator capacity to 77,000 tons per month and the smelter capacity to 16,000 long tons of blister copper per month. The world market for cobalt and the known metallurgical processes for extracting the cobalt metal are such that the company has decided to stockpile its entire production of cobalt-bearing pyrite concentrates until it is proven economical to treat these concentrates. By December 31, 1959, the company had stockpiled approxi-

mately 125,491 tons of cobalt concentrates containing roughly 3,700,000 pounds of cobalt metal.

UNITED STATES

It is impossible to pick a particular date as the beginning of the U.S. cobalt industry. The United States was undoubtedly a consumer of cobalt throughout the 19th century and perhaps earlier. Cobalt oxide was produced in the United States as early as 1869, but the source of cobalt was the Sudbury ores of Canada. Small amounts of cobalt ore were produced at Mine La Motte in Missouri as early as 1857 (?), and some ore was shipped from this mine to Swansea for refining prior to 1900. In 1900, the Mine La Motte Co. erected a plant in Missouri to refine its own ores, and in 1903, the year in which it was shut down, the plant produced 120,000 pounds of cobalt oxide.

In 1906, the North American Lead Co. erected a refinery at Fredericktown, Mo., to recover copper, nickel, and cobalt associated with the lead in its mine at Fredericktown. Numerous difficulties were encountered in the operation of the plant owing to the complexity of the ore, but in 1907 the company produced 2,371 pounds of cobalt oxide. In 1909, 83,394 pounds of cobalt oxide was produced as well as 8,314 tons of nickel and cobalt concentrates. Operations were halted in 1910, and the property was sold. In 1915, the Missouri Cobalt Co. took over the property, and in 1917, production was resumed. In 1920, production had reached the high point of 102,410 pounds of cobalt oxide and hydrate, although the plant was closed down and did not operate for the full year.

Cobalt was first identified in the Blackbird district in Lehmi County, Idaho, in 1893, but the early interest in the deposits was for the gold which they contained. In 1915, the Haynes Stellite Co. acquired a group of 30 claims in the Blackbird district. By 1917, the great increase in the use of cobalt for manufacture of Stellite prompted the Haynes Stellite Co. to develop the Blackbird deposits as a source of cobalt. In 1918, 4,000 tons of ore was mined and reduced to 55 tons of concentrate which contained about 17.7 percent of cobalt. Exploration and development work continued during 1919, but no ore was mined, and the project was abandoned in 1920.

Very little interest was shown in cobalt mining in the United States between 1920 and the beginning of World War II. A small amount of cobalt ore mined at Good Springs, Nev., in 1921 was the last domestic ore produced until 1931, when a small amount of cobalt-manganese ore was mined in Cherokee County, Ala. During the period 1931 to 1940, a small amount of cobalt-bearing residue was

produced at a western electrolytic-zinc plant, and minor quantities of cobalt-bearing ore were produced by prospecting activities at various places.

United States consumption of cobalt increased substantially in 1940, and efforts to find domestic sources were intensified. The Pyrites Co., Inc., of Wilmington, Del., started the production of cobalt oxide from concentrate produced from the treatment of iron ore mined at Cornwall, Pa. The Eastern Magnesia Talc Co. of Burlington, Vt., produced a cobalt concentrate as a byproduct of froth flotation of talc for a few years during the 1940's. Also in 1940, a plant was set up at Niagara Falls, N.Y., to refine crude cobalt alloy produced in the Belgian Congo. This material had previously been refined in Belgium, but after the German invasion of that country, shipments from the Belgian Congo were stopped, and the refining facilities at Niagara Falls were constructed.

In July 1944, The St. Louis Smelting and Refining Co. began commercial production of cobalt from its Fredericktown, Mo., property. Difficulties experienced in the operation of the plant, however, caused suspension of operations in September 1946.

Following the conclusion of World War II, interest in domestic production of cobalt again languished until the start of the Korean war. The Calera Mining Co., a wholly owned subsidiary of the Howe Sound Co., which had acquired a number of claims in the Blackbird district in 1943 and had carried on continuous development work on the mine and research work on the development of a process for the recovery of cobalt from the ore, was requested by the Government late in 1950 to increase the planned capacity of the mine and refinery. In return, the Government, in 1951, contracted for the purchase of 6.5 million pounds of cobalt-nickel alloy containing not less than 93 percent cobalt and not more than 7 percent nickel at a fixed premium price. Although production of concentrate was started in June 1951, numerous operating difficulties were encountered in starting up the refinery, and no cobalt metal was made until March 1953.

The St. Louis Smelting & Refining Division of National Lead Co. reentered the cobalt-production picture in 1955 when it opened a new refinery at Fredricktown, Mo. Development of the refinery was spurred by a Government contract for the purchase of a substantial amount of cobalt at a premium price.

The domestic cobalt industry reached its peak in 1958, when 4,023,000 pounds of recoverable cobalt in ore was produced. From this high point, production dropped to 2,331,000

pounds in 1959, and the indications are that production from domestic ores will continue to decrease and may indeed cease altogether within a few years. The Calera Mining Co., the largest domestic producer, with a capacity of over 3 million pounds of cobalt per year, was permanently closed in mid-1959 after completing deliveries on a Government contract. Price cuts by Union Minière had brought the price down to a point where Calera could no longer operate profitably. Early in 1960, the Government settled its outstanding contract with the National Lead Co., and it remains to be seen if any domestic producing company can operate without Government support at the present low price of cobalt.

CUBA

The extensive laterite deposits along the northern coast of Oriente Province, Cuba, had been looked upon as potential sources of iron and nickel since their discovery shortly after the Spanish-American War. Although several steel companies in the United States staked claims and attempted to use the laterites as iron ore, no commercial utilization of the deposits developed because it was found that the relatively high chromium and nickel contents of the laterites made them unsuitable for the production of pig iron. Further attempts (particularly by Bethlehem Steel Corp.) to develop a process to utilize the deposits by removing the chromium, nickel, and cobalt "contaminants" proved unsuccessful.

In the late 1930's, the Pardners Mines Corp. became interested in utilizing the laterites as a source of nickel, and it conducted extensive prospecting in Oriente Province and discovered large ore deposits at Moa Bay and Nicaro. Freeport Sulphur Co. became interested in the project and started work on the development of a process for extracting the nickel. Freeport soon settled on the Caron process, an ammonia leaching technique, as the most feasible method, and started development work in a small pilot plant. When the United States entered World War II it was realized that a new source of nickel was necessary. Pardners Mines sold out to Freeport, and Freeport arranged with the United States and Cuban Governments to construct a plant at Nicaro to produce 32 million pounds of nickel per year. No attempt was made in the Nicaro operation to recover the cobalt, which occurred in the ore in the ratio of about 1 part of cobalt to 12 to 14 parts of nickel. Since specifications called for a maximum of 1 part of cobalt to 100 parts of nickel in the finished product, every effort was made to reject cobalt from the process and discard it in the tailing.

The capacity of the Nicaro plant was expanded to over 50 million pounds of nickel per year in 1957, but the basic process remained essentially unchanged; cobalt, except for 0.6 to 0.8 percent which remained in the finished nickel, continued to be lost in the tailing. A number of pilot-plant studies were carried out at Nicaro to find a way to recover cobalt, if only to keep it out of the nickel product, but none had proved successful as of the seizure of the plant by Cuba in 1960.

In 1953, the Freeport Sulphur Co. started pilot-plant investigations designed to develop operating data for a new sulfuric acid leaching process which was designed to recover both nickel and cobalt from the ores at Moa Bay. In 1954, at the request of the U.S. Government, construction of a large-scale pilot plant was begun. The pilot plant operated successfully, and plant construction was started in 1957. Two plants were built, one at Moa Bay near the ore deposits and one at Port Nickel, La. At the Moa Bay plant, nickel and cobalt were to be leached from the ore and recovered as a sulfide slurry. The slurry was to be refined to pure cobalt and pure nickel metal at the Port Nickel plant.

The facilities were designed for a capacity of 50 million pounds of nickel and 4.4 million pounds of cobalt per year and were scheduled to commence operations in mid-1959. The refinery at Port Nickel was finished in the fall of 1959, only slightly behind schedule, but construction of the Moa Bay plant was badly delayed by strikes and political difficulties occurring during and after the revolution in Cuba. Construction at Moa Bay finally reached the point where partial operation was possible. A sufficient amount of nickel-cobalt slurry was made to confirm the workability of the process. This slurry was shipped to the Port Nickel plant and successfully refined.

Late in 1959, it became apparent that the new Government of Cuba had adopted a hostile attitude toward all U.S.-owned enterprises in that country, and construction work on the Moa Bay plant stopped because of difficulties in obtaining funds from the sources in the United States which were financing the project. On March 3, 1960, Freeport officials notified the Cuban authorities that the plant was to be closed. On August 18, 1960, the plant was officially intervened by the Cuban government.

CHAPTER 3. RESOURCES

Geology and Minerology

Cobalt is a relatively rare component of the earth's crust. The average content is apparently about 0.001 to 0.002 per cent (6, 14). Small quantities are fairly widespread in most rocks, soils, mineral waters, sea water, and plants and animals. Certain geologic processes are necessary to give concentrations of cobalt that can be useful to man. The amount of concentration and the presence of associated metals are factors in making deposits of economic importance.

The most important geologic processes in the concentration of cobalt are: (a) Magmatic differentiation and segregation (perhaps aided by hydrothermal processes); (b) hydrothermal activity leading to the formation of veins and replacement deposits; (c) weathering, with attendant oxidation and leaching, helped in places by the movement of ground water; (d) deposition of small amounts of cobalt in various sedimentary rocks, followed by further concentration by weathering, or by the activity of hydrothermal solutions or ground water. The relationships of the processes and the importance of associated metals in concentrations of economic importance are discussed below.

Magmatic differentiation, which produces basic or ultrabasic rocks, seems to concentrate cobalt along with nickel, chromium, and certain other elements. The ultrabasic rocks, such as serpentine, pyroxenite, and dunite, do not contain cobalt in commercial quantities, but the soil formed from them has concentrations of iron, manganese, nickel, and cobalt after long-continued weathering and leaching of the rocks, especially under the tropical conditions that cause lateritization. The best known examples of such deposits are the lateritic ores. Manganese and cobalt (as asbolite) concentrate fairly close to the surface, forming deposits of economic grade (New Caledonia and Brazil), whereas nickel silicate concentrates just above bedrock. Cobalt, in amounts between one-tenth and one-twenty-fifth of the nickel content, accompanies the nickel silicate.

Certain types of basic rocks, particularly norite, are associated with concentrations of iron, nickel, and copper sulfides; most geologists believe that some hydrothermal activity as well as magmatic segregation is important

in the origin of such deposits. The cobalt content is one-twentieth to one-thirtieth of nickel content in these ores; and where reserves are large, as at Sudbury, Canada, Petsamo, Russia, some cobalt can be recovered as a minor byproduct during the recovery of nickel and copper.

Some contact metamorphic deposits associated with basic igneous rocks (diabase) contain cobaltiferous pyrite and chalcopyrite in masses of magnetite; hydrothermal activity may have played a part in the origin of these deposits. In some of them, such as those of Cornwall, Pa., the pyrite contains 1 to 2 per cent cobalt. Although the Cornwall ore contains only about 0.056 percent cobalt, a considerable amount of cobalt is produced because of the large tonnage mined and the fact that cobalt, sulfur, and copper, are recovered and used.

Hydrothermal activity, either direct or indirectly, has formed the largest number of cobalt deposits of any appreciable size. Some of these, as originally formed, contain considerable cobalt, usually associated with one or two other metals, to be minable; others have been concentrated by weathering to make them minable enough; and others are primarily minor byproducts of other metals, with cobalt as a byproduct. Some of the deposits are fissure fillings, and some are replacements of the country rock. Primary gangue minerals are quartz, calcite, and pyrite.

The simplest type of hydrothermal deposit is a vein containing cobaltite alone in quartz or calcite gangue. A few such veins have been mined in the Cloncurry district, Australia, in some of the mining districts of Chile. Most of these have been mined only in the oxidized zone, but apparently they are rich in cobalt in places below the oxidized zone to be mined. Of commoner occurrence are deposits containing cobalt in appreciable quantities along with copper or silver, such as certain deposits in Australia and Chile and the Blackbird mine of Idaho. At Blackbird, cobaltite, pyrite, and pyrrhotite occur in a matrix of quartz, mica, and calcite in shear zones.

Deposits in which copper is the important metal and cobalt is present in relatively small quantities have been formed in the Katanga-Northern Rhodesia district. In Katanga, cobalt has been concentrated to commercial grade by oxidation, leaching,

redeposition; in Northern Rhodesia, the small amount of cobalt can be recovered only as a byproduct of copper mining.

In a few base-metal deposits, a small percentage of cobalt is available as a byproduct. The Bawdwin mine of Burma has large replacement ore bodies containing principally lead and zinc, and small quantities of copper, nickel, and cobalt.

Small quantities of cobalt occur in a number of large deposits, formed mostly by replacement of schistose rocks, in which the principal mineral is either pyrite or pyrrhotite. Some of these contain appreciable chalcopryite, but have been mined in the past mainly as a source of sulfur, with iron and copper as the principal byproducts. The iron sulfides may carry a small fraction of 1 percent of cobalt, some of which has been recovered in the past, principally in Europe. The deposit at Outokumpu, Finland, is of this type, and is mined mainly for its copper content. Numerous similar ore bodies occur in the eastern United States, but no attempt has been made to recover the cobalt.

An entirely different type of hydrothermal deposit is the native silver-cobalt-nickel ore type, which is divided into deposits that contain pitchblende and those that do not. The best example of the latter type is the ore of the Temiskaming area of Ontario, where cobaltite, safflorite, and a number of other cobalt and nickel minerals occur in a gangue mainly of calcite, with native silver, argentite, and other silver minerals. The mines were worked mostly for silver, but some have been mined principally for cobalt. Smaller deposits of similar character are known at several places in France, Sardinia, South Africa, and Mexico. Native silver-cobalt-nickel ore, containing appreciable pitchblende, occurs in the Erzgebirge region of Germany and Czechoslovakia; similar ore is also found at Great Bear Lake, Canada.

In sedimentary rocks the deposition of cobalt and other metals may have taken place when the sediments were formed (syngenetic deposits), or the cobalt may have been introduced subsequently (epigenetic deposits).

Deposits of cobaltiferous manganese oxide are syngenetic. Appreciable amounts of cobalt are present in concentrations of manganese oxide in chert or in the quartz portions of the originally calcareous rock. The manganese oxide concentrations were formed during long periods of weathering and leaching of sedimentary carbonate rocks that contained small amounts of manganese and cobalt when deposited. Moving ground water may have further concentrated these metals. Where the manganese oxide is of high grade, it is used in ferromanganese production, and the cobalt is

not recovered. If the lower grade deposits were treated chemically to recover the manganese, the cobalt might be recovered as a byproduct.

Deposits in which stratigraphic control is strong may be syngenetic or epigenetic, although the minerals may be typical of hydrothermal deposits. The deposits of the Katanga-Northern Rhodesia districts display an almost complete stratigraphic control of the distribution of bornite, chalcocite, and linnaeite. Some geologists say, therefore, that the metals were first concentrated by hydrothermal solutions. Similarly, the southeastern Missouri deposits, which consist of galena, chalcopryite, pyrite, and siegenite restricted to a narrow stratigraphic zone, are thought by some to represent originally syngenetic metal content secondarily concentrated by moving ground water.

World Reserves

A listing of the major cobalt reserves of the free world is given in table 12. These reserves, together with a number of minor occurrences, are described in the following text.

NORTH AMERICA

United States—Major Deposits

The United States has long been the major consumer of the world's cobalt supply, but it was not a major producer until the 1950's when production was expanded at the instigation of the Government. Peak production was reached in 1958, when over 4.8 million pounds of cobalt in ore and concentrate was produced, equivalent to slightly over 4 million pounds of recoverable cobalt. Although 1958 production raised the United States to the position of the world's second largest producer of cobalt (a position which it occupied for only 1 year), the United States does not possess large cobalt reserves. A brief description of United States cobalt deposits is given below.

IDAHO

The largest known reserve of high-grade cobalt ore is that of the Calera Mining Co. in the Blackbird district of Lemhi County, about 20 miles west-southwest of Salmon, Idaho. The district was first prospected about 1893, and cobalt minerals were noticed in the district a few years later. Many claims were staked, and a number of small workings were driven in the district during the next few years in attempts to develop deposits of gold or copper. From 1899 to 1902, considerable development was done at the Brown Bear mine. Plans to smelt the ore were abandoned because of its high

TABLE 12.—Major free world reserves of cobalt, in thousands of tons

Deposit	Location	Major cobalt mineral	Estimated reserves	
			Ore	Cobalt
North America:				
United States:				
Bethlehem Cornwall Corp.....	Cornwall, Pa.....	Cobaltiferous pyrite.....	50,000	
Calera Mining Co.....	Blackbird District, Idaho.....	Cobaltite.....	14,000	
National Lead Co.....	Fredericktown, Mo.....	Siegenite.....	3,000	
Canada:				
The International Nickel Co. of Canada, Ltd.....	Sudbury District, Ontario.....	Cobalt replacement in nickel sulfides.....	265,000	
Do.....	Thompson, Manitoba.....	(1).....	25,000	
Falconbridge Nickel Mines, Ltd.....	Sudbury District, Ontario.....	Cobalt replacement in nickel sulfides.....	46,000	
Sherritt Gordon Mines, Ltd.....	Lynn Lake, Manitoba.....	do.....	14,000	
Cuba: ³				
Bethlehem-Cuba Iron Mines ⁴	Mayari District, Oriente Province.....	No identifiable cobalt mineral.....	110,000	
Do.....	Moa Bay District, Oriente Province.....		55,000	
Cuban Nickel Co. ⁴	Levisa District, Oriente Province.....		35,000	
Nicarao Nickel Co. ⁴	do.....		67,000	
Do.....	Moa Bay District, Oriente Province.....		40,000	
Do.....	Taco Bay District, Oriente Province.....		25,000	
Do.....	Plateau Cajabanes District, Pinar del Rio Province.....		24,000	
Do.....				
Australia and Oceania: New Caledonia: ⁵				
Société le Nickel.....		Asbolite.....	220,000	
Africa:				
Morocco: Société Minière de Bou Azzer et du Graara.....	Bou Azzer.....	Skutterudite.....	800	
Northern Rhodesia:				
Baluba Mines Ltd.....	Northern Rhodesian Copperbelt.....	Carrollite.....	112,000	
Chibuluma Mines Ltd.....	do.....	do.....	9,800	
Rhodana Corp. Ltd.....	do.....	do.....	124,000	
Republic of the Congo: Union Minière du Haut-Katanga.....	Southern Katanga Province.....	Carrollite (sulfide zone) Heterogenite, asbolite (oxide zone)......	(1)	

¹ Not available.² Reserves at Thompson are undoubtedly much higher.³ The reserves listed include only the richer nickel-cobalt ores which contain about 1.3 percent nickel and 0.1 percent cobalt. In addition, the listed deposits contain an estimated 1,500 million tons of lower grade material which contains about 0.3 percent nickel and 0.07 percent cobalt.⁴ Names of owners before seizure of deposits by Cuba.⁵ Figures for New Caledonia do not include the cobalt presilicate type nickel ores controlled by Société le Nickel or the ores controlled by other operators on the island.

arsenic content, and all work stopped. During World War I, when the price of cobalt was high, the Haynes-Stellite mine was developed. However, the mineralized rock was extremely hard and the cobaltite very fine grained, and although some cobalt concentrate was shipped, the operation ceased about 1920. From 1938 to 1941, the Uncle Sam mine was operated, along with a small flotation mill. The copper smelter handling the concentrate penalized the operators for cobalt in the concentrate, with the result that most of the cobalt was intentionally depressed and not recovered. Partly because of this, and partly because of a lack of capital, the operation closed.

During World War II the Bureau of Mines explored parts of the Blackbird district with bulldozer and diamond drill, and the Geological Survey mapped the district and logged the drill cores. In 1951, the Calera Mining Co., a Howe Sound Co. subsidiary, drilled a large block of ground and did a great deal of underground work.

The rocks of the Blackbird district are mostly metamorphosed Precambrian sediments intruded by the Idaho batholith in the northern part of the district, and by siliceous porphyry dikes and metamorphosed basic rocks.

Most of the ore deposits occur in a north-south structural block, known as the Blackbird

structural block, separated from the rocks on each side by large faults. This block is 2½ miles wide and extends at least 6 miles from the granite contact. The rocks of the block appear to have been more tightly folded than those on either side, with the development of widespread schistosity. The rocks outside the block are more quartzitic and are in fairly good folds. The Blackbird structural block is a number of mineralized shear zones with some post-ore faults.

The ore deposits were formed mostly by replacement of the shear zones. The ore contains chalcopyrite, cobaltite, safflorite, and pyrrhotite in a gangue consisting mostly of quartz and biotite, plus some ankerite.

Most of the developed ore in the district is on the property of the Calera Mining Co. Many favorable zones exist elsewhere in the district. Most of the ore on the Calera property lies in three zones. The Chicago zone, for a length of about 1,800 feet, strikes west and dips 50° and 80° northeast; the ore shoots in this zone are believed to trend north. The Brown Bear zone is a wide structure that strikes about north and is nearly vertically; in it are a number of ore shoots plunging 25° and 35° north. The tail zone contains veins up to 40 feet wide.

ore sent to the concentrating plant averaged about 0.7 percent cobalt.

During the hearings under Section 8 of the 1958 Trade Agreements Extension Act before the OCDM in 1958, officials of the Howe Sound Co. stated that the known commercial ore reserves contained 15 million pounds of cobalt, whereas the inferred reserves could be 15 times larger.

MISSOURI

The cobalt-bearing lead ores of the National Lead Co. near Fredericktown, Mo., comprise one of the major U.S. cobalt reserves. These deposits are in the southeastern Missouri lead district. Although the cobalt-nickel sulfide, siegenite, was identified in this area as early as 1857, the first attempt to produce cobalt (and nickel) was made by the North American Lead Co. between 1906 and 1910. In 1917-20 the Missouri Cobalt Co. produced some cobalt. The St. Louis Smelting & Refining Co. drilled near Fredericktown from 1927 to 1931 and did some research on the problems of treatment. In 1941, the same company took renewed interest in the area and during World War II began mining. After the war, the company, absorbed into the National Lead Co., continued to produce lead and copper metals and cobalt concentrate, which was stockpiled for future use. A refinery was constructed, and refining operations were begun in 1955.

The rocks in the southeastern Missouri lead district consist of Precambrian granite, porphyry, and a little diabase, overlain by the Cambrian formations listed below:

Elvins group: Dolomite, shaly dolomite, and shale.

Bonneterre formation: Dolomite, some green shale partings; sandy at base.

LaMotte formation: Conglomerate and shale at base; mostly sandstone, in places shaly or arkosic; dolomitic at top.

The surface of Precambrian rocks on which the Cambrian was deposited is one of considerable relief. The LaMotte formation filled in the valleys and lapped up against the Precambrian hills, the top surface of the LaMotte being higher close to the hills. The Bonneterre formation was deposited on the LaMotte and lapped over onto the higher hills of Precambrian.

The ore deposits are mostly limited to the base of the Bonneterre and the top of the LaMotte formations and are apparently further localized to "highs" of the LaMotte where it rises against the Precambrian hills, so the ore bodies appear to lie fairly close to, and around, the exposed or buried knobs or ridges of Precambrian rocks. In places, there is perhaps

some structural control by joints. Most of the deposits of galena lie in a somewhat sandy dolomite zone about 50 feet thick at the base of the Bonneterre formation; some scattered bodies of galena are higher in the formation. At the base of the galena-bearing zone at the bottom of the Bonneterre and in the topmost dolomitic sandstone of the LaMotte formation, the galena is associated with a higher percentage of marcasite and pyrite, accompanied by chalcopyrite and siegenite and small amounts of sphalerite and bravoite.

The National Lead Co. does not publish reserve figures. However, reserves are believed to be fairly extensive, and probably total 2 to 3 million tons of ore averaging about 0.28 percent cobalt.

PENNSYLVANIA

The cobalt-bearing iron ore deposits of the Bethlehem Cornwall Corp. in Cornwall, Pa., probably constitute the second largest cobalt reserve in the United States, although they are very low in cobalt content. Iron has been mined here since 1742, and over 40 million tons of ore has been produced. Present annual production of iron ore is about 1 million tons. Cobalt was first produced commercially in 1941.

At Cornwall, thick diabase sills have intruded Triassic shales and Cambrian limestone. Large bodies of ore contain 40 to 60 percent magnetite and about 3½ percent pyrite. The pyrite contains about 1½ percent cobalt and some chalcopyrite carrying a little gold. The ore thus contains about 0.056 percent cobalt.

Iron ore reserves are estimated to be quite large, probably about 50 million tons.

United States—Minor Deposits

ALABAMA

Small cobalt-bearing manganese deposits are found in northeastern Alabama. A survey of the area by the Federal Geological Survey during World War II disclosed ten small deposits containing a total of 25,000 pounds of cobalt.

ALASKA

At Funter Bay, Alaska, a low-grade copper-nickel deposits carries a little cobalt. Assays range between 0.07 and 0.23 percent cobalt, 0.26 percent nickel, and 0.3 percent copper. Similar copper-nickel deposits on Yakobi Island and on the west coast of Chichagof Island may contain about the same amount of cobalt, but assays are not available.

At Hot Springs, on the lower Tanana River, erythrite is reported in a narrow quartz vein.

ARIZONA

Graham County.—At the Bluebird mine, a zone about 400 feet long contains short irregular en echelon lenses of pyrite, cobaltite, and glaucodot cut by later chalcopyrite and pyrite veinlets. The country rock is highly altered quartzite, cut by basic and siliceous igneous rocks. Only about 100 tons containing 1.10 percent cobalt is estimated, without much chance for finding extensions.

Pima County.—The presence of cobaltite has been reported in the Cababi district.

Yavapai County.—Cobalt is found in short, narrow veins in schist and gabbro surrounded by granite in Grapevine Canyon. The best sample contained 1.9 percent cobalt and some copper. The veins are too small for commercial exploitation.

Some nickel minerals have been identified in the Monte Cristo silver mine, northeast of Wickenburg. The highest cobalt content in dump samples was 0.005 percent.

The Old Dick mine contains a large tonnage of cobalt-bearing copper-zinc ore. Cobaltiferous arsenopyrite has been identified but the grade is unknown.

ARKANSAS

Saline County.—A quartz vein carrying pyrite, galena, millerite, and values in silver and cobalt has been reported at the Rabbitfoot Mine, near Benton.

Montgomery County.—Cobalt has been found in samples of psilomelane and pyrolusite from Montgomery County.

Fulton County.—A specimen of lampadite (a variety of asbolite) was submitted to the Federal Geological Survey from Fulton County.

CALIFORNIA

Calaveras County.—Smaltite and cobaltiferous arsenopyrite were reported at the Hanselt Patent, 2 miles southeast of Sheepranch.

Inyo County.—The mine of the Bishop Silver-Cobalt Co. on Long Lake contains cobalt-bearing material. The best picked sample from a 14-inch zone showed 0.88 percent cobalt, 0.69 percent copper, and 0.11 percent nickel. A sample from a 4-inch vein in the adit assayed 0.53 percent cobalt. The available tonnage probably is low.

Los Angeles County.—Several old reports mention the presence of cobalt in a group of old mines northeast of Azusa. In a survey made in 1941, no cobalt minerals were found.

Madera County.—The ore of the Foothill Copper Belt has been reported to contain up to 3 percent cobalt in places. Skutterudite has been reported in the Daulton mine. Samples taken

from the dumps in 1941 showed only 0.01 percent cobalt. At the Jesse Belle mine there is a relatively small deposit with discontinuous veins of quartz, silicate, and chalcopyrite, and much less pyrite, pyrrhotite, and cobaltite. The ore averages 3.0 percent copper and 0.1 to 0.5 percent cobalt.

Mariposa County.—Cobalt analyses of up to 0.18 percent have been recorded on sample from the Green Mountain mine. Erythrite has been reported in the Pine and Josephine mines.

Napa County.—Erythrite and smaltite in serpentine were reported in Beryessa Valley.

Placer County.—Cobaltite with chalcopyrite was reported in a deposit 4 miles northeast of Alta. Cobalt with arsenopyrite was reported in the Metallic mine near Cisco.

San Diego County.—Nickel-copper deposit similar in occurrence to those of the Sudbury district of Canada, are found near Julian. A drilling program, carried out by Friday Nickel Mines, Ltd., of Vancouver, British Columbia, in 1957 disclosed the presence of relatively large amounts of ore averaging 2.15 percent copper, 1.96 percent nickel, and 0.63 percent cobalt.

Mendocino County.—Large bodies of nickel and cobalt-bearing laterites occur at Little Red Mountain and Red Mountain. Small amounts of garnierite have been found in the laterites but most of the nickel mineralization cannot be identified. The deposits are estimated to contain about 10 million tons.

Imperial County.—Nickel-cobalt deposits have been located in the Coyote Valley mining district about 22 miles west of El Centro.

Del Norte County.—Nickel- and cobalt-bearing lateritic deposits similar to those being exploited in Oregon by Hanna Mining Co. are found in several areas in Del Norte County.

Other Counties.—Deposits similar to those of Del Norte County may exist in Humboldt, Siskiyou, and Trinity Counties.

COLORADO

Boulder County.—At the property of the Infusent Cobalt Gold Mining Co., some nickel matte carrying cobalt and gold was produced. A tight anticline of schist, gneiss, and calcareous silicate rocks is cut by a small diorite stockwork. Ore is disseminated pyrite, pyrrhotite, chalcopyrite, and niccolite replacing amphibole in more calcic beds. Primary ore carries 0.60 percent cobalt; some oxidized ore has up to 6 percent cobalt. The deposit contains small tonnage (perhaps 15,000 tons) of 1 percent ore carrying less than 0.5 percent cobalt. The ore is erratic and difficult to mine.

Chaffee County.—Ore carrying 0.02 percent cobalt has been reported in the Josephine mine.

Custer County.—A fairly large deposit containing 0.2 percent nickel and 0.05 percent cobalt was reported at the Big Stake nickel operty.

CONNECTICUT

Middlesex County.—In the region near Chatham some exploration and development work is carried out between 1762 and 1853, probably on a small, high-grade ore pocket, high in nickel and containing some cobalt.

GEORGIA

Cobalt-bearing manganese deposits occur in a number of places near Cartersville, Ga.

IDAHO

Lehmi County.—A number of unexploited cobalt deposits exist in the area where the Calera Mining Co. operated.

Shoshone County.—Cobalt is present in the zinc ore of the Bunker Hill Mining Co., which annually produces a few thousand pounds of cobalt in concentrate at its electrolytic zinc plant.

KENTUCKY

Cobalt and nickel associated with fluorite have been reported near Marion in Crittenden County.

MAINE

Some cobalt associated with pyrrhotite is found in Maine.

MARYLAND

Four old copper or iron mines (the Carroll, Mineral Hill, Patapsco, and Springfield) in Carroll County were reported to contain a little malachite. All the deposits were relatively small.

MICHIGAN

The Michigan copper district contains nickel and cobalt arsenides, but presumably in very small amounts. No assays are available.

MINNESOTA

On the property owned by the Loon Lake Mass Mining Co. in Cook County near Loon Lake, irregular veins ½ to 6 inches wide have been found in an 8-foot ore zone cutting a base sill in Precambrian slates. The veins contain quartz, arsenopyrite, chalcopyrite, malachite, and probably a cobalt mineral. One sample showed 3.95 percent cobalt.

MISSOURI

In addition to the ores of the National Lead Co., deposits elsewhere in the southeastern lead district, including those of the Hudson Valley Lead Co., the Madison Lead & Land Co., and the Jackson Revelle Co., contain large reserves of lead ore that probably contains some cobalt. An estimate made in 1949 indicated that about 600,000 pounds of cobalt is contained in the lead ore mined annually in this district, but no attempt is made to save it. Recovery of some of this might be possible if the process used by National Lead could be applied to these ores.

MONTANA

The Cherry Creek manganese deposits in Madison County are reported to contain 1 to 2 percent cobalt.

NEVADA

Churchill County.—Cobalt occurs at the Lovelock mine and the Nickel mine in Cottonwood Canyon. There was some production of ore before 1900. The ore occurs as discontinuous small stringers in aplite, quartzite, or altered volcanic rocks with very little quartz. Minerals in the ore are tetrahedrite, niccolite, millerite, and probably a primary cobalt mineral, plus much oxidized material. A sample showed 9 percent copper, 1 percent nickel, and 0.6 percent cobalt.

Clark County.—In the Goodsprings district, heterogenite occurs in a number of small deposits associated with oxidized copper ores. The heterogenite occurs usually as an envelope disseminated in dolomite around the copper ores. The ore is rather low grade, except for scattered rich pockets next to the copper ores, and mineralization fades quickly into the country rock. Most of the known occurrences are around mined-out copper lenses. Some high-grade ore has reportedly been shipped from the Copper Chief deposit. Two other deposits, the Columbia and Highline, were examined briefly in 1941. If an inventory of the whole district were made, it might show a rather large tonnage of low-grade ore (0.3 to 0.5 percent cobalt) scattered in a number of small deposits. In certain areas where structural conditions are favorable, it is possible that other copper-cobalt bodies may be discovered at depth. Most of the known lenses are in shallow workings.

Esmeralda County.—Cobalt was reported in the Ludwig & Carters copper mine.

Humboldt County.—Small amounts of cobalt are reported to occur in the low-grade copper deposits of Champion Copper Canyon mine in the Jackson Mountains.

Lincoln County.—An unknown quantity of cobalt-bearing material is reported at the Caliente Cobalt Mine.

NEW JERSEY

In the Franklin mining district, Sussex County, a mass of nickel-cobalt material was cut at a depth of 340 feet in the Trotter shaft. Cloanthite from here contains 6.37 percent cobalt; arsenopyrite, 1.16 percent cobalt; and pyrite, 1.25 percent cobalt. There is no appreciable tonnage of these minerals in the district.

NEW MEXICO

Cobalt in small amounts is reported in old workings in the Blackhawk district, Grant County.

OREGON

In addition to the cobalt-bearing nickel ore now being mined by the Hanna Mining Co. at Riddle, a number of smaller occurrences of cobalt have been noted as shown below.

Baker County.—Cobalt-nickel minerals occur in a 40-foot-wide gold-silver vein in the Hill-top-Keating Claim, near Keating.

Curry County.—Some cobalt has been reported in deposits in the Cobalt group, the Mule Creek district, and on Mount Emory. Veins carrying pyrrhotite and chalcopyrite containing some nickel and a small amount of cobalt have been reported on Dad's Creek.

Grant County.—Cobalt minerals have been found in the Quartzburg district at the Standard, Juniper, Black Prince, Copperopolis, Willie Boy, and Grover Cleveland mines and on the Boulder group of claims. They are associated with pyrite, arsenopyrite, pyrrhotite, chalcopyrite, and sphalerite in quartz-tourmaline veins and irregular replacement masses. Very little cobalt has been produced.

Jackson County.—Pyrrhotite and chalcopyrite carrying 2.5 percent copper, 2.0 percent nickel, and 0.5 percent cobalt are reported near Rock Point.

Josephine County.—The Cowboy mine contains some cobalt in a small, high-grade copper deposit in serpentine.

PENNSYLVANIA

In addition to the deposits at Cornwall, there are a number of smaller similar deposits scattered throughout eastern Pennsylvania.

Canada—Major Deposits

SUDBURY DISTRICT

Although the nickel-copper ores of the Sudbury district contain only small amounts of cobalt, variously estimated at 0.06 to 0.1 percent, they constitute the largest known reserve

of cobalt on the North American continent. Cobalt occurs in the ores as a complex mixture of cobalt-nickel-iron arsenides closely associated with pentlandite. The total nickel ore reserves in the area are about 310 million tons, which would mean a cobalt reserve of about 370 to 620 million pounds.

TEMISKAMING SILVER-COBALT AREA

Cobalt occurs in the Temiskaming area in gently dipping sediments known as the Cobalt series, in basic volcanic rocks of the Keewatin complex, and in the Nipissing diabase, all of Precambrian age. The lower part of the Cobalt series has been the host rock for more than three quarters of the ore produced in the area; the Keewatin rocks and the Nipissing diabase have been host to the remainder.

Cobalt-bearing minerals in the ore are mainly cobaltite and safflorite, with lesser amounts of skutterudite and smaltite. Nickel-bearing minerals include rammelsbergite, niccolite, and chloanthite. Also present are calcite, arsenopyrite, and native silver. In rich deposits, silver and cobalt contents may be as high as 10 percent each.

The width of the veins ranges from less than 1 inch to over 2 feet, averaging about 3 inches. The ore minerals are also disseminated in the wall rocks for several feet.

Several factors affect the localization of the ore bodies. The most important seems to be the proximity of the Nipissing diabase, either above or below the ore. Not much ore is found more than 300 feet from the contacts between the Cobalt series and the Nipissing diabase or the Keewatin rocks, or between the Nipissing and the Keewatin rocks. Most of the ore has come from depths of less than 900 feet. Structural factors that influence ore deposition are the presence of large pre-ore faults plus minor diagonal or flatly dipping faults branching from the main faults. Large low-angle domical folds also seem to affect localization. Careful prospecting with all these factors in mind probably will add to the estimates of cobalt ore in the area.

As the narrow veins rarely extend more than 500 feet and generally have a maximum vertical extent of only a few hundred feet, it is difficult to estimate ore reserves. The operators usually mine the ore as they find it and rarely publish figures on ore reserves. Several independent estimates, however, seem to agree that the district contains about 4 million pounds of cobalt.

LYNN LAKE

The Lynn Lake, Manitoba, nickel-copper ore of Sherritt Gordon Mines, Ltd., contains small

amounts of cobalt. Nickel concentrate produced from the ore contains about 12 percent nickel and 0.4 percent cobalt. The reserves of the company, as published in its 1960 Annual Report, total 14,300,000 tons of ore with a nickel content of 0.92 percent. Assuming the same nickel-cobalt ratio in the ore as exists in the concentrate, this would give a cobalt reserve of approximately 8.8 million pounds.

THOMPSON

The large deposits of nickel-copper ore in Thompson, Manitoba, some of which are being developed by Inco, are reported to contain some cobalt. The cobalt content of these ores is reportedly somewhat lower than that of the Sudbury ores, but no analyses have been announced. The 1960 annual report gave proven reserves in the Thompson area as 25,000,000 short tons, but they must be much larger to warrant the proposed expenditure of \$175 million for development of the mine, refinery, powerplant, and auxiliary facilities in the area.

Canada—Minor Deposits

A number of minor occurrences of cobalt have been reported which might be capable of development should the need arise. Some of these occurrences are listed below.

NEW BRUNSWICK

Bathurst.—Officials of the Captain Yellowknife Gold Mines reported the presence of cobalt in a copper deposit being examined by the company in the Bathurst area. A fairly large deposit, analyzing 0.45 percent cobalt, was reported.

QUEBEC

Calumet Island.—Relatively low-grade (0.8 to 0.9 percent nickel) deposits of nickeliforous pyrite and pyrrhotite, containing about 0.17 percent cobalt, exist on the southern part of Calumet Island.

Mount Wright.—Cobalt, as cobaltite, occurs with nickel, gold, and silver in deposits lying about 185 miles south of Seven Islands in New Quebec.

ONTARIO

Hart Township.—Small amounts of ferriferous and nickeliforous cobaltite occur in a deposit of magnetite in Hart Township, about 4 miles west of Cartier. Mineralization is reported as being similar to that of the Cornwall, Pa., deposit.

Massey.—A small deposit reported to contain 2.13 percent cobalt is located about 5 miles from the town of Massey in Harrow Township.

The cobalt minerals are skutterudite and smaltite-chloanthite with traces of erythrite. Reserves are small.

Michipicoten area.—Cobalt occurs in some of the deposits in the Michipicoten mining district.

Palmer Township.—Cobaltite is present in a copper-gold deposit in Palmer Township, on the east shore of Lake Superior, about 40 miles from Sault Ste. Marie.

Otter Township.—Cobalt occurs with nickel, gold, and bismuth in deposits north of Thessalon. Cobalt minerals are smaltite-chloanthite and erythrite. A sample from the deposit analyzed 1.41 percent cobalt and 1.01 percent nickel.

Werner Lake area.—In the Werner Lake area, about 55 miles north of Kenora and 15 miles east of the Ontario-Manitoba boundary, small lenses of high-grade cobaltite with pyrite, pyrrhotite, and chalcopyrite, with a maximum width of 4 feet, are found along the contacts of a narrow garnetiferous zone in sedimentary gneiss. Other ore of high enough grade to warrant milling may occur in widths of up to 12 feet. In 1932, about 20,000 pounds of cobalt in hand-picked ore was shipped from the mine. Small amounts of hand-sorted ore were produced in 1940. In 1943, following the discovery of additional ore, a small mill was erected and run for slightly over 1 year. Total production during World War II was 123,386 pounds of cobalt. The extent of cobalt reserves in this area is unknown, but they are probably very limited.

MANITOBA

Cat Lake.—Officials of New Manitoba Gold Mines, Ltd., reported in 1957 the presence of 1.8 million tons of cobalt-bearing nickel-copper ore on their Cat Lake property, 120 miles northeast of Winnipeg.

Maskwa and Oiseau River Areas.—Cobalt is present in nickel-copper deposits in the Maskwa River-Oiseau River areas, Lac du Bonnet Mining Division, southeast Manitoba. Total reserves are not known, but by 1930 drilling tests had indicated the presence of 200,000 tons of ore in the two areas. Cobalt content was reported to be higher than in the Sudbury ores.

SASKATCHEWAN

Uranium City, Beaverlodge Area.—Cobalt is reported to be present in the uranium ores of this area.

BRITISH COLUMBIA

Estella Mine.—Very small amounts (less than 0.02 percent) of cobalt have been reported to occur in the lead-zinc ores of the Estella mine at

the head of Tracey Creek in the Canadian Rockies.

Giant Nickel Mine.—The nickel-copper deposit near Hope, British Columbia, formerly known as B. C. Nickel Mine and Pacific Nickel Mine, is now being operated by Giant Nickel Mines, Ltd. The mine was reopened in mid-1959, and the rated milling capacity of 1,000 tons of ore per day was reached within a few weeks. The ore consists of massive sulfides and disseminations of pyrrhotite with pentlandite and chalcopyrite. The ore bodies occur in pyroxine and peridotite close to the contact with the surrounding diorite. Ore reserves were reported in 1959 as 1,072,000 tons at 1.18 percent nickel and 0.30 percent copper. Information on the cobalt content of the ore has not been published, but analyses of a shipment made in 1940 showed a cobalt content of 0.2 percent.

Hazelton.—Small amounts of cobalt-bearing ore were once produced by Western Uranium Cobalt Mines, Ltd., which had a property 5 miles south of Hazelton on the northwest slopes of Rocher Deboile Mountain. Only one of the four veins on the property has been developed to any extent. This vein consists mostly of hornblende up to 2 feet wide in a fracture in granodiorite; in it are streaks and masses of cobalt-nickel sulfarsenides, arsenopyrite, molybdenite, and uraninite, plus silicates and quartz, which carry good values in gold. According to the British Columbia Minister of Mines, between 1918 and 1941 four shipments totaling 63.6 tons averaged 2.62 ounces of gold and 2.56 percent cobalt, but apparently none of the cobalt was refined. The British Columbia Annual Report for 1949 lists 15 samples of cobalt-bearing material which averaged 1.60 percent cobalt over an average width of 9 inches.

Little Gem Mine.—The Little Gem deposit, on Roxey Creek in the Lillooet Mining Division, is in a zone of altered granodiorite of the Coast Range intrusives, about one-half mile from the contact with older rocks. A number of small pegmatite lenses (the maximum size is 7 by 16 feet) contain cobaltian arsenopyrite, (Fe, Co) AsS, and cobaltian lollingite, (Fe, Co) As₂, allanite, silicates, calcite; some molybdenite and uraninite; and a fair amount of gold. A number of assays reported in the Annual Report of the British Columbia Minister of Mines averaged 2.87 percent cobalt over 41 inches. Samples analyzed at the University of British Columbia ran 6.8 percent cobalt.

Nickel Plate Mine.—The Nickel Plate Mine, operated by French Mines, Ltd., on Nickel Plate Mountain in the Osoyoos Mining Division, is primarily a gold mine. Limestone and argillite have been intruded by sills, altered to marble and calcsilicate rocks, and fractured. The ore bodies consist of arsenopyrite with a

little cobaltite, gold, chalcopyrite, and iron sulfides and are grouped along plunging folds. The company ships a flotation concentrate to a smelter and receives credit only for the gold and copper content. Cobalt is not recovered and Jones (17) states that an estimate of 70,000 pounds of cobalt is lost annually in the operation.

Victoria.—Cobalt occurs in the Victoria mine 5 miles south of Hazelton as cobalt-nickel arsenites and erythrite with gold, silver, arsenopyrite, molybdenite, and small amounts of other sulfides. The ore lies in small veins in fractures of hornblende rock. Small shipments of ore were made from this mine from 1918 to 1919 and in 1941 and 1942. Analyses of shipments showed cobalt contents ranging from 1.18 to 4.6 percent, according to the Annual Report of the Minister of Mines for British Columbia during those periods.

Windpass Mine.—At the Windpass Mine, North Thompson Valley, a mineralized shear zone in a quartz-diorite sill carries a small amount of high-grade cobalt-gold ore; some copper and bismuth are also present. The property has been closed down many years and has no known reserves.

YUKON

Quill Creek, Kluane Lake.—A nickel-copper deposit containing a small amount of cobalt was discovered on Quill Creek in 1952. Diamond drilling in 1952 outlined 67,000 tons of nickel-copper ore having a cobalt content of 0.1 percent.

NORTHWEST TERRITORIES

Francois River.—Veins of massive nickel with some smaltite and chloanthite occur on Francois River about 1½ miles south of Caribou Lake.

Great Bear Lake Area.—Cobalt is found in uranium ore produced from the Eldorado mine about 35 miles south of the Arctic circle at Inuvik, Great Bear Lake. Veins contain cobalt (as skutterudite and smaltite), nickel, bismuth, and copper occur with pitchblende and silver veins. From time to time relatively small quantities of hand-cobbed cobalt ores have been shipped from the mine, but the major cobalt production is from the uranium refinery residues (about 3.5 percent cobalt) which are converted into a speiss (about 12.5 percent cobalt) and shipped to Deloro Smelting and Refining Co., Ltd. The reserves of cobalt are not known but they are presumably small since it was estimated in 1959 that the uranium ore was not worked out. The mine was closed in September 1960.

Cuba

The immense nickeliferous laterite deposits in Oriente Province probably constitute the largest potential reserve of cobalt in the Western Hemisphere. According to estimates (18), the ore deposits of the Levisa Bay, Moa Bay, Toca Bay, and Mayari districts of Oriente Province together with the Plateau Cajabanes deposit of Pinar del Rio Province contain a total of 740 million pounds of cobalt in ore which averages over 1 percent nickel and 0.1 percent cobalt, plus an additional potential reserve of lower grade material (less than 1 percent nickel and about 0.07 percent cobalt) which contains about 2,314 million pounds of cobalt.

McMillian and Davis described the geology and mineralogy of the ores of the Levisa district as follows:

The nickel ores of the Levisa district are typical laterites, derived from chemical weathering of serpentinized peridotite, which were intruded into earlier sedimentary rocks, probably in late Cretaceous time. During the Quaternary the district was gradually uplifted and warped, and serpentinization begun. From observations throughout the district, it appears that during the early stages of this uplift the entire district was subjected to only slight weathering and erosion, which resulted in its being reduced to a peneplain with a gentle slope to the north in which there were several monadnocks in the more resistant rocks, such as basic dikes of diorite, anorthosite, and metamorphic rocks. In the later period of the uplift, it appears that there was an increase in rainfall and humidity in the district, which resulted in laterization and erosion and the beginning of the present drainage system. Remains of this peneplain, with tertiary alluvials at altitudes up to 750 meters (2,500 feet), are to be found throughout the district, the present peaks in the Sierra del Cristal and Pinales de Mayari probably representing remnants of the monadnocks. The best example of the former peneplain is the plateau of Pinales de Mayari, where no large streams were formed; there are also remnants of this peneplain on the terraces and plateaus in the ranges between the Cabonico and Levisa Rivers and between the Levisa and Mayari Rivers.

During the uplift and warping of the peridotite there was considerable faulting, and in the valley of the Rio Coco east of the Marti claim is evidence of a graben with downward slumping of the laterite.

Throughout the district are numerous dikes of unaltered serpentine, ranging in width from a few centimeters up to 5 meters (16 feet), with steep dips and rounded hills of unaltered serpentine that stand up above the surrounding laterite. During the exploration it was observed that the nickel content of both the laterite and altered serpentine adjacent to these dikes and hills increased.

The peridotitic rocks, parent rocks of the nickel ore, are predominantly harzburgite, consisting mainly of the magnesium-iron silicates olivine and enstatite. It is believed that olivine and enstatite crystals contain the nickel and cobalt in their crystal interstices.

During serpentinization of these peridotitic rocks these minerals were altered by meteoric waters containing carbonic acid. The olivine crystals were changed to antigorite (one of the serpentine minerals), with the iron protoxide altering to a residue of mag-

netite along fractures in the crystals, and the enstatite crystals were altered into patches of bastite or Schiller spar.

Coincident with serpentinization of the peridotite laterization began and is continuing at present. The process of laterization is due to leaching of the magnesia and silica, which are redeposited in the altered serpentine below the laterite. The ferrous oxide of iron and the nickel and cobalt in the serpentine go into solution. The ferrous iron is immediately oxidized and precipitated, but the less soluble elements (aluminum, chromium, cobalt, and nickel) become residually concentrated, the major part of the alumina, chromium, and cobalt being precipitated in the upper part of the column. The nickel is the most soluble of these four elements; consequently, it is leached from the upper part of the laterite and precipitated in the lower part of the laterite, with the greatest concentration occurring on coming in contact with the redeposited magnesia and lime in the altered serpentine.

The nickeliferous ores of the Levisa district consist of blanket deposits of high-iron laterite overlain in part by high-iron but lower nickel laterite. The ore is underlain by altered serpentine, which grades into unaltered serpentine and has a fairly consistent iron and nickel content of 5.0 and 0.02 percent respectively.

The overburden, which overlies about half the area of the Cuban Nickel Co. ore deposits, varies in depth from 1 meter (3 feet) to 4.8 meters (16 feet), with an average depth of 1.83 meters (6 feet). The iron content varies from 35 to 55 percent and the nickel content from 0.50 to 0.90 percent, with an approximate average of 0.75 percent. The overburden totals 8,300,000 dry metric tons and with improved metallurgy is potential ore.

The high-iron laterite ore on the Cuban Nickel Co. claims varies in thickness from 1 meter (3 feet) to 5 meters (16 feet), with an average 2.6 meters (8.5 feet) and iron content between 33 and 50 percent with an average of 42.7 percent. The nickel content varies from 1.10 to 2.20 percent, with an average of 1.33 percent. The cobalt content varies from 0.06 percent to a high of 0.38 percent, with an average of 0.11 percent. Chromium is also found in the high-iron laterite ores and in percentages of 1.30 to 2.62.

The low-iron, high-nickel, altered serpentine varies in thickness from 1.20 meters (4 feet) to 20 (65 feet), with an average of 2.43 (8 feet). The iron content ranges from 7 to 25 percent, with an average of 15.6 percent. Serpentine ore with less than 12 percent iron was not included in the indicated reserve estimates, although high nickel values with lower iron content were found in the serpentine at depths up to 27 meters (90 feet). The nickel values in the altered serpentine ore ranged from 1.20 to 2.30 percent, with an average of 1.61 percent. Cobalt values were very low, ranging from 0.02 to 0.06 percent, with an average of 0.04 percent.

The highest nickel-cobalt sample found during exploration was in a drill hole where the analysis of a 60-centimeter sample of altered serpentine was 5.15 percent.

Dominican Republic

A long list of concessions obtained to work ore deposits in the Dominican Republic mention cobalt as one of the metals sought. Nothing is known regarding the reserves or development attempted in the areas of the concessions. Most of the concessions apparently cover areas of lateritic material developed

on serpentine, as the cobalt is associated with chromite, nickel silicate, or manganese oxides.

Minera y Beneficiadora Falconbridge Dominicana C por A, a subsidiary of Falconbridge Nickel Mines Limited, carried out an extensive exploration program for nickel ore in the Dominican Republic from 1956 to 1960. Deposits of lateritic type ore amounting to 50 million tons at 1.55 percent nickel were found. Cobalt content of the ore was not given, but cobalt is present. Development of a pilot plant for construction in the Dominican Republic was underway at Falconbridge in 1960, and it was scheduled to be in operation in 1961.

Honduras

The Aqua Fria mine, El Paraiso Department, is primarily a gold mine. The gold is recovered in an arsenopyrite concentrate which carries 0.90 to 3.30 percent cobalt. The vein is reportedly 25 to 42 inches wide, consists mostly of arsenopyrite with lesser amounts of chalcopyrite, pyrite, and pyrrhotite in a quartz gangue, and assays 0.05 to 0.58 percent cobalt. Nothing is known about the geology of this deposit.

Mexico

Baja California.—The Boleo copper deposit at Santa Rosalia contains chalcocite, with minor amounts of other copper minerals in a gangue consisting largely of clay minerals, plus some barite and gypsum; the ore occurs irregularly in beds of volcanic tuff and conglomerate. A study made by the Panel on Cobalt Supplies of the Minerals and Metals Advisory Board in 1952 revealed that at that time, about 200,000 tons of ore a year was smelted, averaging about 3.5 percent copper and from 0.02 to 0.86 percent cobalt. No attempt was made to recover the cobalt, which apparently went into the slag and the flue dust. Approximately a million pounds of cobalt was thus involved, which, at 60-percent recovery, represents over 600,000 pounds wasted a year.

Chiapas.—A minor amount of cobalt has been detected in the copper deposit at La Fe mine.

Chihuahua.—In the Batopilas district, diorite and andesite have been intruded by granite and are cut by veins carrying primary native silver and other silver minerals, pyrite, galena, sphalerite, and arsenopyrite, and a small amount of safflorite and rammelsbergite.

At Sabinal, Lower Cretaceous sedimentary rocks are intruded by granite and cut by several parallel veins carrying primary native silver, other silver minerals, pyrite, sphalerite, galena, safflorite and rammelsbergite, and a little copper and gold, in a gangue of barite, quartz, and

calcite. The veins are believed to be low temperature epithermal fissure fillings.

Cobaltite is reported to occur at Iturbide.

Durango.—Cobaltite is reported at Guanaceo and in the Tamazale district.

Guerrero.—A deposit carrying cobalt, antimony, tin, nickel, copper, silver, and gold was once reported. Nothing has been heard about it since, and it may be a doubtful occurrence.

Hidalgo.—Smaltite is reported at the Pitman mine.

Jalisco.—At the Esmeralda and Pilhuan mines, Ciudad Guzman, a large vein of magnetite carrying some pyrite and pyrrhotite, andesite is cut by numerous veinlets of cobaltite, smaltite, and niccolite in a gangue of calcite and barite. Small shipments of cobalt-nickel ore have been made from these deposits.

At the Mirador mine the presence of cobalt has been reported.

Oaxaca.—A number of concessions have been granted to work deposits of cobaltiferous magnetite in the central part of the State.

Sinaloa.—Fifteen miles northeast of Culiacan, cobaltite and niccolite are reported disseminated in diorite and andesite. This is believed to be possibly the most important cobaltiferous area in Mexico. Cobaltite is reported at Cosala.

Puerto Rico

Large deposits of cobalt-bearing nickeliferous laterites were recently found in Puerto Rico by the Federal Bureau of Mines (22). The deposits lie on the west coast of the island, south and southeast of Mayaguez, and are somewhat similar to those found in Cuba. An inferred reserve of 90.5 million tons of laterite and serpentine (0.88 percent nickel and 0.09 percent cobalt) was estimated for the deposits, which gives a total cobalt content of approximately 163 million pounds.

SOUTH AMERICA

Argentina

At the Rema Alejandra mine near Vinchi, La Rioja Province, some cobalt was mined before 1904. Here cobaltite and arsenopyrite occur in a quartz vein cutting talcose schist and a granite intrusion.

In Catamarca, cobaltite is associated with pyrite and chalcopyrite in a quartz vein.

Bolivia

Little cobalt has been produced in Bolivia, though in 1937, 1939, and 1940 some cobalt was exported. It is not recorded where it was produced.

At the Chulchucani and San Luis claims northeast of Potosi, cobalt, as asbolite, is reported in rocks of Cretaceous age.

At Marcamarcani, southeast of Sorata, cobalt is reported.

At San Pablo, near the Argentina border, a cobalt deposit is reported to exist.

Brazil

Cobaltiferous manganese-iron-oxide "pebbles" occur in the ferruginous clay overlying the nickel silicate deposits near Sao Jose do Tocantins, Goiaz. The nickel deposits, first recognized in 1908, were extensively prospected between 1932 and 1942; because of transportation and recovery difficulties, however, there has been no appreciable production in nickel. During 1939 to 1941 a Japanese-controlled company mined the cobaltiferous material and shipped about 450 metric tons containing 3 to 5 percent cobalt to Japan.

In this area are long, narrow strips of un-serpentinized pyroxenite interlayered with serpentinized peridotite. Long-continued weathering of the pyroxenite on what now is a relatively flat upland surface has produced a layer of nickel-rich green clay, overlain by red and purple clay. Near the top of the section, in a zone 1 to 2.5 feet thick, are hard "pebbles" of manganese oxide containing 1 to 2 percent cobalt and generally a little less nickel.

It has been estimated that two of the larger deposits in this area may contain 75,000 metric tons carrying at least 1 percent cobalt. It may be inferred that more material of similar grade occurs in the rest of the district. The nickel deposits of this area contain about 4 million metric tons averaging 2 to 4 percent nickel and 0.28 to 0.4 percent cobalt, some of which presumably would be recoverable.

Chile

Cobalt was first mined in Chile in the first half of the nineteenth century at the Buitre and Minillas mines and in the Volcan and Maipo Valleys. In 1865, mining began in the Huasco region and in the San Juan district; in 1875, the mines in the Copiapo region began producing cobalt. After 1904 production fell, but in 1937 work was resumed in the San Juan district, and at present cobalt is being produced by the Cia. Minera la Cobaltina in that district, and exploration is being carried out near Santiago. For 1939 to 1944 the cobalt production of Chile averaged about 20,000 pounds a year.

All the cobalt deposits of Chile are hydrothermal in origin, supposedly related to the diorites of the Andes (Upper Cretaceous to late Tertiary in age). In some places cobalt is the

only metal of value; in others it occurs with copper or silver deposits. Most of the cobaltiferous deposits lie in the region extending from the Copiapo area in Atacama Province south into O'Higgins Province.

Aconcagua Province.—At the Boldo mine, Coligie Gerro, cobalt deposits occur in Mesozoic sedimentary rocks.

Atacama Province.—In the San Juan district, about 18 miles south of Freirina, a Triassic mica schist is cut by dikes of diorite porphyry. Cobaltite occurs in veins of quartz, tourmaline, and a little calcite; some veins also carry chalcopyrite and pyrite and are mined for copper. The principal mines are La Despreciada, Blanca, Rosa Amelia, and Prosperidad.

In the region around Copiapo a number of occurrences are recorded; at the Deseada and Hacienda Florida mines, veins contain cobaltiferous arsenopyrite. Cobalt has also been noted at Charnarcillo, Ladrillos, Pabillon, and Pampa Larga.

Elsewhere in Atacama, cobalt occurs at the Elisa and Codomira copper mines, in the Freirina mining district, and at German Riesco, Merceditas, 15 miles east-northeast of Pan de Azucar, Sierra de Totorita, Vallenar, and the Vulcana mine.

Coquimbo Province.—At Buitre and Minillas mines, Tambillos, calcareous shale and limestone beds near a diorite intrusion have been silicified and replaced by amphibole and diopside under the influence of widespread metamorphism. Cobaltite, associated with diopside, was the first ore mineral introduced, followed by chalcopyrite and arsenopyrite. These mines produced the greatest amount of cobalt in Chile. Work was stopped in 1905; some was done in the periods 1924 to 1928, and in 1941.

It was reported in 1952 that a group was attempting to develop a cobalt deposit near La Serena (15).

Cobalt also occurs at La Barilla mine, near Coquimbo.

O'Higgins Province.—There are cobaltiferous veins in Quebrada Paredone.

Santiago Province.—At Cajon del Rio Maipo a group of veins carries cobalt. Cobaltite occurs at Cajon del Rio Yeaa and San Simon, Volcan, high in the Andes Mountains. In 1953, Cia. Minera Merceditas reported that high-grade cobalt deposits had been found in its El Colcan copper mine not far from Santiago (15).

Northern Provinces.—Safflorite and rammelsbergite accompany the silver ore in many places.

Peru

At Cerro San Francisco, near Vilcabamba, glaucodot, smaltite, and niccolite occur in veins

cutting carboniferous limestone near an intrusive contact. At a place about 11 miles north-northeast of Cuzco, cobalt is also reported. A deposit at Rapi contains cobalt and nickel minerals, but is reported to be a very small and weak vein.

Venezuela

Venezuela has large areas underlain by nickel silicate deposits similar to those of Brazil. The cobalt content of these deposits is unknown.

EUROPE—MAJOR DEPOSITS

The higher grade cobalt deposits of Europe have probably been exhausted, but low-grade cobalt-bearing materials are distributed throughout the continent.

Finland

The copper ore deposit at Outokumpu, Finland, is in a large mass of quartzite surrounded by mica schist and probably constitutes the largest cobalt reserve in Europe, outside of Russia.

The average mineral composition of the ore is: Chalcopyrite, 13; pyrrhotite, 14; pyrite, 32; sphalerite, 1; and quartz, 40 percent. The ore contains about 0.1 to 0.2 percent cobalt and 0.1 percent nickel.

Known reserves are about 22 million tons containing about 800,000 tons of copper (3.6 percent) and 50 million pounds of recoverable cobalt, assuming 70 percent recovery (12).

Germany, Austria, and Czechoslovakia

The early development of cobalt mining in this area (Saxony and Bohemia) has already been discussed in the history chapter. Much of this mining was carried out in the Erzgebirge and adjoining mountain ranges between Germany and Czechoslovakia. On the north and northwest side of the mountains (in Saxony) are the mining districts at Schneeberg, Johanngeorgenstadt, Zwittermuhl, Geyer, Ehrenfriedersdorf, Annaberg, and Marienberg, and to the south in Bohemia is Joachimsthal.

The main mass of the Erzgebirge is composed of Precambrian rocks overlain on the north by folded Paleozoic sedimentary rocks. These rocks have been intruded by numerous granite masses and by acid porphyry dikes and a few basic dikes. Mineralization is localized in three northwest-trending zones; one extends from Schneeberg to Joachimsthal, another through Geyer and Annaberg, and the third includes Marienberg. In all the zones there are four main types of ores—older tin ores, older

pyrite-galena ores, younger silver-cobalt cores and younger iron-manganese ores. The silver-cobalt deposits have been the most important economically; most of them contain native silver and bismuth, a number of silver sulfides and sulfo-salts, bismuthinite, smaltite, and safflorite; the nickel minerals chloanthite, niccolite, and rammelsbergite; the iron minerals pyrite, marcasite, and arsenopyrite, and small quantities of chalcopyrite, bornite, calcocite, galena, and sphalerite. The gangue minerals include quartz, fluorite, one or more carbonates, and, in some veins, barite. One source of information indicates that cobalt-nickel minerals are more characteristic of the Schneeberg type of deposit and are rarer at Joachimsthal. The cobalt-nickel minerals are also less abundant in the neighboring Freiberg districts.

Other districts from which cobalt has been obtained include Schweina (Thuringia), Siegerland, Wolfback (Schwarzwald), Quersbach and Giehren (Riesengebirge), Andreasberg (Harz Mountains), Siegen (Prussia), and Dobschau (Hungary). From available information, it appears that these deposits have been substantially depleted, except perhaps at depths greater than 1,000 to 2,000 feet.

Turkey

The Ergani copper mine, near Maden, yields ores which contain about 0.3 percent cobalt. The upper part of the ore body is a massive pyrite-chalcopyrite replacement of chloritized diabase, carrying a little sphalerite and variable amounts of secondary chalcocite and covellite. This material averages 8 to 10 percent copper. Below the massive ore is disseminated ore of lower grade, averaging 4.0 percent copper.

In 1952, the Panel on Cobalt Supplies of the Minerals and Metals Advisory Board (MMAB) of the National Academy of Sciences—National Research Council was requested by the Defense Materials Procurement Agency to study the possibility of recovering cobalt from the Ergani deposits. At that time it was estimated on the basis of the production of copper that over 650,000 pounds of cobalt per year was being lost. In 1953, the Panel on Cobalt Supplies issued a report on its findings (16), in which it stated that the refining process, as operated at that time, could not be modified to recover cobalt and that the only practical approach would involve removal of cobalt from the ore, probably by leaching, before further processing.

U.S.S.R.

Not much is known about the production of cobalt in the U.S.S.R., but it appears that the country may produce enough cobalt for its mil-

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ary needs. Some is probably obtained from inland, and a little may be obtained from eastern Germany and Czechoslovakia. The following data on cobalt-bearing deposits in the U.S.S.R. were assembled from Russian sources (25).

COBALT-ARSENIC ORE VEINS

Dashkesan, Transcaucasia, N. mine.—A series of roughly parallel zones cutting through Middle Jurassic volcanogenic-sedimentary rocks less than 2 kilometers from the Lower Cretaceous granitoid intrusion contains ore mostly in tectonically disturbed contacts of a basic dike. Cobaltite, glaucodote, and cobaltiferous arsenopyrite are present as lenslike bodies, dendritic veinlets, and disseminated granules. Erythrite is found in the oxidized zone.

Ishkininskoye, S. Ural.—The host rocks are apoperidotitic serpentinites and gabbro-diorites in the midst of Silurian and Devonian shales and effusives. Clusters, veinlets, and disseminated granules of cobaltite are found on the periphery of massive sulfide ores (pyrite, pyrrhotite with pentlandite, and chalcopryrite with cubanite), magnetite, and chromite, as well as in brecciated and chloritized serpentinites near contacts with Silurian shales. Magnesium erythrite and heterogenite occur in the oxidized zone.

Khovuaksinskoye, Tuva.—Intensely skarnized Silurian sedimentary rocks contain small quantities of cobaltite and cobaltiferous arsenopyrite; cobaltiferous pyrite is present. Rammelsbergite, khovaksite, smoljaninovite, erythrite, annabergite, roselite, heterogenite, and asbolanes occur in the oxidized zone.

Chimbastau, Southern Kazakhstan.—A tectonically disturbed contact of Lower Paleozoic schists with dikes of basic rocks of Har 3 age contains small clusters and lenses of gersdorffite. Erythrite, heterogenite, asbolane occur in the oxidized zone.

Berikul', Kuznetsk Alatau.—Upper Cambrian auriferous quartz-sulfide veins cut by dolerite dikes contain nickelite with native gold in central sections of carbonate veinlets 4 to 6 centimeters thick. Annabergite occurs in the oxidized zone.

Akol, Western Sayan Mountains.—Strongly metamorphosed Cambrian shales and quartzites contain maucherite, nickelite, and gersdorffite in metacollisidal structures. Annabergite occurs in the oxidized zone.

Labinskoye, N. Caucasus.—Tectonically disturbed contacts of Upper Paleozoic serpentinized ultrabasic rocks with schists and others contain disseminated nickelite, corinnite, miller-

ite, arsenopyrite, pyrite, and chalcopryrite. Annabergite occurs in the oxidized zone.

Zolotogorskoye, S. Ural (Karabash).—A fissure in serpentinites, longer than 4 kilometers, contains finely dispersed nickelite, chalcocite, cyprian gold, and millerite. There apparently is no oxidized zone.

COBALTIFEROUS SKARNS

Dashkesan, Transcaucasia.—Mineralized skarns in intrazonal contacts of the hanging wall of Upper Jurassic limestones and volcanogenic-sedimentary rocks contain clusters mostly of cobaltite; many other cobalt-bearing minerals are also present. Erythrite, cobalt-adamite, cobalt-sodium carbonates, heterogenite, and asbolites are found in the oxidized zone.

Chalkuyryuk-Ankzhilgin, S. Kirgizia.—The deposit consists of Silurian and Cretaceous limestones and sedimentary rocks intruded by Permian granodiorite series. The ore is in hornfels, marble, and various skarns. Skutterudite veins, accumulations, and clusters; gold and bismuth tellurides; and cobaltiferous arsenopyrite, safflorite, danaite, and many other minerals are also present. There apparently is no oxidized zone.

Vysokogorskoye, Central Ural.—Contacts between Lower Paleozoic tuffs, limestones, and so forth and post-Devonian syenites contain disseminated fine-grained cobaltiferous pyrite in garnet-magnetite skarns. Chalcopryrite is also present. Copper and iron varieties of cobalt asbolites occur in the oxidized zone.

Others.—The following deposits are mentioned but not described (cobaltite skarns):

Vladimirovskoye, Gornyy Altay
Karagem, Gornyy Altay
Abkan, Central Siberia
Pokrovka, Northern Ural
Sayak, NW of Balkhash Lake
Turanglysay, E. Karamazar Mountains
Odra-Bash, Gornaya Shoriya

COBALT-COPPER ORE BODIES

Pyshma-Klyuchevskoye, Central Ural.—Ore zones occur in metamorphosed and altered effusives and tuffs of the Greenstone Belt. The ore consists of lenses, veins, and disseminated grains of cobaltiferous pyrite in magnetite, of pyrrhotite with pentlandite, and of chalcopryrite with cubanite. Cobalt-bearing manganese hydroxides occur in the oxidized zone.

COBALT-NICKEL MINERALS IN LEAD-ZINC ORES

- Berkut District, S. Kirgizia; no data.
- The coast of Murmansk; no data.

COBALTIFEROUS COPPER-NICKEL SULFIDE ORES

Moncha-Tundra, Kola Peninsula.—A stratified complex of Paleozoic intrusive basic and ultrabasic rocks in Archean crystalline rocks contains a small accumulation of nickel and cobalt in various rock-forming minerals. The ore bodies are of the hanging-wall and footwall type, as well as veins, veinlets, and lenses. Cobalt-bearing iron and manganese hydroxides, morenosite, and "cobalt soot" are found in the oxidized zone.

Noril'sk, Central Siberia.—The ore occurs in sheetlike stratified mineralized gabbrodiabase cutting through Silurian sediments and bedded diabase porphyries. Mostly pyrrhotitic ores are found in the gabbrodiabase, and chalcopiritic ores in the intruded rocks. Massive sulfide ore bodies and veins; disseminated cobalt-bearing pentlandite and chalcopyrite; and native gold, sphalerite, and many other minerals are also present. The oxidized zone contains morenosite, cobalt-bearing manganese and iron hydroxides, millerite, and bravoite.

NICKEL SILICATE ORES

The Kempirsay and the Orsk-Khalilov Districts, S. Ural.—Cobalt-nickel asbolites occur in all zones of the nontronite profiles. The ore is cobalt-nickel enriched in the upper horizons and in nontronitized serpentinites. The ratio of cobalt oxide to nickel oxide is 1:1 in asbolites, as a rule, but may be 1:10 in asbolites from lower horizons. Copper is low, but may be up to 2 percent locally. Up to 2 percent cobalt oxide may be present in wads and in earthy accumulations of ocherous ores. The overall cobalt-nickel ratio is 1:20 for the mineralized ancient weathered crust, ranging from 1:30 to 1:10.

Others:

Akkerman, S. Ural

Elizavetinskoye, Central Ural, (cobalt in goethite-hydrogoethite ores in fissures and joints of weakly serpentinized dunites)

Aydyrlinsk (contact-karst), S. Ural

Adamovsk District, S. Ural (cobalt in quartz veins near serpentinites)

Shaytantass, Kazakhstan (manganese-cobalt in Tertiary sediments)

Malka, N. Caucasus (cobalt-nickel ores; not more than 0.06 percent cobalt in a buried weathered crust).

Traces of cobalt are found in the Chiatury and the Nikopol' manganese deposits.

Berg and Friedensburg (10) give the U.S.S.R. a possible total production of 1,100,000 pounds of cobalt in 1939. If cobalt is also being

recovered from Petsamo, the present total production may be considerably larger.

EUROPE—MINOR DEPOSITS

Bulgaria

Nickeliferous asbolite in the weathered zone overlying serpentine and asbestos is reported to carry 2.3 percent cobalt in a deposit near Nevrokop.

France

Deposits at Chalcanches were worked in the 18th century for silver and cobalt. Veins, generally 1 foot or less wide, with north-south and east-west trends, cut amphibole gneiss. They carry silver, cobalt, and small amounts of copper, nickel, antimony, and gold; the gangue is reported to be quartz and "ocher" (limonite?). Apparently most of the work has been in the oxidized zone, where the silver was enriched and the cobalt occurred as the black oxide.

Cobalt oxide has been recognized near Grand-Clos.

Cobalt and nickel are associated with argentiferous galena in a very high and inaccessible location in Haute Luce.

Deposits at St. Marie-aux-Mines were worked for silver, lead, and copper in the 16th and 17th centuries. Cobalt was noted in veins with a different trend from those of lead and copper.

Manganese veins in gneiss and sedimentary deposits (Jurassic); and psilomelane carry cobalt, associated with galena, sphalerite, and stibnite, have been reported at Nontron.

Quartz veins carrying cobalt as the sulfide and oxide occur at Juset. The deposit was worked early in the 19th century.

A vein of quartz carrying cobalt was reported at St. Lary.

Cobaltiferous galena and sphalerite have been reported at the Aulus mines.

United Kingdom and Ireland

A few hundred tons of cobalt ore were produced during the last century from the following copper mines of Cornwall and Devon: Wheal Truro, Dolcoath, Wheal Sparnon, Wheal Huckworthy, Herland, Wheal Ann, Whealworthy, St. Austell, Fowey, and East Fowey. Smaltite and cobaltite are associated with chalcopiritic, native silver and bismuth, argentiferous galena; erythrite and asbolite are reported from the oxidized zone.

At Moel Hiraddug, Flintshire, asbolite occurs in a red residual clay overlying limestone.

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Alderley Edge and Mottram St. Andrews, Cheshire, copper carbonate in sandstone and conglomerate carries a little cobalt, which has been recovered in the past. At Coille-Chragbeen mines, Inverary, nickel ore carries a little cobalt. In Derbyshire, a small quantity of cobalt is associated with arsenic. Linnaeite was noticed in the coal beds in South Wales. At Talnotry, Scotland, smaltite and niccolite were reported in granodiorite. Erythrite was reported at Hilderstone mine, Linlithgowshire, Scotland. At Alva mine, Clackmannanshire, two veins mined once for silver carry argentite, native silver, chalcopryrite, and arsenopyrite in a barite-calcite-quartz gangue; malachite and erythrite occur in the oxidized zone. Muckcross mine, Ireland, has produced a little cobalt ore.

Italy

At Val di Sesia, Valle Strona, and Valle del Toco, a gneiss is intruded by norite, and along the contact masses of magnetite it contains some pyrite and chalcopryrite and a little nickel and cobalt. There has been a little production. In Sardinia, at Rin Plann, veins carrying nickel and cobalt occur in schists near a granite intrusion. In the Sarrabus district, veins carrying silver, cobalt, and nickel occur in schist and in intrusive granite. About 11,500 pounds of cobalt were produced here in 1938.

Norway

At Modum, southern Norway, a mineralized zone of north-south trend, approximately 6 miles long and 250 to 300 feet wide, occurs in quartzite and hornblende schist intruded by amphibolite and gabbro. The mineralized rock originated as a replacement of the metamorphic rock, and the ore occurs as discontinuous overlapping lenses. The ore minerals are cobaltite, skutterudite, and danaitite, associated with pyrite, pyrrhotite, chalcopryrite, arsenopyrite, and molybdenite; the gangue, partly country rock and partly introduced minerals, consists of tourmaline, mica, and other silicates. Skutterud and Snarrum mines lie along this zone, and before 1900 considerable ore was mined here.

Ancient silver mines are found at Kongsberg, the ores of which carry a little cobalt. Cobaltiferous arsenopyrite is reported at Sulitjelma.

Portugal

In the Braganca district, cobalt occurrences are probably related to the weathering zone of basic igneous rocks, as they are reported associated with chromite and nickel silicate. At

Breto and Castanhiero smaltite occurs in quartz veins cutting granite.

Spain

At the Gistain mine, 3 miles northeast of San Juan da Plan, Huesca Province (in the Pyrenees), the ore-bearing formation lies in limestone and shale cut by porphyry dikes. Here numerous intersecting stringers carry smaltite, niccolite, bismuth, and bismuthinite in a calcite gangue.

At the Los Cordeles mine at Burguillos, Badajoz Province, granite has intruded sedimentary rocks. At places along the contact, magnetite and glaucodot occur in widths of 1 to 15 feet. Reserves are reported to be 100,000 tons of ore containing about 2 percent cobalt.

At La Profundia mine, Carmenes, Leon Province, a pipelike ore body about 100 feet in diameter has been mined to a depth of 800 feet in steeply dipping limestone. Chalcopryrite and siegenite (?) are present, and the crude ore reportedly averages 3 percent cobalt. There are no developed ore reserves.

The Aramo mine, La Saterrana, Asturias Province, and the deposits of Guadalcanal, northern Sevilla Province, have both been producers of silver and cobalt.

Sweden

Several mines in Sweden produced cobalt long ago. There apparently has been no recent production.

At Gladhammar in Kalmar Lan, replacement deposits occur as lenses in mica schist and quartzite; ore minerals include cobaltite, linnaeite, gersdorffite, chalcopryrite, and pyrite. Similar minerals are found in fine-grained gneiss at Vena, north of Vettern. Replacement deposits in the schistose part of a gabbro mass at Los in Helsingland contain cobalt and copper minerals with pyrite, associated with calcite and quartz. At Tunaberg, Sodermannland, a marble bed in gneiss carries cobaltite, smaltite, chalcopryrite, chalcocite, and galena. At Hakanbol, Orebro Lan, veins cutting slate and limestone carry some cobaltite and glaucodot.

Some cobalt might be recovered from the copper ore of Boliden and the copper-iron deposits at Riddarhyttan, Bergslager area.

Switzerland

In the Einfischal and Turtmannstal districts, cobaltite occurs in veins associated with chloanthite, niccolite, pyrite, arsenopyrite, chalcopryrite, bornite, and bismuthinite. At various times between 1847 and 1875, nickel ore was produced at the Grand Praz, Gollyre, and

Plantorin mines; the ore presumably also carried some cobalt. At all these mines there is a possibility of more ore at depth. The complicated structures in these deposits make the possibility of much cobalt production here rather slight.

Yugoslavia

In 1960, cobalt deposits were discovered in Kosovo and Mehohija in southwest Serbia and also near Prizren. No information on the size or tenor of the deposits is available.

ASIA

Burma

Europeans reopened the Bawdwin mine about 1901, and for a number of years only lead, zinc, silver, and copper were produced. After World War I cobalt and nickel were also recovered. The deposit is a replacement of a shear zone, about 8,000 feet long and 500 feet wide, in which there are several ore shoots.

The ore averages 25 percent lead, 15 percent zinc, 1 percent copper, less than 1 percent each nickel and cobalt, and about 20 ounces of silver per ton. Reserves are reported to be about 4 million tons.

The cobalt and nickel were recovered in matte carrying 40 to 45 percent copper, 20 to 30 percent lead, 1 percent nickel, 0.3 to 0.8 percent cobalt, and 2,000 to 3,000 ounces of silver per ton, and a speiss containing 29 to 30 percent nickel, 15 to 17 percent copper, 3 to 4 percent cobalt, and 800 to 1,000 ounces of silver per ton. About 4,000 to 5,000 tons of matte and speiss were produced annually before World War II.

The reserves of the mine are reported to be sufficient for only an additional 5 to 10 years of operation.

At Henzai (Tavoy) asbolite is reported occurring with deposits of manganese oxide.

Celebes

Fairly large deposits of garnierite-type nickel ore, similar to those found in New Caledonia, are present in the Celebes. Since the ore has been reported to be very much like that from New Caledonia, it is probable that it contains about the same amount of cobalt and that it is overlain with laterite deposits of higher cobalt content. It is not known whether any plans to exploit the cobalt deposits have been made, although the nickel ore is being mined. Japan has regularly imported nickel ore from the Celebes in the past, and indications are that the amount of such imports will increase appreciably in the future. At least one Japanese

nickel producer contemplates the recovery of cobalt from nickel ores.

China

Very little information is available about cobalt in China. About 10 localities in the Province of Yunnan have produced some cobalt, which is used locally as a pigment in the ceramic industry. In most of these deposits the cobalt is obtained from cobaltiferous manganese oxide or asbolite nodules. In Lu-nam (24°46' N., 103°17' E.) and A-mi (23°44' N., 103°10' E.) districts copper ores are reported to contain as much as 7 percent cobalt.

India

Some cobalt has been produced in India for local ceramic use. In Rajputana cobaltite and danaite are associated with chalcopyrite and pyrite in small copper mines in slate. A little cobalt is reported in sulfide ores near Arumanal-lar, Travancore, and Madras, and linnaeite is found in the copper ore from Sikkim. Some of the manganese ores of India are reported to contain appreciable quantities of cobalt.

Japan

Although cobalt has been used in Japan for over 300 years, most of it was imported before World War II. During the war intensive efforts were made to find cobalt, but little was produced; in the best year, 1944, the total amount was less than 34,000 pounds.

The Naganobori mine (probably the same as Nagato) in Yamaguchi Prefecture, primarily a copper mine, has produced cobalt since 1936 averaging just under 6,600 pounds a year. The deposit consists of a number of lenses of ore near or at the edge of a granite-porphyry stock intruded into upper Paleozoic sedimentary rocks. The ore consists of chalcopyrite and cobaltite in the contact zone.

The Dogatani mine, Nara Prefecture, produced 14,550 pounds of cobalt in 1943-45. The deposit consists of a quartz vein carrying glaucodot and smaltite in Mesozoic mudstone near an intrusion of quartz porphyry.

The Sanyo and the Taishio mines, both in Wakayama Prefecture, have produced a little cobalt. Both mines produce from narrow quartz veins cutting Mesozoic sedimentary rocks. The Sanyo deposit carries cobaltite, glaucodot, and a little chalcopyrite, pyrrhotite and pyrite; the crude ore averages 0.4 to 0.6 percent cobalt and carries a little gold and silver. Cobalt at the Taishio mine occurs as arsenopyrite and averages about 0.6 percent.

Total reserves of the four mines just described are about 900,000 metric tons averaging about

RESOURCES

53 percent cobalt ore containing about 10.5 million pounds of cobalt. A 60-percent recovery would give about 6.3 million pounds of cobalt.

Besides the deposits described above, about nine deposits containing cobaltiferous pyrite or arsenopyrite (probably carrying less than 0.05 percent cobalt) are known, and cobalt minerals are reported at six other places. Some cobalt is also recovered during the refining of concentrates from the Horai mine, Yamaguchi Prefecture, the Mukogami copper mine, and the Oshimamru nickel mine.

Officials of Japanese nickel refineries in 1959 revealed that the demand for low-cobalt nickel is increasing rapidly and that at least one major nickel refinery plans to commence recovery of cobalt from nickel ore as a separate product in 1960 or 1961.

Korea

Cobalt is found in a number of places in Korea, mainly in association with copper. The Poguk mine in southern Korea was worked primarily for cobalt and produced 6 tons of speiss containing 8 to 9 percent cobalt in 1944. The Ham-an and the Kumbuk copper mines in Kyongsangnamdo Province produced about 3 tons per year of cobalt contained in concentrates as a byproduct of copper production.

Cobaltiferous material reportedly occurs at Keizan in northern Keisho Province. Erythrite is reported on weathered vein material in Teuson do, Oryomen Keisan; in Kelsu-ri, Jocho-men, Sanchoku; and at the Rogusan mine, Kankyohokudo. Quartz veins carry cobaltite at Kumhwa, Kogendo. A study directed by the U.S. Army shortly after World War II (13) stated that cobalt reserves of all Korea were estimated at 442,000 metric tons of ore averaging between 0.1 and 0.2 percent of cobalt.

Nepal

Deposits of cobalt ore are known to exist in Nepal, but very little commercial exploitation has been done. In 1936, ore and speiss containing about 4,000 pounds of cobalt were exported from Nepal.

Republic of the Philippines

Immense deposits of lateritic-type iron-nickel-cobalt ores have been discovered in the Philippines, but no large-scale exploitation of the deposits has been undertaken. The ore is similar to that mined in Cuba, and the reserves are extensive. A measured reserve of 157 million tons of ore, containing 1 percent nickel and 0.08 percent cobalt, has been developed in Parcel II of the Surigao Mineral Reservation.

This reservation embraces an area of about 225,000 hectares, including about 64,200 hectares of the mainland of Mindanao. Parcel II comprises the islands of Nonoc, Awasan, Hani-gad, and southern Dinagat. Exploratory surveys of the remainder of the reservation indicate that the total reserve may reach 3 billion tons.

Laterite is also found in areas outside the Surigao Reservation. Ores of the same type as those found in the reservation were discovered in 1959 on the island of Homonhon, just south of Samar and north of the Surigao Reservation. These deposits were reportedly being developed by the Ferrum Exploration and Development Co., Inc., which planned to ship the ore to Japan. The company claimed a measured reserve of 3 million metric tons.

AUSTRALIA AND OCEANIA

Australia

Cobalt has been reported from a number of districts in Australia and in a great variety of forms and associations, but apparently the only cobalt produced is precipitated by the Electrolytic Zinc Co. of Australasia, Ltd., from solutions obtained during the treatment of ore from the Broken Hill lead-zinc deposit and of a little ore from Tasmania. About 25,000 to 30,000 pounds of cobalt is produced per year.

Other localities from which cobalt has been produced in the past, or at which cobalt is known to occur, are noted briefly below.

New South Wales.—At Port Macquarie, cobalt was produced before the Cobalt, Ontario, deposits came into production. Here the deposits, similar to those of New Caledonia, developed by the deep weathering of serpentine, consist of asbolite in ferruginous clays. At Bungonia, cobaltiferous manganese oxide occurs as nodules near the surface. At Carcoar, cobalt occurs as glaucodot in veins. At the Bismuth mine and nearby properties near Torrington are pegmatite or greisen deposits that were mined principally for their bismuth and tungsten; smaltite is associated with the native bismuth, and the tailing is reported to carry about 6 percent cobalt.

Queensland.—A considerable amount of cobalt was produced in the Cloncurry district, Queensland, in the 1920's and early 1930's. The rocks of the Cloncurry district consist of several groups of altered sedimentary and volcanic rocks of Precambrian age, extending about 200 miles from north to south and 100 miles from east to west, which have been intruded by granites several times. There is much faulting and folding of all these rocks.

The principal producer of the Cloncurry district was the Mount Cobalt mine, 18 miles south of Selwyn. Discovered in 1919, the deposit produced 1,530,000 pounds of cobalt between 1920 and 1934. Production was restricted greatly by a shortage of water after 1924, and in 1931 the shaft and part of the surface plant were destroyed by fire. Since then there has been only a little production from shallow workings and from the dump.

The workings consist of several shafts (one to a depth of 229 feet) and over 1,800 feet of workings in three levels. The ore occurs in hornblende schist, which occupies a shear zone between amphibolite on one side and mica-quartz schist and quartzites on the other side. The shear zone strikes north-south and dips 70° to 80° east. Ore shoots in the zone apparently plunge east at relatively low angles. Ore has been found over a length of 1,000 feet and an average width of about 3 feet, although in places it is 13.5 feet wide. The primary ore is cobaltite in a gangue of quartz, calcite, siderite, biotite, and hornblende; a little scheelite occurs in places, and the northern extension of the shear zone also contains pyrite and chalcopyrite.

Down to a depth of about 50 feet, the cobaltite has been oxidized to erythrite and heterogenite. The process of handpicking, jigging, and tabling, used to beneficiate the ore, must have been inefficient, as the dump contains about 16,000 tons averaging 2 percent cobalt, which is higher than the average grade of the vein worked for the last few years. Rayner (9) concludes that with careful exploration and development of deeper levels, this deposit could produce a moderate amount of cobalt.

The Success mine, 2 miles northeast of Longarra, which is 19.5 miles south of Cloncurry, was a high-grade copper mine before 1929, when cobalt was discovered in the deposit. During the period 1929 to 1931, about 11,000 pounds of cobalt was produced. The ore is in a shear zone, striking east-northeast and dipping steeply south-southeast, which cuts across northeasterly striking bands of amphibolite, hornblende schist, and chlorite schist in the east limb of a north-plunging anticline. The lens-shaped ore shoot plunges east and contains pyrite, cobaltite, bornite, chalcopyrite, and enargite with secondary chalcocite and covellite. The high-grade copper and cobalt ore was handpicked and jigged, and cobalt concentrate averaging about 22 percent cobalt was recovered in addition to a high-grade copper concentrate. Rayner concluded that although the exposed ore shoot has been worked out, there are possibilities for picking up faulted extensions or other en echelon ore bodies.

The Queen Sally mine, 6 miles southeast of Kajabbi, a railroad station 60 miles northwest of Cloncurry, has produced about 5,200 pounds of cobalt. Output was hampered because of too much water underground. The deposit, discovered in 1924, is in a band of quartz striking N. 25° W. in hornblende schist; tourmalin bearing pegmatites and calcite lenses are present. The primary ore is cobaltite in quartz and calcite, occurring as short lenses trending east-west. More development would be necessary to determine whether this deposit contains much cobalt.

Other deposits which contain cobaltite, erythrite, heterogenite, or asbolite are listed below. They are all small or only slightly developed deposits, associated with copper or manganese:

Pinkie mine, 12.5 miles W. of Kajabbi
Cantipede mine, 7 miles SSW. of Kajabbi
Dugald River deposits, several in vicinity of Naku
Soldier's Cap deposits, several known, 25 miles of Cloncurry
Quamby Area, at the Volga and Lady Belle mines
Boomera, 90 miles N. of Cloncurry
Mountain Home, 17 miles SE. of Cloncurry
Ballara, in western part of the Cloncurry district

The district is said to have good possibilities of becoming a source of cobalt, but it needs closer examination and development, plus a custom concentrator.

New Caledonia

The nickel and cobalt deposits of New Caledonia were discovered in 1863. Exploitation of the deposits for cobalt commenced in 1910. Only small, relatively unimportant amounts of cobalt have been produced since 1910.

Approximately one-half the total surface of New Caledonia is underlain by serpentine peridotite. In areas where the decomposition products of the original peridotite have not been washed away, three distinct layers can be distinguished. The top layer consists of limonite high in iron but with a nickel content of only about 0.025 percent. The middle layer is of laterite and has a nickel content of about 1 percent. The bottom layer contains garnierite and has about 2 to 3 percent nickel, although pockets of 10 to 15 percent nickel occur. Samples as high as 30 percent have been found.

Cobalt is present in all of the nickel-bearing layers in varying amounts. In the unaltered peridotite the cobalt content is from 10 to 20 percent. In the laterite layer, cobalt is present in amounts up to 0.5 percent, and some rich deposits may contain as much as 5 percent, but the general average is probably around 1 percent. The cobalt content of the garnierite is somewhat lower. Cobalt occurs as nodules

olite distributed throughout the laterite and laterite layers.

Officials of the Société le Nickel, the company which controls most of the New Caledonian ore reserves, reported to the Federal Bureau of Mines in 1959 that known cobalt ore reserves on the property of Société le Nickel amounted to 200 million metric tons at 0.2 percent cobalt.

New Guinea

In February 1957, the Netherlands Government reported the discovery of large nickel- and cobalt-bearing deposits on the island of Waigo, on the northeast coast of Netherlands New Guinea and separated from the mainland by the Dampier Straits. The deposits, of the laterite type, were estimated to contain 75.5 million tons of ore.

AFRICA

Morocco

The cobalt-nickel deposits of Bou Azzer and Graara are about 105 airline miles southeast of the railhead at Marrakech, lying at the east base of the Anti-Atlas Mountains. They are at an altitude of about 4,600 feet, in a rocky, arid region.

The deposits occur in two areas of Precambrian rocks exposed by the erosion of an anticline of younger rocks. The oldest of the Precambrian rocks are diorite and a series of mica schists and gneiss. Younger than these is a complex of serpentine and olivine basalts.

The ore occurs in vertical east-west veins or veinlike masses at or near the contact of the serpentine and the diorite; more of the veins are in the serpentine than in the diorite. The veins have a maximum width of 5 feet and have been mined to a depth of 575 feet; lengths of the veins are not given. Nine veins are reported.

The ore consists of skutterudite, with small amounts of cobaltite, safflorite, niccolite, rammsbergite, arsenopyrite, lollingite, and gold, with a gangue of calcite and some quartz. Oxidation has produced minable amounts of erythrite, annabergite, and black oxides. The average content of concentrate as shipped is 11 to 12 percent cobalt, with 2 to 2.5 percent nickel, although there are places where the nickel content is higher than that of cobalt. The ores are reported also to contain 0.1 to 9.6 ounces of gold and up to 1.6 ounces of silver per metric ton.

Apparently little development is done ahead of mining in this district, with the result that the reserves can only be inferred roughly. Inferred reserves are about 800,000 tons carrying

1.6 percent cobalt, or a total of about 28 million pounds of cobalt.

Republic of the Congo and Northern Rhodesia

The deposits of Katanga and Northern Rhodesia are geologically in a single mineral district and are therefore discussed as a unit.

The primary ore deposits are replacements of certain lithologic units which belong to the Roan system, divided into three groups: (1) The Mwashya or Christmas group, consisting of feldspathic sandstone and quartzite, block shale, chert, and siliceous oolite; (2) the Upper Roan group with dolomite, dolomitic shales, and sandstones; (3) the Lower Roan group with shales and sandstones underlain by feldspathic sandstone and conglomerates.

In Katanga, the primary ore is found in the "Mine Series" belonging to the Upper Roan group, whereas in the Rhodesian Copperbelt the ore occurs in the Lower Roan group.

The rocks were folded into a large arc; the axes of the folds trend northwesterly in Northern Rhodesia, swing around to an east-west trend in central Katanga west of Jadotville, and then turn southwest and enter eastern Angola. In Northern Rhodesia the folds are open and relatively simple, but going northwest into Katanga the folding becomes much tighter and more complex, and there are numerous thrust faults. The structures in Northern Rhodesia plunge northwest; as a result of extensive erosion, only scattered synclines of the schistodolomitic group remain, separated by extensive areas of older rocks. On the other hand, because of the northwest plunge, similar structures are deeply buried in Katanga, where only anticlines of the same group, separated by wide areas of younger rocks, outcrop at the surface. After folding, the rocks were intruded first by granitic rocks and later by basic rocks. The granites crop out mostly in the more deeply eroded Northern Rhodesian area and in the southern part of Katanga.

The primary ore deposits consist mostly of bornite, chalcocite, and chalcopyrite, with small amounts of carrollite or linnaeite and pyrite. A long period of erosion and deep oxidation destroyed the primary minerals to considerable depths. Zones of supergene sulfide enrichment, containing secondary chalcocite, and covellite have formed to a certain extent, but of much greater importance economically has been the formation of a thick, oxidized zone containing principally malachite, plus some azurite, chrysocolla, cuprite, native copper, heterogenite, asbolite, and a host of rarer oxides and minerals of the oxidized zone. In places, especially in the

Katanga area, richer spots of copper or cobalt have been formed.

Formerly the mines of Katanga and Northern Rhodesia produced only from the oxidized zone, but at present most of the Northern Rhodesia production comes from the sulfide zones, which average 0.13 percent cobalt. In Katanga, the cobalt ores were originally derived from a number of small enrichments in the oxidized zone in mines near Elizabethville and Jadotville and from mines in the Western group. These deposits contain 3 to 4 percent cobalt. Now most of the cobalt comes from sulfide ores, mainly around Kolwezi, in which the cobalt content is about 0.3 percent. In the future, most of the Katanga production will have to come from the sulfide zones.

The Union Minière du Haut-Katanga has stated that its reserves contain enough cobalt for 80 years production at the present rate of 19 million pounds a year, or roughly 1,500 million pounds of cobalt.

The reserves of Northern Rhodesia contain about 750 million pounds of cobalt. The percentage of recovery under present operations is not known.

Uganda

Copper deposits carrying some cobalt occur near Kilembe on the east side of the Ruwenzori Mountains, in western Uganda, British East Africa.

As of December 31, 1960, reserves were esti-

mated at 8 million tons of ore averaging 1.95 percent copper. The ore probably contains about 0.2 percent cobalt.

Union of South Africa

There are a few known occurrences of cobalt minerals in the Union of South Africa, but virtually no cobalt has been produced. A few tons of concentrate are reported to have been exported on a trial basis.

At the Kruis River deposit (in the Transvaal), a narrow vein of smaltite occurs in altered quartzite several feet below a large gabbro sill; it contains some chalcopyrite and gold. The crude ore contains less than 3 percent cobalt, which together with the apparent thinness of the deposit probably accounts for the lack of successful exploitation.

At Laatse Grift 82, a few miles west of Kruis River, a cobalt occurrence is reported.

South of Balmoral, at Wenzan Leid, are several parallel east-west zones consisting of smaltite and actinolite, plus some feldspar, calcite and quartz. Some of the zones appear to be over 2 feet wide. Considerable development has been carried out, but there is no record of cobalt production.

At Edwards Goldfields mine (Waaikraai 206), in the Rustenberg district, smaltite occurs with high-grade gold ore in the upper part of the reef and in the overlying magnetite band. There is no record of cobalt production.

CHAPTER 4. SECONDARY RESOURCES

Nature and Quantity

Very little published material is available concerning the generation, collection, and disposition of secondary cobalt-bearing materials. High-temperature alloy scrap seems to be the cobalt scrap item in greatest supply. For many years, approximately one-third of all the cobalt consumed in the United States has been used for the manufacture of these alloys. The largest use for these alloys has been in jet engine manufacture, mostly for military uses, where the service life of the parts is relatively brief. Large quantities of scrap collect every year at military installations where jet aircraft are serviced. This type of scrap probably accounts for an appreciable fraction of the original cobalt used in the manufacture of high-temperature alloys.

Another type of cobalt-bearing scrap is generated in the manufacture of high-temperature alloys. Most alloys of this type require rather extensive treatment of the ingot before any further finishing operations can be performed. The ingot treatment normally consists of cropping the ends and cleaning up the surface, either by scalping or grinding. Further removal of metal is also often required to free the ingot of cracks or other imperfections. This is also often accomplished by grinding. The amount of metal removed in these ingot-conditioning operations is often rather large, amounting in extreme cases to 20 percent or more of the original weight. Large quantities of fines from these grinding operations are generated annually, but they find no market since they are badly contaminated and contain about 25 percent by weight of grinding medium. Smaller quantities of grindings are also generated in finishing operations on fabricated items.

Scrap from casting operations, such as gates and risers and imperfect and rejected castings, is remelted at the plant where it is generated.

The manufacture of permanent magnets consumes annually about the same amount of cobalt as is used in high-temperature alloys. Most of these magnets are used in applications such as loudspeakers, motors, meters, magnetic latches, thermostats, and special electronic applications where the service life is relatively long. Magnet scrap is much more widely distributed than the bulk of high-temperature-alloy scrap and is therefore correspondingly more difficult to collect. It is thus probable, although not certain, that magnet scrap plays a relatively minor role in the cobalt scrap picture.

Since cast magnets are usually finished by grinding, some scrap is generated in this fashion, although not nearly as much as in the preparation of high-temperature ingots. Grinding scrap is badly contaminated with particles of abrasive and bonding materials, and usually finds no market.

Present Methods of Recovery

At present, no large-scale commercial operations are being conducted in the United States to recover cobalt from scrap. Some of the producers of cobalt salts and compounds use relatively small amounts of scrap in their operations, but they will not divulge the details of their processes.

The only recovery of cobalt from scrap on a large scale is being carried out in West Germany. During the period 1955-57, the United States exported annually an average of over 1 million pounds of cobalt scrap to West Germany.

CHAPTER 5. TECHNOLOGY

Prospecting and Exploration

Modern methods of exploring large areas for minerals can be broken down into the following major steps: (1) Selection of likely areas from geologic, tectonic, geophysical, and other types of available maps; (2) aerial reconnaissance of the chosen areas, including mapping and airborne geophysical surveys; (3) ground geological and geophysical exploration and prospecting; (4) physical exploration, including collection of surface samples, trenching, and drilling.

Nearly all of the producing cobalt deposits, however, were discovered long before the advent of the airplane. New cobalt-bearing deposits are still being sought, although not specifically for cobalt. The International Nickel Co. has, since 1943, devoted much effort to searching for new deposits of nickel ore. Inco has spent as much as \$8 million in exploration in a single year and has conducted airborne magnetometer surveys which involved as much as 28,000 miles of flying for a single survey. Since cobalt normally occurs with nickel, cobalt reserves are being constantly increased by the intensive effort devoted to nickel.

A brief summary of the method of discovery of some of the major cobalt deposits is given below:

Katanga.—The cobalt-bearing copper deposits in Katanga were discovered and worked for copper by the natives long before white men explored the area. Explorers, including Livingston, brought word to the outside world of the mineral wealth of the region long before exploitation of the ore deposits was begun by the Belgians.

Sudbury.—In 1856 a Provincial land surveyor noticed a strong magnetic deviation when surveying a meridian north of White Fish Lake. He mentioned his findings to the Assistant Director of the Geological Survey of Canada, who examined the area and found a deposit of sulfides which, when assayed, gave low values in nickel and copper. The site investigated was only a short distance from the spot where the Creighton mine of Inco now stands.

No further attention was given to the deposits until they were accidentally rediscovered in 1883 during construction of the Canadian Pacific Railway. This time the find brought

out prospectors who soon located the richest areas by searching for outcroppings.

Most of the ore bodies in the Sudbury area were located by discovery of outcropping within a few years of the first discovery. In Falconbridge Township, however, the ore was overlain by gravel, and the prospectors of the day had little interest in the area. It was here in 1901 that Thomas Edison made one of the first attempts at scientific detection of ore bodies in the Sudbury area in order to find a source of nickel for the manufacture of batteries. He conducted a magnetic survey of the area and discovered an anomaly which indicated the possible presence of an ore body. The shaft was sunk, but quicksand was encountered and the claims were abandoned and allowed to revert to the Crown. Thus, the exploration ended in failure. Some years later, the area was restaked, and a diamond-drilling program confirmed the existence of a large body of ore. The claims were then sold, and the area subsequently developed into the Falconbridge mine, one of the major producers of the Sudbury area.

Manitoba.—Sherritt Gordon, while operating its former copper-zinc mines at Sherridon, Manitoba, had conducted an extensive prospecting campaign in the Granville Lake area from 1937 to 1941; the investigation culminated in the discovery of nickel-copper mineralization in a small rock outcrop at Lynn Lake by one of its prospectors in the fall of 1941. Owing to the war it was not possible to follow up the small sulfide showing, and the discovery was kept secret until 1945, when the property was restaked and surveyed for geophysical anomalies. Diamond drilling of the anomalies, covered by overburden, resulted in the discovery of the Lynn Lake nickel-copper ore body that Sherritt Gordon brought into production in the fall of 1953.

Mining COBALT-BEARING COPPER DEPOSITS

Most of the world's supply of cobalt is produced as a byproduct or coproduct with copper. The only known large deposits of cobalt-bearing copper ores are in central Africa in mineral concessions of Union Minière du Haut Katanga in Katanga Province and in the

the copper belt of Northern Rhodesia. These deposits were originally mined solely for copper and are almost free of nickel.

Katanga

Union Minière du Haut-Katanga has tremendous mining concessions along the southern edge of Katanga Province. The area leased for copper mining is about 200 miles long and averages about 35 miles in width. In 1958, Union Minière listed (21) 32 copper and copper-cobalt deposits and 1 cobalt deposit in the lease area. Only seven were being worked in 1958 (20), and only three produced ore of sufficiently high cobalt content to be of interest. The three cobalt-producing mines were Musonoi and Kamoto, which lie at the extreme western tip of the mining concessions, and Kambove, which lies in the center of the concession. All are of the open-pit type.

The operations at the Musonoi mine described in the following paragraphs are illustrative of the mining practices in use at the Union Minière open pit properties.

The ore is developed in benches approximately 10 meters (33 feet) high. Overburden is soft enough to be stripped by shovels in some areas, but in other areas it must be blasted. Overburden removal accounts for only about 15 percent of the total drilling and blasting at the mine. Overburden is removed by electric locomotives pulling six or seven side-dump cars of 22- or 28-cubic-yard capacity.

Drilling is by churn drills using 6 $\frac{5}{8}$ -, 7-, or 9-inch bits, depending on the hardness of the ore. In soft ground, the holes are drilled to the foot of the bench; in hard ground, they are drilled 1 meter below the foot. Holes are drilled in staggered rows and are spaced from 3.5 to 7 meters apart, depending on the hardness of the rock.

The explosive used is manufactured locally and has 75 percent of the strength of blasting gelatin. Primacord with 20-millisecond-delay connectors is used for firing. Electric blasting caps are not used because the frequent electrical storms encountered in the area for 6 months of the year might cause premature firing. The blasting practices used give excellent fragmentation, and only a minor amount of secondary blasting (1 to 2 percent of total explosive consumption) need be done.

The broken ore is removed by electric shovels of 4- to 6 $\frac{1}{2}$ -cubic-yard capacity and is hauled from the mine in 20-ton-capacity diesel trucks.

Northern Rhodesia

The ore deposits of the copper belt of Northern Rhodesia are a continuation of the same mineral district as those in Katanga. However,

the copper-cobalt mineralization occurs at a greater depth in the Northern Rhodesian deposits, and the only two cobalt-producing mines, Chibuluma and Rhokana, are of the underground type.

Mining at Chibuluma is carried out by modified sublevel stoping and modified cut-and-fill stoping. After the ore has been removed from two adjacent stopes, they are sandfilled with tailing from the concentrator. After the water has drained sufficiently from the sand, the pillar between the two stopes, which contains 15,000 to 35,000 tons of ore, is removed by cut-and-fill stoping.

COBALT-BEARING NICKEL-COPPER DEPOSITS OF CANADA

Cobalt is now recovered from most of the nickel-copper ores mined in Canada, but always as a byproduct, since it never occurs in a content high enough to make it profitable to mine only for cobalt. Consequently, all mining techniques used are those developed for nickel and will be only briefly described here.

International Nickel

Inco, as of 1960, was operating six mines in the Sudbury District: Crean Hill, Creighton, Frood-Stobie, Garson, Levack, and Murray. It was also developing the Thompson mine at Thompson, Manitoba, for operation in 1961.

A number of different mining methods are used at the Sudbury mines. At the Frood-Stobie mine, once an open-pit operation, blast-hole stoping is being used. At the Creighton mine, also originally an open-pit operation, block caving methods are used to recover large quantities of low-grade ore left unmined during earlier underground operations.

Various methods are used in other mines, depending on the conditions peculiar to the specific area being worked in each mine. Methods other than those mentioned include square-set, cut-and-fill, and shrinkage. Inco uses hydraulic sand fill in connection with square-set stoping. Sand is recovered from the tailing and pumped, at a density of about 60 percent solids, into the worked-out levels of the mine. Water draining from the sand fill is recirculated.

Falconbridge

Falconbridge has eight mines in the Sudbury District. As of 1960, six of these, East, Falconbridge, Fecunis Lake, Hardy, Longvack, and McKim, were in full operation and the others, Boundary and Onaping, were under development. Stoping methods used at the various mines are as follows: Falconbridge—longitudinal cut-and-fill and square-set with small ton-

nage by shrinkage; Fecunis Lake—cut-and-fill and square-set; Hardy—horizontal cut-and-fill; Longvack—shrinkage and glory-hole; McKim—blasthole with small amount of shrinkage stoping in isolated pockets.

Backfilling in most mines is done with development rock or tailing sands. Hydraulic fill is used at the Hardy mine. Underground haulage at all mines is usually by battery locomotive, but trolley locomotives equipped with cable reels are also used at the Hardy mine.

Sherritt Gordon

Sherritt Gordon is presently mining several ore bodies at its Lynn Lake, Manitoba, property. The ore bodies are pipelike in character and nearly vertical, with strong rock walls, and thus lend themselves to simple mining operations. An open-stope method is used with a sublevel interval of 75 feet. Stopping is by long-hole ring drilling. Ore is drawn from the stopes through horizontal scrams with discharge to ore passes which feed directly to the jaw crushers.

U.S. DEPOSITS

The Calera mine at Cobalt, Idaho, was, when operating, the only mine in the Western Hemisphere in which cobalt ore was the primary product, and it was one of only two mines in the world (the other being in Morocco) which were so operated. At the time the mine was closed, three ore bodies—Chicago, Brown Bear, and Blacktail—were being exploited.

In the Chicago ore body, the ore is in a fairly continuous, vein-type deposit. The method used for development was horizontal cut-and-fill, with hydraulically delivered sand as the fill material. In most areas, the ground was strong enough to stand unsupported before filling. Timber was required in faulted areas and in the top slices of some stopes as they approached the oxidized area near the surface.

In the Brown Bear ore body, the ore lies in flat, plunging pods in fairly weak ground, and timbering was required for most stopes. Each individual stope presented a separate problem, and mining methods were varied from stope to stope accordingly. Hydraulically delivered deslimed mill tailings at 60 percent solids were used as fill.

The Blacktail ore body was developed by open-pit methods.

Milling

COPPER-COBALT ORES

Of the three producers and processors of copper-cobalt ores (Union Minière du Haut-Katanga, Rhokana Corporation, Ltd., and

Chibuluma Mines Ltd.), the largest is Union Minière. The following description of the milling practices of Union Minière was translated from the description in French furnished by the company:

The copper and cobalt minerals extracted from some of the mines in the Western Group (Kamoto, Musonoi, Kolwezi) are treated at the Kolwezi concentration plant. They are treated in one or the other section of the plant according to their composition.

Oxide Ores.—These are treated by flotation. The reagents used are a combination of sodium carbonate and sodium silicate with palm oil. The sandy plateau surrounding the plant furnishes such soft feed water that the consumption of reagents is relatively low and the operation can be carried out at ambient temperature (19° to 23° C).

The plant treats ordinary copper ores which are always slightly cobaltiferous. The concentrates are sent to the electrolytic plant at Shituru and since April 1960 to the new electrolytic plant at Luilu; these malachite concentrates contain 22 to 26 percent Cu and 0.8 to 1.3 percent Co.

Mixed Ores (Oxides, Sulfides).—These minerals mark the transition between the oxides or carbonates of the surface and the sulfide mineralization encountered at depth. They are generally clearly dolomitic; the oxidized part is basically malachite with some chrysocolla; the sulfide is primarily chalcosite.

The process of concentration by sulfidization comprises the following steps: Fairly fine grinding of the ore; flotation of chalcosite by standard reagents, xanthate, and pine oil; flotation of malachite by superficial sulfidization; regrinding and refloating of mixed sulfides.

It consists essentially therefore of conditioning of the pulp tailings of the flotation of the sulfides by means of an alkaline sulfide or sulfhydrate.

The malachite is covered with a film of copper sulfide, and can then be collected as a true sulfide with a collector of the xanthate type. The dolomitic character of the mixed ores precludes flotation of the malachite content with palm oil; the sulfide minerals have to be previously collected.

The sulfidization technique was tested in 1951 in one of the palm oil flotation sections. In 1954, an addition to the concentrator was constructed with an initial monthly capacity of 40,000 metric tons. The present capacity is over 110,000 metric tons per month.

The sulfide concentrate contains 42 to 54 percent copper and 0.8 to 3 percent cobalt. It is treated in the leaching works at Jadotville after first undergoing a sulfatizing roast. The oxide concentrate, containing 1 to 2.5 percent cobalt, is treated in the Panda electric smelter or by leaching.

From the standpoint of equipment, it is pointed out that for the concentration of mixed ores the method of wet grinding in two stages has been adopted. The ore is granulated to $\frac{1}{2}$ to $\frac{3}{4}$ inch in cone crushers, fed in open circuit to rod mills which discharge at minus $\frac{1}{2}$ inch to spiral classifiers (duplex) operating in closed circuit with the ball mills (two ball mills for one rod mill). For the regrinding of mixed particles, classification by cyclones and wet grinding in ball mills with 1- to $1\frac{1}{2}$ -inch forged steel balls was chosen.

Sulfide Minerals.—In the future, the exploitation of the deeper levels will furnish these ores. The concentrates obtained will be richer, containing 1.5 to 3 percent cobalt. They will be sent to the plants at Shituru and Luilu for treatment.

A simplified flow diagram of the sulfidization section of the Kolwezi concentrating plant is shown in figure 4.

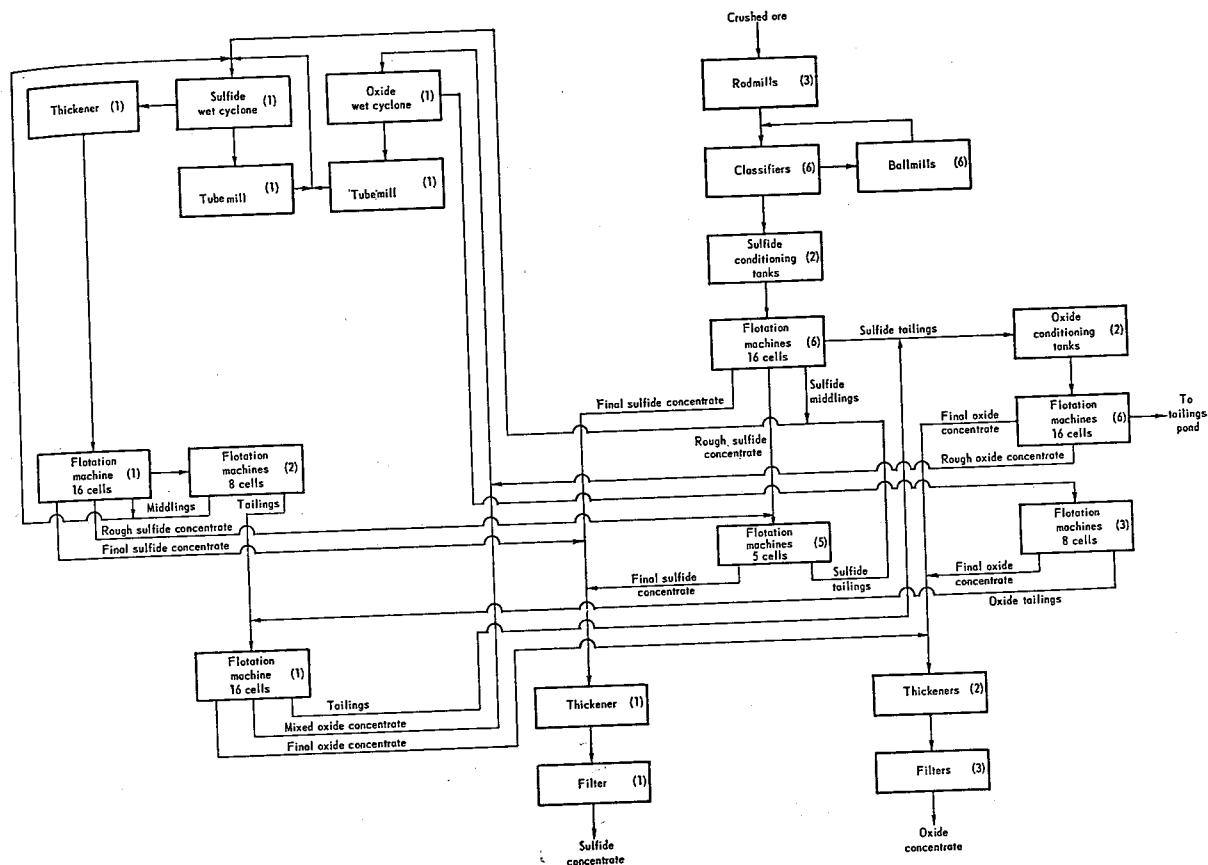


FIGURE 4.—Simplified Flow Diagram of Kolwezi Concentrator.

NICKEL-COPPER-COBALT ORES

In milling the cobalt-bearing nickel-copper ores, such as those of the Subdury district of Canada, no effort is made to obtain cobalt as a separate concentrate. The milling of these ores is confined to the removal of gangue materials and the production of separate nickel and copper concentrates. Almost all the cobalt remains with the nickel and is removed in the final purification step in the production of nickel.

OTHER ORES

Bou Azzer

The milling practices at the cobalt concentrator at Bou Azzer, Morocco, are extremely simple. The ore mineral, skutterudite, is liberated by crushing and concentrated by gravity separation in large washing tanks. A concentrate containing approximately 10 percent cobalt is produced. No other milling or refining operations are carried out on this material in Morocco.

Calera

A flow diagram of the process which was used in the Calera mill at Cobalt, Idaho, is shown in figure 5. The refining process used necessitated production of a concentrate containing a definite ratio of cobalt, iron, and sulfur. Much of the necessary control of this ratio was done in the milling process, whereas the final adjustment was made at the refinery by blending concentrates. The concentrate produced at the mill had the following approximate composition:

Element:	Percent
Cobalt	17.5
Iron	20.0
Sulfur	29.0
Arsenic	24.0
Nickel	1.0
Copper	0.5

The conditioning step indicated in the flow diagram consisted of adding lime to the concentrate and then holding it for 1 hour at 100° F. with a pH of 10.4 to depress the cobalt and iron. Reclaimed water from the process could not be used in the flotation plant.

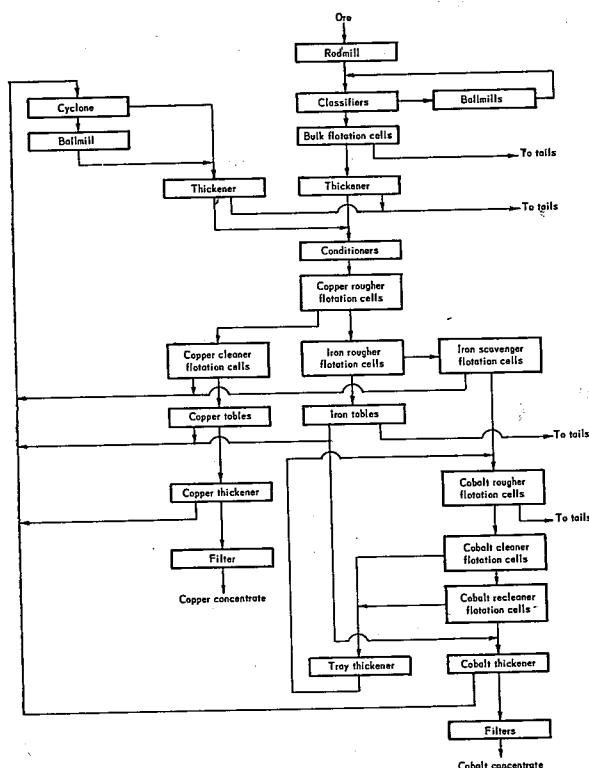


FIGURE 5.—Simplified Flow Diagram of Calera Cobalt Mill.

Refining

SMEETING AND ELECTROLYSIS

Union Minière du Haut-Katanga

Union Minière refines cobalt by several different methods. In the chituru refinery, cobalt is produced by a combination of electrolytic and fire refining. No complete flow diagram for the refining process is available, but an outline of the main operations is shown in figure 6. The first step in the process, the sulfate roasting, is a comparatively new addition, made to take care of the increasing amount of mixed or sulfide ores which are developed as mining reaches the deeper deposits.

The sulfide ores contain copper in the form of finely divided chalcocite and cobalt in the form of carrolite accompanied by a dolomitic gangue. Since concentrates of this material could not be handled by the normal leaching methods in use with oxide ores, the fluo-solid equipment for sulfate roasting was installed. An advantage of the sulfate roast is that over 80 percent of the original sulfur in the flotation concentrate goes into the formation of copper sulfate and therefore is made available for the production of sulfuric acid during the electro-

lytic step. The remaining sulfur either is lost in the roasting step as SO_2 which is vented from the stack or is retained in the leaching residues as soluble (Mg-Co-Fe) or insoluble (Ca) sulfates.

The roasted sulfide and the oxide (malachite) concentrates are leached in Pachuca tanks with spent electrolyte which contains free sulfuric acid. The leached pulp is run through a series of classifiers and thickeners, where the residue is separated and washed free of soluble copper and cobalt values. Final clarification of the solution is obtained by adding a flocculating agent and then passing the solution through filter beds formed by layers of coarse sand and gravel. Iron is then removed from a portion of the clarified solution by precipitation as ferric phosphate, and the solution is sent to the copper electrolysis section.

Cobalt does not deposit with copper and builds up in the electrolyte. To recover the cobalt, some of the electrolyte is bled off into the cobalt recovery circuit. The tankhouse bleed solution, which contains 25 to 30 grams

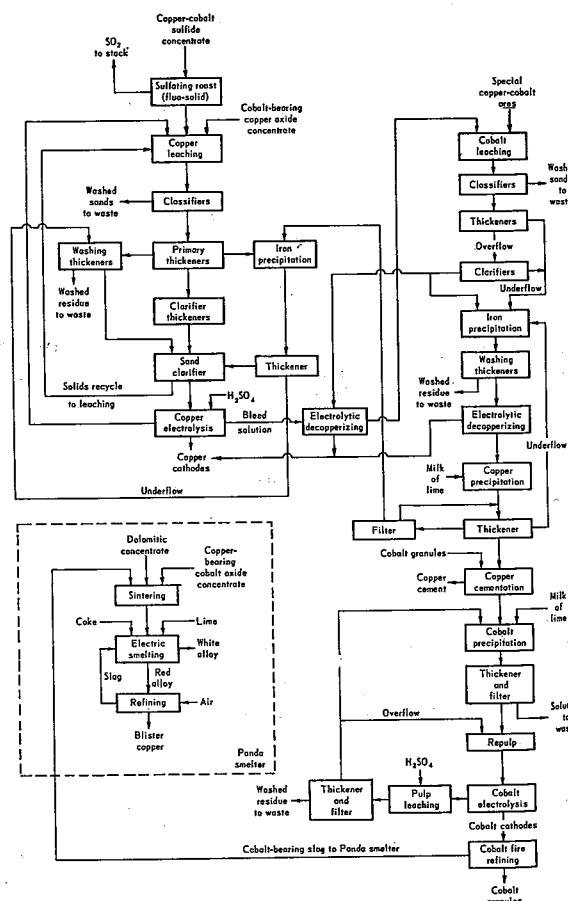


FIGURE 6.—Simplified Flow Diagram of Jadotville Shituru Refinery and Panda Smelter.

liter of copper, is mixed with some of the solution obtained from leaching ores, and copper is removed electrolytically down to about 5 grams per liter. The decopperized solution is then used to leach additional ore. The remainder of the solution resulting from ore leaching is electrolyzed separately. Iron and aluminum are precipitated as the hydroxides by the addition of lime to bring the leached solution to a pH of 3 to 3.5, and the clarified solution, containing about 8 grams per liter of copper, is subjected to an electrolytic decopperizing step which reduces its copper content to 0.5 grams per liter. Most of the remaining copper is removed by a second lime addition which raises the pH to 5.8. The solution, now containing only about 0.1 gram per liter of copper, is passed over a bed of cobalt granules where the last traces of copper are cemented out.

Cobalt is precipitated from the decopperized solution as the hydrate by the addition of calcium hydroxide and filtered from the solution, which is discarded. The cobalt hydrate is repulped with spent electrolyte to which sulfuric acid has been added, and the resulting suspension is fed to the cobalt electrolytic section. The electrolysis is referred to by the company as electroleaching, since it combines electrolysis of the cobalt sulfate in the solution and decomposition of the hydrate by the regenerated acid. The cobalt hydrate in the electrolyte is kept in suspension by blowing air through the cell. Cobalt with a purity of 92 to 94 percent is deposited on mild steel cathodes.

Cobalt cathodes are melted in an electric furnace and further refined by the use of special slags and poling. The manganese, sulfur, and zinc are reduced to a low level by this process, and the molten purified metal, now over 99.5 percent cobalt, is granulated by pouring into water.

The slags from the fire refining step are high in cobalt and are sent to the electric smelting plant at Panda for further treatment. The Panda smelter, in addition to the previously mentioned slags, handles high-cobalt (6 percent) concentrate from the Kolwezi concentrator, selectively mined high-cobalt ores, and certain dolomitic concentrates unsuitable for leaching. After sintering, the charge is smelted with coke and lime in an electric furnace to produce red alloy and white alloy. The red alloy consists of about 90 percent copper and 5 percent cobalt, and the white alloy contains about 42 percent cobalt, 16 percent copper, and 35 percent iron. The molten alloys are mutually insoluble and have different densities; thus, they separate into two layers. The white alloy is cast into ingots and shipped to the Société

Générale Métallurgique de Hoboken in Olen, Belgium, for further refining. The red alloy is refined at the Panda smelter by blowing compressed air through the molten metal in a rotary furnace. The result is blister copper, which is further refined and cast into anodes, and a high-cobalt slag, which is recirculated to the smelting furnace.

In the cobalt section of the new Luilu copper-cobalt refinery, an improved refining process is used. The electrolytic decopperizing steps have been discarded in favor of decopperizing by addition of lime. A preliminary denickeling step has been added in which nickel is removed as the sulfide by the use of NaHS. This step also makes it possible to eliminate the final decopperizing step in which copper is cemented out on cobalt granules, since the final traces of copper are precipitated by the NaHS. A decopperizing step has been provided to eliminate the zinc as zinc sulfide by the addition of H_2S ($H_2SO_4 + NaHS$) and Na_2CO_3 . The pulp-electrolysis method is not used at the Luilu plant. The electrolysis is carried out on a purified and clarified solution at 60° C. Electrolytic cobalt produced at Luilu will be of high purity and will not require further refining. A flow diagram of the Luilu cobalt refining process is given in figure 7.

The white alloy produced by the plants of Union Minière in the Congo is refined in Belgium at the plant of the Société Générale Métallurgique de Hoboken. The white alloy arrives from the Congo in the form of ingots of approximately 92 pounds. These have approximately the following composition: Cobalt, 42 to 43 percent; iron, 33 to 35; copper, 16 to 18; manganese, 0.5; nickel, 0.1; silicon, 2.5; phosphorous, 2.0; and carbon 1 to 1½.

Impurities are removed by dissolution followed by selective precipitation, but before the material can be leached, it must first be reduced to 100-mesh powder. To facilitate crushing of the very hard alloy, the ingots are heated between 1,020° and 1,060° C. and are immediately hot-crushed in a hammer mill. Final grinding to 100-mesh is done in a ball mill. The powdered alloy is hot-leached in sulfuric acid with the cobalt, iron, manganese, and nickel going into solution as sulfates, while the metallic copper remains insoluble. The small amount of copper oxide in the white alloy goes into solution, but immediately cements out on any metallic iron and cobalt present. Hydrogen is formed during the leaching process, and special safety devices are used to prevent buildup of hydrogen in the atmosphere over the leaching vats.

After the alloy is dissolved, the solution is filtered to remove the copper and other insolubles. The filtrate contains about 65 grams per

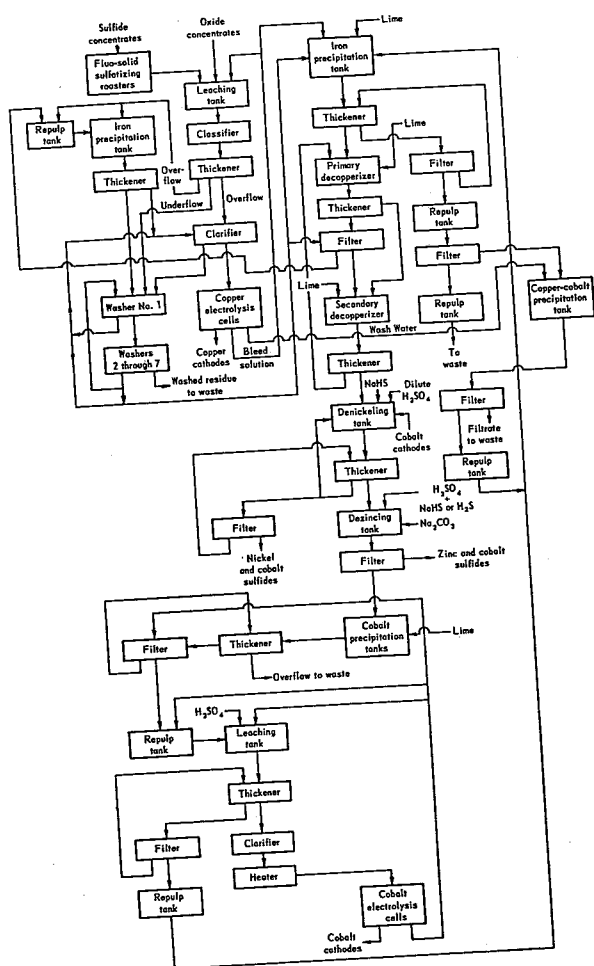


FIGURE 7.—Simplified Flow Diagram of Luilu Copper and Cobalt Refinery.

liter of cobalt, 45 grams per liter of iron, and 5 grams per liter of manganese.

Iron is removed from the solution by oxidizing it to the ferric state by compressed air, precipitating the ferric hydroxide by lime and filtering. A part of the iron also precipitates in the form of complex basic sulfates. Filtrate at the end of the iron removal step contains 40 to 45 grams per liter of cobalt and about 1½ gram per liter of manganese.

Manganese is next removed by the addition of sodium hypochlorite to the solution which precipitates a mixture of manganese and cobalt oxides, which are removed by filtration. The filter cake of mixed manganese and cobalt oxides is retreated to recover the cobalt. The filtrate, which now contains only cobalt, is treated by the addition of sodium carbonate to precipitate cobalt carbonate. The cobalt carbonate is calcined in an oil-fired kiln to produce crude cobalt oxide.

Two types of oxide can be obtained, depending on the method of production. Gray oxide (CoO) is obtained at high temperatures, and black oxide (Co_3O_4) at lower temperatures. After cooling and grinding, the crude oxides are acid-leached to remove compounds of impurity metals such as calcium and magnesium, and are prepared for sale. Some cobalt is still used in the form of rondelles, which are prepared from grey oxide. The pure oxide is compressed into small cylinders approximately 16 millimeters high and 16 millimeters in diameter, which are then placed in a furnace with alternate layers of charcoal (about 30 percent by weight). The furnace is maintained at $1,100^\circ \text{C}$., at which temperature reduction occurs to form pellets of metallic cobalt. The rondelles thus formed plus any excess charcoal are cooled, and the rondelles are separated from the charcoal magnetically. Rondelles are then polished in rotating cylinders and packed for shipment. Where metal of a very low carbon content is needed, the rondelles are given a special decarbonizing treatment in a controlled atmosphere furnace which reduces the carbon below 0.02 percent.

Powdered cobalt of 100-, 300-, and 400-mesh size is made by grinding specially prepared and decarbonized rondelles in a ballmill. A special grade of extra fine powder is made by calcining cobalt oxalate followed by grinding under protective atmosphere in a special mill.

The International Nickel Company of Canada, Ltd.

The cobalt in the ore stays with the nickel through the various concentrating processes used and ends in the anodes from which nickel is electrorefined. Metal anodes contain about 93 percent nickel and 0.8 percent cobalt, and sulfide anodes, cast directly from matte, contain about 72 percent nickel and 0.6 percent cobalt. During the electrorefining step, cobalt goes into solution at the anode along with nickel. A flow diagram of the refining process used at the Inco cobalt refinery in Port Colborne, Ontario, is shown in figure 8.

The solution produced by dissolution of the anodes is bled from the cells and sent to a set of tanks, where about 85 percent of the iron is precipitated as ferric hydroxide by the addition of nickel carbonate and air. Iron slime is removed by filtration, and the filtrate is sent to a second set of tanks, where cobalt is oxidized and precipitated from solution. The cobalt oxidation tanks are constructed of brick-lined concrete and are 8 feet in diameter and 25 feet deep. They are arranged in groups of five tanks in series. In the first tank in each series, residual cuprous ion is oxidized by injecting air

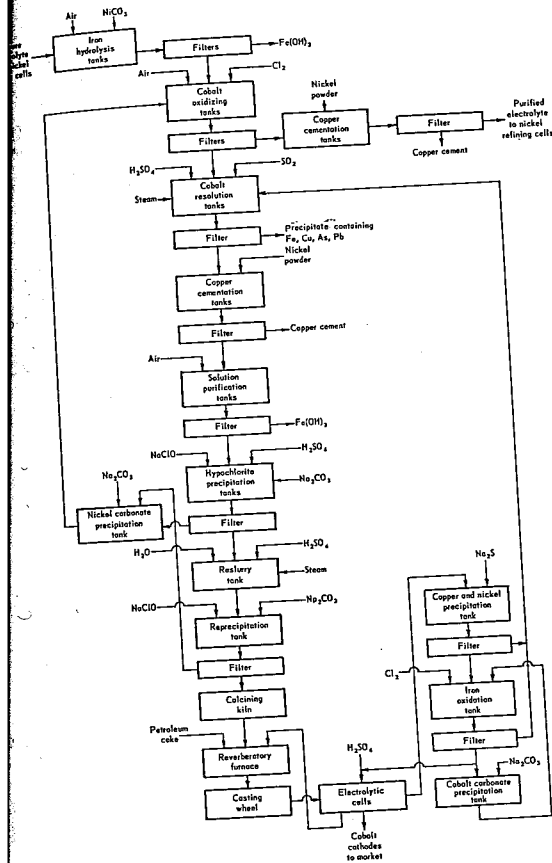


FIGURE 8.—Simplified Flow Diagram of Inco Port Colborne Cobalt Refinery.

at the bottom of the tank. Nickel carbonate slurry is added at the second tank, and chlorine is introduced into tank 3. Tanks 4 and 5 are holding tanks to provide sufficient time for the reaction to take place. Air agitation is used in all tanks except No. 3. All of the copper, iron, arsenic, lead, and cobalt are oxidized along with a portion of the nickel. The material leaving the oxidizing tanks is filtered, and the filtrate passes to copper cementation tanks, where traces of residual copper are removed by addition of nickel powder. The clarified solution from this step is the purified nickel electrolyte which is returned to the cathode compartment of the nickel refining cells.

The filter cake from the oxidizing tanks, which contains about 12 percent cobalt, 22 percent nickel, 5 percent copper, 2 percent iron, and small amounts of lead and arsenic, is reslurried and transferred to a holding tank. The slurry is then treated in batches of about 800 cubic feet each for the removal of iron and other impurities by treatment with hot 8-percent sulfur dioxide gas. After the cobalt and nickel are

reduced, concentrated sulfuric acid is added in sufficient quantity to lower the pH to 1.0. Live steam is injected to increase the temperature to 165° F., and an additional quantity of primary cobalt slime is added to oxidize and hydrolyze the ferrous iron. The resulting slurry is filtered to remove the ferric hydroxide together with about 80 percent of the remaining copper and substantially all of the residual arsenic and lead. The filtrate is decopperized by adding active nickel powder. After the copper cement is removed by filtration, any iron dissolved during the cementation step is removed by oxidation with air followed by filtration. The filtrate from this final purification step contains essentially only cobalt and nickel.

Cobalt is selectively precipitated from the purified solution by oxidation and hydrolysis with alkaline sodium hypochlorite. Subsequent filtration separates the first-stage cobalt precipitate, which contains about 55 percent cobalt and 4 percent nickel. This precipitate is further purified by reslurrying with sulfuric acid and reprecipitation with additional amounts of sodium hypochlorite. (Filtrate from these two operations is delivered to the nickel carbonate plant, where the contained nickel is precipitated as basic nickel carbonate by the addition of sodium carbonate. The nickel carbonate is re-circulated to the primary cobalt precipitation.) The filter cake from the second precipitation step, which contains about 56 percent cobalt and less than 1 percent nickel, is converted to cobalt oxide by calcination at 1,800° F. The calcine is pulverized and leached with dilute soda ash to remove residual sulfates. The oxide at this point, which contains 72 percent cobalt, 1 percent nickel, 0.15 percent iron, 0.15 percent sulfur, and 0.05 percent copper, may be marketed directly or treated further to produce electrolytic cobalt.

For the production of electrolytic cobalt, the leached oxide is charged into an oil-fired reverberatory furnace and reduced by the addition of petroleum coke. The metal, which contains about 95 percent cobalt, 1.5 percent nickel, 0.8 percent iron, 0.4 percent copper, and 0.6 percent sulfur, is cast into anodes weighing 550 pounds each. The anodes are anodically pickled in a sulfuric acid-sodium chloride bath and are electrolyzed using stainless steel cathodes in a sulfate-chloride bath to which boric acid is added. Anode slime and anode scrap is recycled to the reverberatory furnace. Electrolyte is treated for the removal of copper, nickel, and iron, and the purified electrolyte is recycled to the cells. Cobalt cathodes have the following analysis: Cobalt, 99.55 percent; nickel, 0.40; copper, 0.005; iron, 0.005; sulfur, 0.001; carbon, 0.02; and lead, 0.0001.

Falconbridge

The operations of Falconbridge in Canada are confined to the preparation of a nickel-copper-cobalt matte for shipment to the refinery of its subsidiary, Falconbridge Nikkelverk Aktieselskap, Kristiansand S., Norway. At the smelter, in Falconbridge, concentrate from various mills is either briquetted or sintered and smelted to matte in a blast furnace. Feed to the briquetting section of the plant is from the Hardy and Fecunis Lake mills in the Onaping area, whereas concentrate from the mills in the Falconbridge area is mixed with flue dust, pelletized, and sintered.

Crude matte from the blast furnace is tapped into settlers together with molten converter slag. Settler matte is then tapped for charging to the converters. Settler matte has the following average analysis:

Component:	Percent
Fe	53.7
S	24.7
Fe ₂ O ₄	17.6
Ni	8.5
Cu	5.0
SiO ₂	0.6

In the converters, ore and gravel (for flux) are added to the molten settler matte, and the charge is blown until the iron content of the matte has been reduced to less than 1 percent. The initial charge of smelter matte to the converter is about 75 tons, with more charge added during the blowing cycle. The blowing cycle lasts for about 44 hours and consists of about 40 blows of 50 minutes each. Refined matte from the converters has the following average composition:

Component:	Percent
Fe	0.92
S	21.48
Fe ₂ O ₄	48.60
Ni	27.96
Cu	
SiO ₂	

The smelter, enlarged in 1958, contains four blast furnaces and six converters, together with the necessary briquetting and sintering equipment. A flow diagram for the Falconbridge smelter is given in figure 9.

At the refinery in Norway, the matte is crushed and ground to 95 percent minus 10-mesh and roasted at 800° F. in Herreshoff-type furnaces to remove the sulfur. The copper in the resulting calcine is nearly all soluble whereas practically all the nickel is insoluble in the spent electrolyte used for leaching. The nickel is removed from the leached material by filtration, and the filtrate is sent to the copper electrolytic cells. The small amount of nickel which is in solution builds up in the electrolyte during copper deposition and is periodically re-

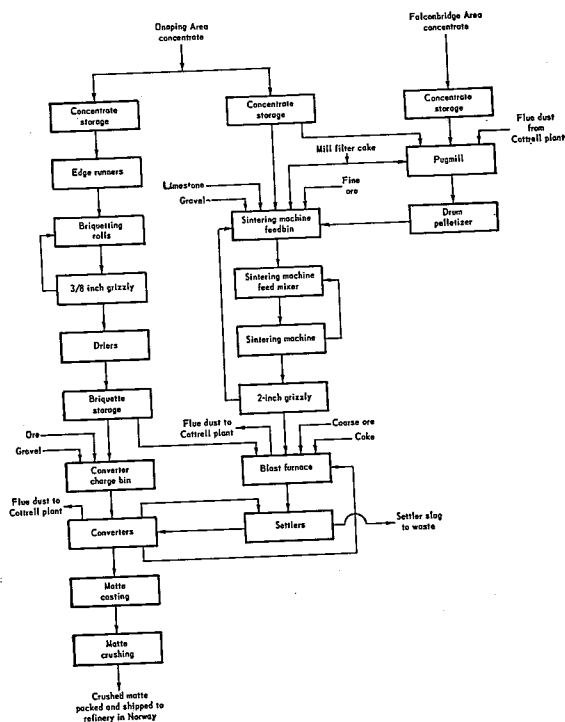


FIGURE 9.—Simplified Flow Diagram of Falconbridge Smelter, Falconbridge, Canada.

moved by bleeding off a portion of the spent electrolyte for recovery of contained nickel sulfate.

The major portion of the nickel filter cake from the leached calcine is charged into one of three electric furnaces and reduced by the addition of coal. The furnaces are equipped with forehearths from which the nickel is cast into anodes. The anodes are refined in Hybinette-type cells.

A small portion of the nickel in the leached calcine is converted to metal by reduction with water gas at 1,600° F. The active nickel thus produced is used to cement copper from anolyte bled from the nickel electrolysis cells. After removal of copper, the iron and arsenic are precipitated and removed by filtration. The solution, which then contains only nickel and cobalt, is passed through a chlorination tower where the cobalt is precipitated. The cobalt is recovered by filtration and sent to the cobalt electrolysis section, and the dechlorinated filtrate is recycled to the nickel electrolytic cells. A flow diagram of this operation is presented in figure 10.

LEACHING AND REDUCTION

Sherritt Gordon

The Sherritt Gordon refinery operates on nickel-copper-cobalt concentrate from the Lyr

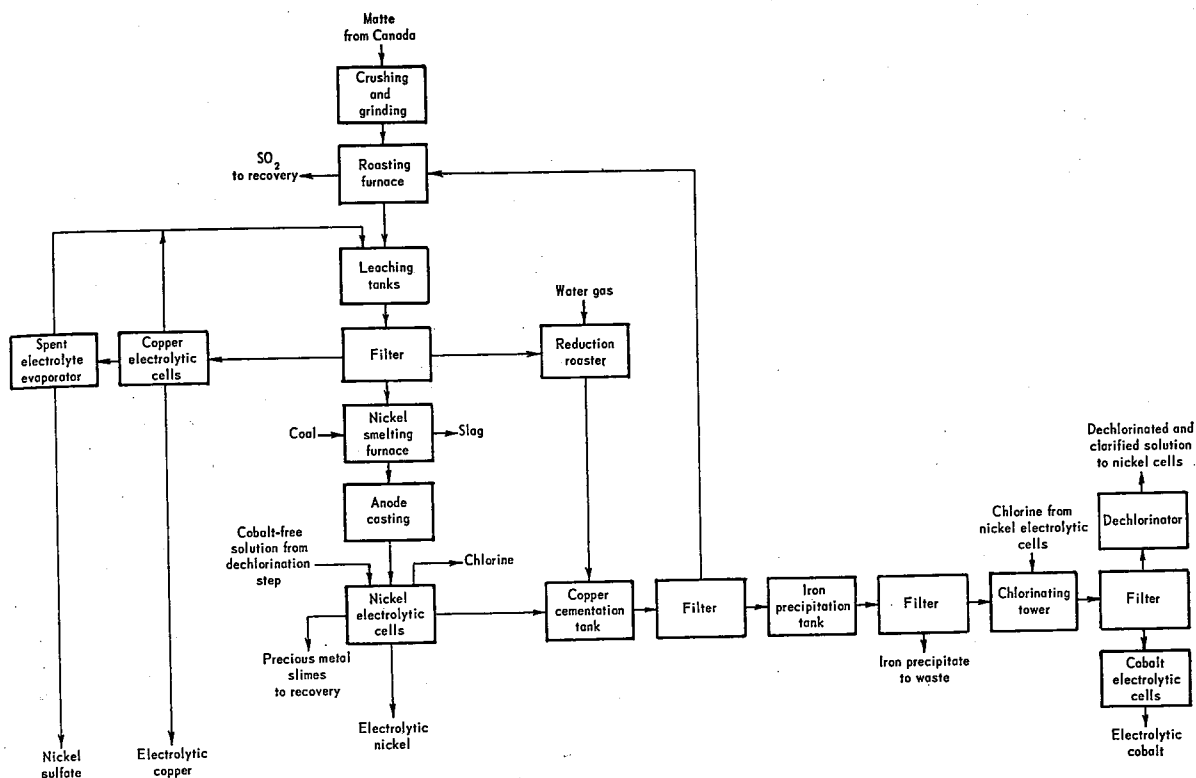


FIGURE 10.—Simplified Flow Diagram of Falconbridge Nikkelverk Aktieselskap Refinery.

Lake plant. This concentrate consists of 35 to 49 percent pentlandite, 3 to 6 chalcopyrite, 1 to 6 pyrite, and 24 to 42 pyrrhotite. In 1960, the average analysis of the concentrates was as follows: 12.11 percent nickel, 0.37 cobalt, 1.56 copper, 37.65 iron, and 31.33 sulfur. The balance consisted of iron and magnesium silicates and water of hydration in gangue minerals. The plant, as originally built in 1954, was to use 235 tons of concentrate per day, but by 1960 the plant was consuming up to 375 tons per day, including custom concentrates. A flow diagram for the plant is shown in figure 11.

Incoming concentrate is screened, and oversize is fed to a pulverizer. The sized concentrate is then stored for further use. From storage, the concentrate goes to a repulp tank where it is made into a slurry by adding water and overflow solution from the final leach thickener. After pulping, the concentrate is fed to two adjustment leach autoclaves operating in parallel. Each autoclave is 11 feet in diameter and 45 feet long, and is divided into four compartments, each equipped with a stirring mechanism and cooling coils. Leaching is carried out at approximately 175° F. and 110 p.s.i.g.

The air and ammonia necessary for the leaching reaction are furnished by the exhaust from the final leach autoclaves. Gas exhausted from the adjustment leach autoclaves is sent to the

ammonia recovery system. Approximately 60 percent of the total leaching is done in the adjustment autoclaves. At the end of the leaching cycle, slurry is sent through coolers where its temperature is reduced to 90° F. After leaving the cooler, the pressure is reduced, and the slurry is sent to the adjustment thickener. Slurry fed to the thickener contains from 20 to 25 percent solids by weight and has a pH of about 10. The solution contains about 55 grams per liter of nickel, copper, and cobalt. Aqueous ammonia and Separan are added to the thickener to assist in settling the slimes.

Underflow from the thickener is sent through a 7-disk Dorr-Oliver filter, and the filtrate is recycled to the thickener. Overflow from the thickener is sent to the copper boil pots. Solids from the adjustment thickener are repulped with solution obtained from a later step in the process and then are fed to the final leach autoclaves, which are similar in construction to the adjustment leach autoclaves and consist of two groups of three autoclaves operating in parallel. The final leach autoclaves operate at about 175° F. and 125 p.s.i.g. Anhydrous ammonia and air are added to each compartment of each autoclave. Slurry from the final leach autoclaves is cooled to 90° F. and sent to the final thickener. At this point, the slurry contains about 20 percent solids and the solution contains

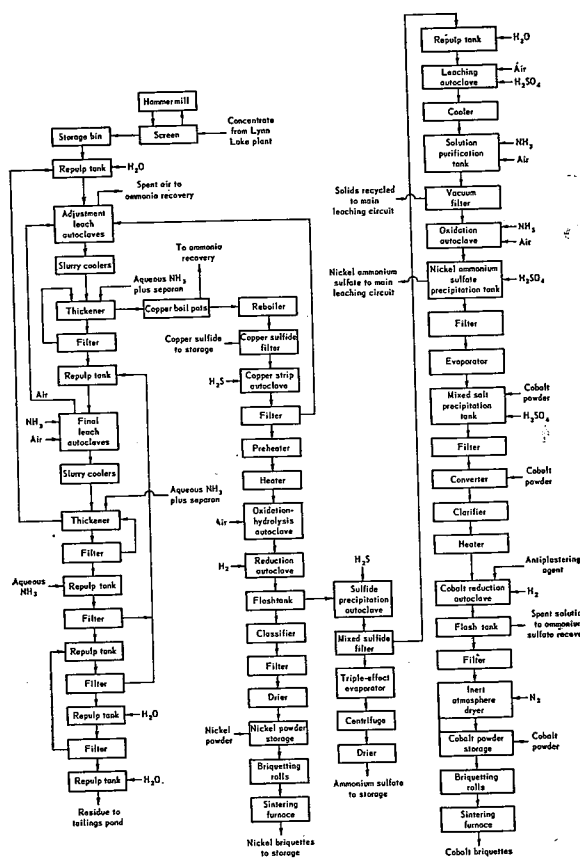


FIGURE 11.—Simplified Flow Diagram of Sherritt Gordon Refinery.

about 25 grams per liter of valuable metals. Aqueous ammonia and Separan are added to the thickener, as was done in the adjustment thickener. Overflow from the final thickener is recycled to the first repulp tank to form the slurry, which is fed to the adjustment autoclaves. Underflow is filtered, the solution is returned to the thickener, and the solids are sent to a repulp tank, where they are reslurried with aqueous ammonia. This process is repeated through a total of four repulp tanks and three filters, with filtrate from each filter being recycled up the system. Slurry from the last repulp tank is piped to the tailings pond.

At this point, all of the metals which can be recovered have been washed from the leached residues and recycled back up the system so that all of the metal values leached from the ore and all of the ammonium sulfate formed in the process go to the copper boil unit. This unit consists of four copper boil pots and a reboil unit, which make up a five-plate distillation column. Agitation is provided in the last two boil pots in the series to keep the copper sulfide precipitate in suspension. Much of the free

ammonia in the solution is removed in this unit and sent to the ammonia recovery system. From the reboiler, the slurry of solution and copper sulfide is filtered to obtain a mixed cuprous and cupric sulfide. In 1960, the mixed sulfides recovered from the system amounted to 18.7 tons per day.

The solution leaving the copper sulfide filter still contains a small amount of residual copper, which is removed in the copper strip autoclave by the addition of hydrogen sulfide. The copper strip autoclave operates at 250° F. at 15 p.s.i.g. Solution leaving the copper strip autoclave contains less than 0.005 grams of copper per liter. Copper sulfide formed in the stripping autoclave is removed by filtration, and the filter cake is recycled to the adjustment leach autoclave.

Filtrate is then sent to what Sherritt Gordon engineers refer to as the oxydrolisis circuit. This step involves heating the solution to 475° F. at 700 p.s.i. and then passing the solution into autoclaves where sufficient retention time is provided to complete the hydrolysis of ammonium sulfamate to ammonium sulfate. Air introduced with the solution before the heat exchangers oxidizes the thionates and thiosulfate to ammonium sulfate. Solution leaving the oxydrolisis autoclave contains 45 grams per liter of nickel and 0.8 gram per liter of cobalt. This solution is fed to the reduction autoclave where over 95 percent of the nickel is precipitated as a metallic nickel powder by the addition of hydrogen. Only about 3 percent of the total cobalt in the solution is reduced along with the nickel, thus providing an effective nickel-cobalt separation. The reduction autoclave is operated at 375° F. and a hydrogen pressure of 450 p.s.i.g.

The production of nickel powder in the reduction autoclave is a batch process. First, the autoclave is charged with a special solution from which nickel nuclei are precipitated by hydrogen. Next, the nuclei are allowed to settle, and the solution is decanted. The autoclave is then filled with the process liquid from the oxydrolisis step. Upon the addition of hydrogen, the nickel in the fresh solution precipitates out on the nuclei provided by the previous reduction step. This process of charging fresh liquor, reducing the nickel, and discharging the spent solution is repeated until the nickel particles have grown to the desired size. Each step in this process is called a densification. When a sufficient number of densification steps have been carried out, the total contents of the reduction autoclave are discharged into a flash tank. Approximately 2 percent of the nickel reduced in the autoclave comes out in the form of a plating on the walls of the autoclave which must be removed before a new cycle is started. This is

accomplished by dissolving the nickel with ammonium sulfate solution and air at 200° F. and a total pressure of 200 p.s.i.g. The nickel solution thus obtained is brought to the proper strength by adding more nickel and is then used to form nuclei for the next reduction cycle. Finished nickel powder is drawn from the flash tank, filtered, dried, and stored. Nickel is then shipped as a powder or as sintered briquettes. In 1960, production of nickel powder amounted to 44 tons per day, including nickel recovered from custom concentrates.

The solution from the flash tank still contains some nickel and over 95 percent of the original cobalt leached from the ore. The metal concentration in the solution at this point amounts to about 1.0 gram per liter each of nickel and cobalt. The solution also contains a large amount of ammonium sulfate. The metals remaining in solution are precipitated in the sulfide precipitation autoclave by reacting with hydrogen sulfide at 155° F. and atmospheric pressure. The metal sulfides thus formed are filtered from the solution and washed with water. The solution is then evaporated to recover ammonium sulfate as fertilizer-grade crystals. In 1960, ammonium sulfate production totaled 350 tons per day.

The washed mixed sulfide cake (including ammonium sulfate made by neutralization of sulfuric acid with ammonia) from the filter contains about 19.9 percent nickel, 19.7 cobalt, 0.2 iron, and 1.3 zinc on a dry basis. This filter cake is repulped with water and sulfuric acid and dissolved in a leaching autoclave at 250° F. and 100 p.s.i.g. Solution leaving the autoclave contains 50 to 60 grams per liter of nickel plus cobalt. After being cooled to 180° F., the mixed nickel-cobalt solution is sent to the solution purification tank, where ferrous salts are oxidized by air, and the pH is raised to about 5 to precipitate all of the iron as hydrated ferric oxide. After clarification, the iron-free solution is oxidized with air at a total pressure of 100 p.s.i.g. and at 165° F. in the presence of a slight excess of free ammonia above the pentammine ratio for both nickel and cobalt. The cobaltous sulfate present forms a soluble cobaltic pentammine sulfate, and the nickel remains in the divalent form as nickel ammine sulfate.

Nickel ammonium sulfate is then precipitated by cooling and acidification with sulfuric acid to a pH of 2.5 to 3.0. The cobaltic pentammine sulfate remains in the solution, which is separated from the crystalline nickel salt by filtration.

A second-stage precipitation is necessary to complete the removal of nickel from solution. The concentration of salts is increased by evaporation, and a small quantity of cobalt powder

is added to reduce part of the cobaltic salt in solution back to the cobaltous state. A small quantity of sulfuric acid must be added at this stage to maintain the pH at about 2.5. Cobaltous ammonium sulfate crystallizes out, carrying with it the remainder of the nickel. The precipitated salts are again separated by filtration. A cobalt-to-nickel ratio of 1,500:1 is attainable in the solution by this two-stage separation.

The nickel-free cobaltic pentammine solution is converted to a cobaltous ammine complex solution by agitation with pure cobalt powder at atmospheric pressure and 180° F.

Solution leaving the conversion step is sent to the cobalt reduction autoclave. This equipment is similar to that used for nickel reduction, and the sequence of operations is the same except that a mixture of sodium sulfide and sodium cyanide is used instead of ferrous sulfate as a nucleation catalyst. The antiplastering agent used in the cobalt reduction autoclave consists of ammoniacal polyacrylic acid solution. Approximately 25 to 30 densifications are necessary to achieve a desired particle size for cobalt powder. The solution remaining after precipitation of cobalt contains approximately 0.8 grams per liter of residual cobalt and 250 grams per liter of ammonium sulfate, and is transferred to the ammonium sulfate recovery plant. Cobalt powder produced is treated in the same manner as nickel powder except for the drying step. Since cobalt powder oxidizes rapidly in contact with air, the drying operation is carried out in an atmosphere of heated nitrogen. In 1960, the capacity of the cobalt section was 1,000 pounds per day of cobalt powder.

Freeport Nickel Company

At the Moa Bay plant, ore mined by draglines was delivered to a 20-inch grizzly, which removed coarse material arising from pinnacles of undecomposed rock extending up into the ore. From the 20-inch grizzly, the ore was fed to a shaking grizzly which removed the plus 5-inch material. At this point water was added at the rate of 5,000 gallons per minute, and the resulting slurry was fed to a log washer to break up lumps and mud balls. Subsequent two-stage screening removed all plus 20-mesh material. The rock and plus 20-mesh material removed in this processing amounted to about 10 percent of the total ore mined, and were discarded because their nickel content was too low. The slurry from the screens, at about 25 percent solids, was delivered to the plant by gravity through a 24-inch concrete pipeline approximately 14,000 feet long.

When the ore arrived at the plant, it was fed to one of two raw ore thickeners, which were

325 feet in diameter. Here the slurry was thickened to about 45 percent solids and fed to the leaching columns at the rate of about 5,500 tons per day, dry basis, or 11,500 tons per day of slurry. Feed slurry was preheated to 180° F. with 15-pound steam generated in the process. From the preheaters it was delivered to slurry heaters where it was heated with high-pressure steam to close to reaction temperature. The ore going to the leaching reactors was split four ways, each quarter of the ore going to a battery of four brick-lined reactors. Each reactor was approximately 55 feet high and 9 feet in internal diameter and weighed 160 tons (exclusive of the brick lining). The reactors were lined with lead, a course of acid brick, and a final course of carbon brick. Each of the four batteries of reactors consisted of four reactors connected in series. The reactors were heated by high-pressure steam and operated at 475° F. and approximately 550 p.s.i. Concentrated sulfuric acid (98 percent) was fed to the first reactor in each series through titanium piping.

In the leaching reactors, approximately 95 percent of the total nickel and cobalt was dissolved as soluble sulfates. Under the leaching conditions in the reactors, the solution of iron was largely repressed, and only small amounts of aluminum, copper, magnesium, zinc, and chromium were converted to sulfates. The material leaving the reactors consisted of about 35 percent inert leach solids, the soluble sulfates, and approximately 25 grams per liter of free sulfuric acid. This slurry was passed through titanium heat exchangers to recover its sensible heat, and the residue then was washed free of all soluble values in six countercurrent washers, each 225 feet in diameter. To neutralize free acid in the solution, treated coral was added in a series of neutralizing tanks. In the neutralizing tanks the pH was raised to about 2.5 to 2.8, and the resulting material was fed to two gypsum thickeners, each 140 feet in diameter. The clear solution from the gypsum thickeners was heated and sent to the precipitation reactor, where 99 percent of the contained nickel and cobalt was precipitated as insoluble sulfides by the addition of hydrogen sulfide under pressure. The resulting mixed cobalt and nickel sulfides were washed, thickened to about 65 percent solids, and stored for shipping.

The Moa Bay plant had its own auxiliary plants on the grounds: A hydrogen plant using liquid petroleum gas as a raw material and capable of producing 1½ million cubic feet of hydrogen per day; a hydrogen sulfide plant, the largest plant of its type ever built, capable of delivering 60 tons of liquid hydrogen sulfide per day; and a sulfuric acid plant which was

one of the ten largest plants in the world and had a capacity of 1,300 tons per day of 98 percent sulfuric acid. Sulfur and liquefied petroleum gas for the plants in Cuba were delivered from Louisiana in a special tanker owned by the Freeport Nickel Company. The tanker was a converted Liberty ship and had a capacity of 5,800 tons of molten sulfur, plus 140 tons of liquid petroleum gas, which was carried in cylindrical tanks on the deck. On the run from Cuba to Louisiana the tanker carried about 2,500 tons of nickel-cobalt slurry, contained in eight rubber-lined slurry tanks, approximately 18 feet deep. Each tank was equipped with an agitating device which allowed the concentrate to be slurried for pumping from the vessel to storage tanks in the Port Nickel, La., refinery. A flowsheet of the process is shown in figure 12.

At the Port Nickel refinery, mixed sulfide slurry from the tanker was pumped to a battery of 16 wooden storage tanks. The battery was equipped with movable agitators which could be used to stir any tank when feeding sulfide slurry to the process. From the storage tanks, slurry was pumped to sulfide oxidation autoclaves where the insoluble sulfides were converted to soluble sulfates by the action of sulfuric acid and air. The oxidation autoclaves were operated at 750 p.s.i. and approximately 375° F. Solution leaving the autoclaves was brought to a pH of 2.5 with ammonia and then fed to a thickener, where the unreacted sulfides were separated and recycled to the oxidation autoclaves. Overflow from the thickener was sent to a series of precipitation tanks, where iron, aluminum, and chromium were precipitated by adjusting the pH to 5.5 with ammonia, and agitation with 15-p.s.i. air. Material leaving the precipitation tanks was fed to a pressure filter to remove insoluble material. The filter cake from this operation contained some nickel and cobalt, which was recovered by redissolving the filter cake in sulfuric acid and refiltering. Filtrate was sent to a second series of iron-aluminum precipitation tanks, where ammonia and air were again added. Insoluble residue from the first filter was sent to the oxidation autoclaves. The filtrate from the second set of precipitation tanks was sent back to the first set of precipitation tanks. The filter cake from the second filter was sent to waste. Filtrate from the first pressure filter was adjusted to a pH of 1.5, and copper, lead, and part of the zinc in solution were removed by passing the solution together with hydrogen sulfide through the primary scavenging pipeline reactor. Precipitate which resulted from this operation was removed by filtration, and the filter cake, which contained mainly copper sulfide with small amounts of lead and zinc sulfides, was sent

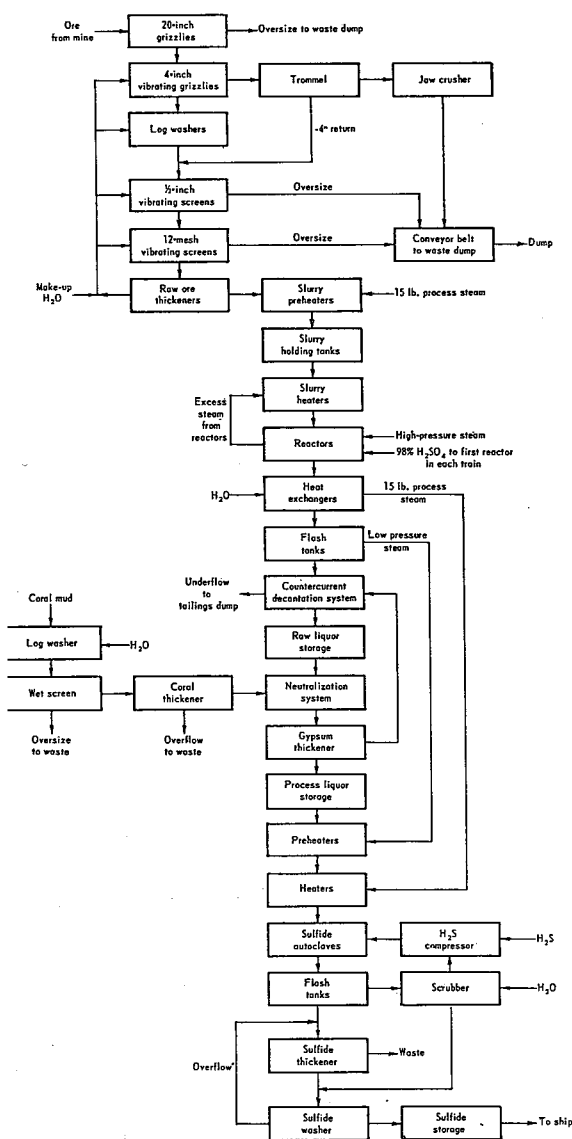


FIGURE 12.—Simplified Flow Diagram of Freeport Moa Bay Plant.

storage. This material was generated at the rate of approximately 1,800 pounds per day during capacity operation, but no plans had been made for recovering the copper contained in it. Filtrate was then heated by steam and fed to a series of insulated holding tanks where it was stored for further treatment.

From the holding tanks, solution was fed to one of six nickel-reduction autoclaves, where about 95 percent of the nickel was precipitated as nickel powder by introduction of hydrogen under pressure. The nickel reduction autoclaves operated at 600 p.s.i. and 350° F. The nickel precipitated in this step contained only about 0.3 to 0.4 percent cobalt (if lower cobalt

content was desired, it could be obtained by finishing the precipitation at a slightly higher pH, in which case the amount of nickel precipitated was somewhat less). Ammonia was fed to the autoclaves along with the hydrogen to maintain the pH at the proper level. The first step in the reduction involved the use of a catalyst to precipitate nickel as a very fine seed material. Nickel from succeeding charges of pregnant solution was precipitated on the nickel seed which remained in the autoclaves. The spent solution, containing nearly all the original cobalt and about 5 percent of the original nickel, was drained off, leaving nickel powder in the autoclaves, and fresh pregnant solution was again added. Each densification deposited more nickel on the original particles of seed nickel until the powder reached the desired mesh size (normally about 10 densifications).

When the nickel powder reached the proper size it was drawn off into flash tanks, where it was separated from the spent solution by gravity, and fed into a washer, where any remaining spent solution was removed. Overflow leaving the washer went through a magnetic separator to recover nickel fines which were recycled to one of the reduction autoclaves. Nickel powder went to a filter, where most of the water was removed, and then to a kiln-type dryer, where the powder was completely dried. From the dryer, nickel powder was removed for storage as powder or sent to a briquetting machine, where a binder was added and the nickel was made into small pillow-shaped briquettes. The briquettes directly from the machine were too weak to withstand shipping, and were sintered to increase their mechanical strength. Nickel briquettes discharged from the sintering furnace were sent to storage.

Spent solution from the flash tanks, which still contained nearly all the original cobalt and about 5 percent of the original nickel, was sent to the double-salt evaporator-crystalizers, where water was removed and a mixed nickel-cobalt ammonium sulfate crystallized out. The mother liquor was removed from the double-salt crystals in a centrifuge, and then the crystals were redissolved by the addition of water and ammonia. In this process the cobalt was converted to cobaltous pentammine, which was further oxidized to cobaltic pentammine by the addition of air in the pentammine oxidation autoclave. The pentammine oxidation autoclave operated at 500 p.s.i. and 150° F. Sulfuric acid was added to adjust the pH, and nickel and zinc precipitated as a mixed nickel-zinc ammonium sulfate from the pentammine liquor in the mixed salt crystalizers. The mixed salt was removed from the cobalt-bearing

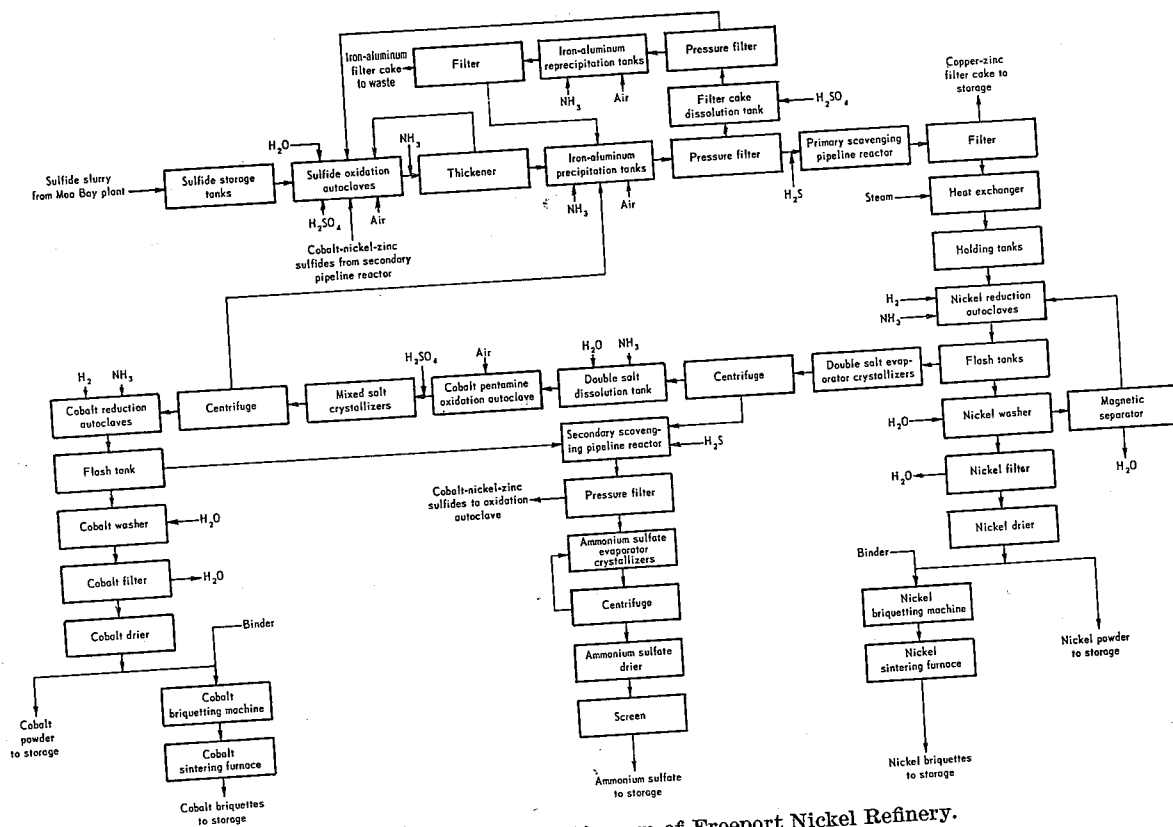


FIGURE 13.—Simplified Flow Diagram of Freeport Nickel Refinery.

ing liquor in a centrifuge, and the crystals were sent to the iron removal step. Filtrate was sent to one of two cobalt reduction autoclaves. The cobalt reduction autoclaves were similar to the nickel autoclaves and operated at approximately the same temperature and pressure. Cobalt powder produced in the autoclaves was separated from the spent liquor in a flash tank, washed, filtered, dried, and briquetted or stored as powder.

Spent solution from the flash tank together with the solution from the double-salt centrifuge was sent to the secondary scavenging pipeline reactor, where hydrogen sulfide was added, and cobalt, nickel, and zinc sulfides were precipitated. These were removed in a pressure filter and recycled to the sulfide-oxidation autoclaves. The filtrate was sent to ammonium sulfate crystallizers, where ammonium sulfate was recovered for use as fertilizer. A flowsheet for the process is given in figure 13.

Calera Cobalt Refinery

The Calera refinery had a rather short life, with operations commencing in 1953 and terminating in 1959. During that time, however, a number of improvements were made in the

process, and at the time of the shutdown, operations were running fairly smoothly. An idea of the changes made in the process can be gained by comparing figure 14, a flow diagram of the early process, with figure 15, a flow diagram of the process used at the time of shutdown.

The operation of the most recent process may be briefly described as follows: Concentrate from the mill, which contained cobalt, about 11 percent; nickel, 1; iron, 20; arsenic, 22; sulfur 25; and copper from $\frac{1}{2}$ to 5, was slurried with wash water to about 25 percent solids. The slurried concentrate was fed to the first compartment of the six-compartment acid-oxidation autoclave. The autoclave was a carbon steel shell, 6 feet in diameter and 40 feet long clad on the inside with type 316 stainless steel $\frac{3}{16}$ inch thick and lined with 12-pound lead brick. The autoclave was divided into six equal compartments by acidproof brick walls, which had openings at the top to allow material overflow from one compartment to another. Each compartment contained an agitator mechanism and an arrangement for sparging high pressure air. The autoclave was operated about 400° F. and 600 p.s.i.

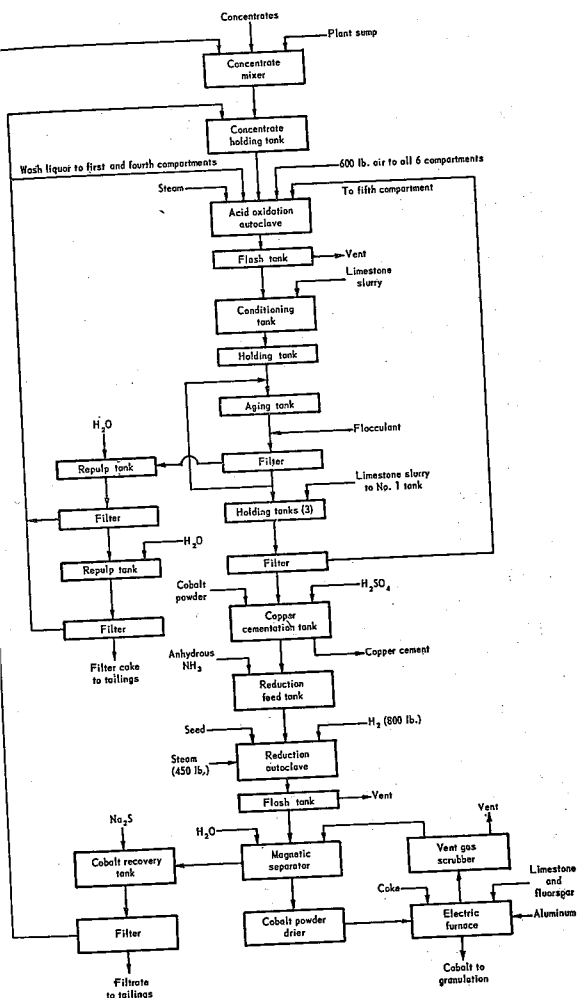


FIGURE 14.—Simplified Flow Diagram of Original Calera Cobalt Refining Process.

Concentrate was sent to the first compartment. The exothermic reaction between pyrite, oxygen, and water produced sulfuric acid, which converted the metals in the concentrate to sulfates and also produced enough heat to maintain the optimum leaching temperature. Residue from the lime-purification system was added to the fifth compartment and reacted with most of the excess sulfuric acid. Excess gas from the autoclave, consisting of oxygen-deficient air and steam, was exhausted to the atmosphere through scrubber towers. Oxygen utilization from the air introduced to the reactor was approximately 60 percent. From 95 to 97 percent of the cobalt was solubilized in the autoclave. The acid slurry discharged from the oxidation autoclave was neutralized by the addition of limestone, with care being taken to prevent precipitation of cobalt as the hydroxide. The leach residue was removed from the cobalt-bearing solution by filtration. Traces of solu-

ble cobalt in the residue were recovered by repulping and additional filtration.

Copper was removed from the filtrate by cementation on cobalt granules in a rotary copper reactor which consisted of a rotating drum, 6 feet in diameter and 8 feet long, lined with acidproof brick. The copper-free solution was then sent to the lime-purification circuit, where iron was removed by addition of limestone followed by oxidation with compressed air. Almost all the arsenic was also removed in this step. The precipitated iron and arsenic were removed by filtration, and the clarified solution was sent through the solvent-extraction column. The iron filter cake contained from 5 to 10 percent of the original cobalt, and this was recovered by returning it to the acid-oxidation autoclave. The solvent-extraction column was a relatively new piece of equipment which was added when the plant shifted from production of metal by hydrogen reduction to production by electrolysis. The solvent-extraction step was found necessary to remove certain organic substances which interfered with electrolysis. The column was a rotating-disk type, 18 inches in inside diameter and 16 feet long. Stripping was carried out by benzene which was regenerated by distillation.

The purified solution from the solvent-extraction column was then sent to the paste-precipitation tank, where cobalt was precipitated as cobalt hydroxide by addition of limestone

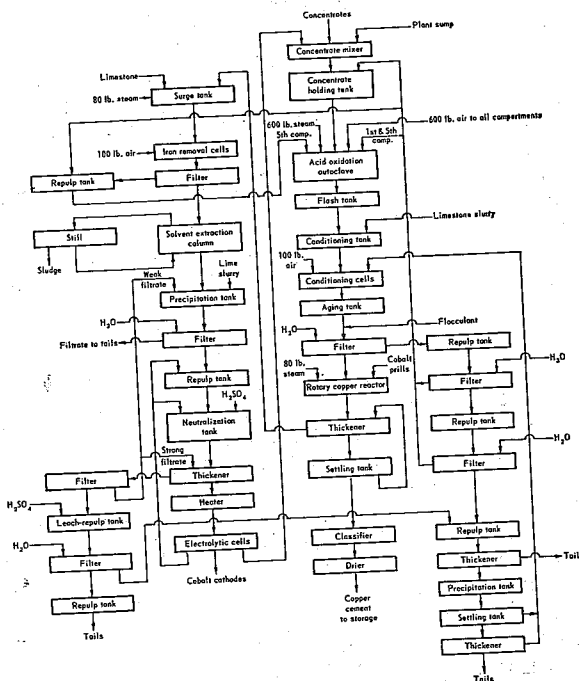


FIGURE 15.—Simplified Flow Diagram of Calera Cobalt Refining Process in Use at Shutdown of Plant.

slurry. The hydroxide precipitate was removed by filtration and repulped in enough spent electrolyte to produce a cobaltous hydroxide suspension. The slurry from the repulp tank was used to neutralize spent electrolyte from the cells and to replenish its cobalt content. The gypsum formed during the neutralization step was removed by thickening followed by filtration. The thickener overflow was fed to the electrolytic cells for production of cobalt cathodes. The nickel in the ore stayed with cobalt throughout, except for a limited amount which was removed from the system in the final neutralization step by precipitation with the gypsum. Therefore, the final electrolytic product contained over 1 percent nickel.

National Lead

At the Fredericktown Metals Refinery of the St. Louis Smelting and Refining Division of National Lead Co., Fredericktown, Mo., cobalt is produced by the method developed by the Chemical Construction Corp. The process is basically the same as the one originally used at the Calera refinery, although some of the details are different.

Partially roasted nickel-cobalt concentrate from the mill is made into a slurry and pumped to the refinery. It is thickened and blended to the proper composition and pulp density and is fed to one of two oxidation autoclaves. The autoclaves have three compartments and are brick lined. Each compartment is furnished with steam and air lines and agitation equipment. All parts coming into contact with the slurry are made of titanium. The autoclaves operate at about 450° F. and 650 p.s.i.g. air pressure.

The nickel, cobalt, and copper in the concentrate are converted into sulfates in the autoclaves, but the iron, which was converted to iron oxide during the partial roast, does not react. After the leached slurry is discharged from the autoclave, the iron and other insoluble materials are filtered out and discarded. The pregnant solution is sent to a second autoclave, where most of the copper is precipitated as metallic powder by treatment with hydrogen. The copper reduction autoclave operates at 325° F. and 625 p.s.i.g. hydrogen pressure. Copper powder is removed from the nickel-cobalt solution in a settling box, and the solution is then treated with iron powder to cement out the remaining copper.

The relatively small amount of iron which went into solution in the oxidation autoclave is then removed by the conventional method of adjusting the pH with limestone and treating with air. The precipitated iron hydroxide is removed by filtration and recycled to the begin-

ning of the process to recover the coprecipitated nickel and cobalt. At this point in the process the solution is quite dilute, and in order to concentrate the metal values it is fed to a double-effect evaporator where sufficient water is removed to bring the solution to just above the solubility limit of the dissolved metal compounds. The solution is then almost iron-free, but still contains a trace of copper, which is removed by adding cobalt powder to the concentrated solution leaving the evaporator. The resulting copper cement and the gypsum precipitated during the evaporation are removed by filtration and recycled to the beginning of the process.

The solution now contains only cobalt and nickel. By an autoclave treatment with ammonia and ammonium sulfate and air, the cobalt is converted to cobaltic pentammine sulfate. The pentammine-oxidation autoclave operates at 160° F. and 370 p.s.i.g. air pressure. Nickel does not form a stable ammine, and the addition of sulfuric acid to the oxidized solution precipitates the nickel as nickel ammonium sulfate, while the bulk of the cobalt stays in the solution as the pentammine. The crystals of nickel ammonium sulfate are separated from the solution in a centrifuge and dissolved in an ammonia-water solution. The cobalt solution contains about 1 part of nickel to 300 parts of cobalt; the nickel solution contains about 1 part of cobalt to 15 parts of nickel.

The cobalt and nickel are recovered separately from solution by reduction with hydrogen in autoclaves operated at about 425° F. and 600 p.s.i.g. hydrogen pressure. The standard procedure of precipitation of nuclei followed by repeated densification steps is used. The spent solutions from both the cobalt- and nickel-reduction autoclaves contain ammonium sulfate which is recovered by concentration and crystallization. The solution from the nickel-reduction autoclave also contains cobalt, which is recovered. A flow diagram of the process is given in figure 16.

Fabrication

Very little cobalt is used in the pure metallic state. Almost all the metal used goes into the manufacture of alloys, primarily magnet and high-temperature alloys.

MAGNETS

Most of the cobalt used for magnet manufacture is consumed in the production of alloys of the Alnico type. Since these alloys are extremely brittle, many of the standard metal fabrication techniques cannot be used with them. Nearly all Alnico magnets are made by casting

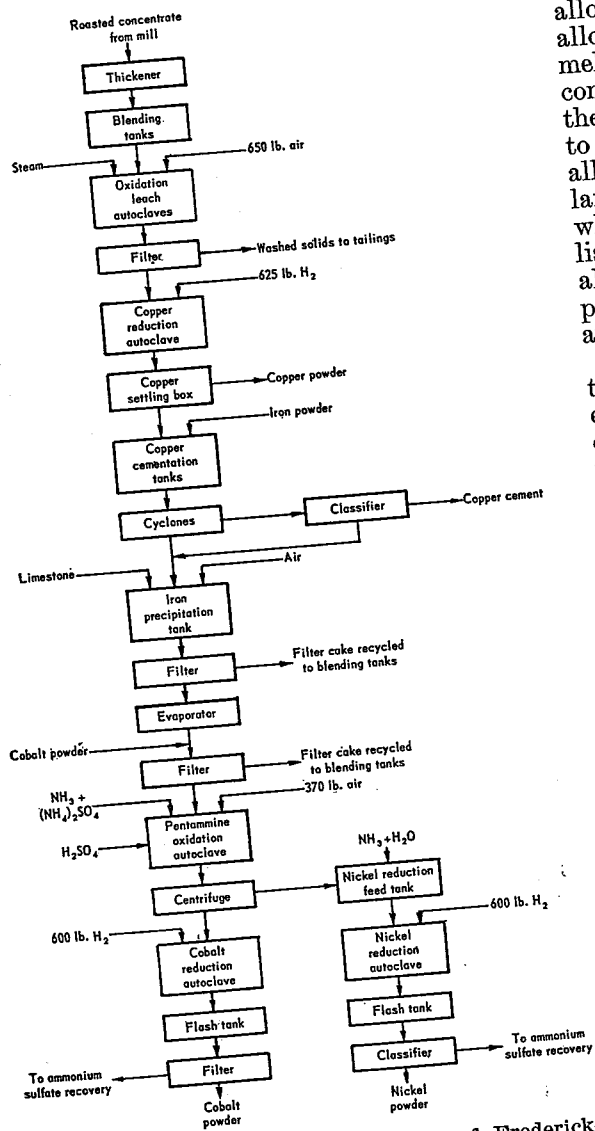


FIGURE 16.—Simplified Flow Diagram of Fredericktown Metals Refinery.

in sand or shell molds and are finished by grinding, when necessary. Small magnets are usually made by powder metallurgical techniques, since it is difficult to cast small shapes in Alnico. Alnico alloys cannot be drilled by normal methods; all holes in the magnet required for the insertion of shafts and for mounting or other purposes must be provided by inserting cores in the mold.

HIGH-TEMPERATURE ALLOYS

High-temperature alloys are usually prepared by vacuum melting, using high-purity

metals. Although most of the cobalt-base alloys and some of the other high-temperature alloy compositions are still prepared by air melting, the vacuum-melting processes are becoming more common. The major reasons for the use of vacuum-melting techniques are (1) to lower gas content, (2) to obtain cleaner alloys, free from porosity, segregation, and large inclusions, and (3) to produce alloys which cannot be made by air melting. The last listed alloys contain appreciable amounts of aluminum or titanium. The vacuum-melting processes in common use are induction melting and consumable-electrode electric-arc remelting.

Vacuum-induction melting is carried out in the same manner as ordinary induction melting except that the furnace and ingot molds are enclosed in an evacuated shell. In the larger furnaces, provision is often made to allow charging of the furnace and removal of the ingots without destroying the vacuum in the main shell. In consumable-arc remelting, a cast or forged ingot of air-melted alloy is used as the positive electrode and a water-cooled copper mold as the negative electrode in a low-voltage, high-ampere arc.

For the production of alloys of extremely high quality, the consumable electrode may be cast or forged from vacuum-induction-melted material. This procedure (double-vacuum melting) yields alloys of very low gas and impurity content. Another double-melting procedure in limited use consists of recycling an ingot formed by consumable-electrode vacuum melting through a second remelting by the same process.

Many of the high-temperature alloys are forgeable, and these may be fabricated by rolling or forging, using techniques developed for the particular alloy in question. Machining of these alloys is usually accomplished by means of carbide tools. Welding is normally done by inert-gas methods, such as the Heliarc process.

A number of the high-temperature alloys are not forgeable, and must be cast. Casting of small parts, such as turbine blades, is carried out by the investment casting process. The castings produced by this method are clean and dimensionally accurate, and need only light grinding for the production of a finished item.

OTHER ALLOYS

Most of the other cobalt alloys are fabricated by standard melting and normal fabricating procedures. A new technique is the development by Sherritt Gordon of a process to produce cobalt strip, rod, and wire directly from powder.

CHAPTER 6. SUPPLY AND DISTRIBUTION

World Production

Table 13 gives details of mine production of cobalt by the major free-world cobalt producers since 1901. In addition to the countries listed in table 13, the following countries have produced in the past or are still producing small quantities of cobalt-bearing ore, concentrates, speiss, or residues: Australia, Austria, Bolivia, British West Africa, Burma, Chile, Finland, Germany, Italy, Jamaica, Japan, Mexico, Spain, Sweden, and Union of South Africa. Figure 17 shows the output of the major producers and the world total (estimated) in graphic form.

As can be seen from figure 17, Katanga has been the source of most of the world's supply of cobalt for many years. The Union Minière du Haut-Katanga, the sole producer in Katanga, started mining its concessions for copper in 1911, and for the first few years much of its output of crude copper was shipped to Germany for refining (5). The crude copper contained 2.8 to 3.25 percent cobalt, much of which was recovered by the Germans. In 1921, Union Minière announced plans to start mining cobalt-rich copper deposits with the intention of producing cobalt, and in 1924 production began. By 1926 Union Minière had become the leading cobalt producer, a position which it has held

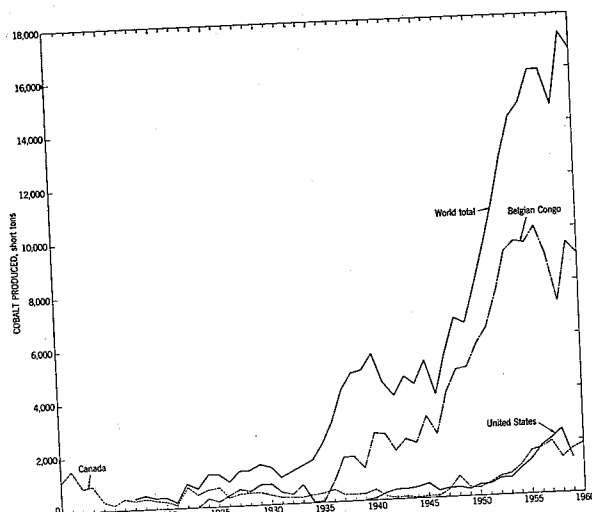


FIGURE 17.—World Production of Cobalt, 1910-60.

ever since (except for 2 years in the middle 1930's).

SECONDARY PRODUCTION

The production of cobalt from secondary sources is not as large in proportion to the primary production as is normal with many other metals. The major use for cobalt is as a constituent in alloys which are often of an exceedingly complex nature. Recovery of cobalt from such alloys is difficult; consequently, cobalt recovered from scrap does not constitute a major item of supply. Cobalt consumed in nonmetallic uses such as pigments, driers, and frit is not recoverable.

High-temperature alloys, which use about one-third of the total cobalt consumed, have relatively short service lives in many applications such as in turbine blades and other jet engine parts, and a large volume of scrap comes from these sources. Sporadic attempts have been made in the United States to recover cobalt from high-temperature alloy scrap, but none has resulted in a continuing commercial operation.

PLANT PRODUCTION

Data are not available for world production of cobalt products. Data for U.S. production are tabulated in table 14 and shown in graphic form in figure 18. A list of all U.S. refiners or processors of cobalt is given in table 15.

Metal

Cobalt metal is produced in only a small number of plants in the free world. Table 16 gives a list of the major plants which produce metal from primary sources and the form in which the metal is produced.

Oxides

Although cobalt, like iron, has three stable oxides, only two are widely used commercially. Cobaltous oxide, CoO , is the principal constituent of commercial gray oxide. Pure CoO contains 78.65 percent cobalt, but the commercial product normally contains only 75 to 76 percent.

SUPPLY AND DISTRIBUTION

65

TABLE 13.—*Mine production of major cobalt-producing countries, 1901-60, in short tons of contained cobalt*

Year	Belgian Congo	Canada	Morocco	New Caledonia	Northern Rhodesia	United States	World total (estimate)
1901				1 190		(2)	200
1902				1 565		(2)	600
1903				1 600		(2)	700
1904		(2)		1 520			600
1905		118		1 335			500
1906		321		1 145			500
1907		739		1 210		(2)	1 000
1908		1 224		1 130		(2)	1 500
1909		1 533		1 30		(2)	1 600
1910		1 098		1 3		(2)	1 100
1911		852					900
1912		934					950
1913		821					900
1914		351		24			400
1915		206		9			400
1916		400		19			250
1917		337		7			450
1918		380		3			400
1919		298		(3)		(2)	500
1920		238		(3)		35	400
1921		126		7		(2)	400
1922		776		3		2	200
1923		476					900
1924	301	640		(3)			700
1925	222	733					1 200
1926	397	332					1 200
1927	615	440					1 300
1928	496	477					1 300
1929	771	465					1 500
1930	771	347					1 400
1931	408	261				(3)	1 000
1932	369	245					1 200
1933	681	233					1 400
1934	19	297		74	18	1	1 600
1935	755	341		196	509	1	2 200
1936	1 655	444		491	586	1	3 000
1937	1 689	254		410	523	1	3 000
1938	1 190	230		642	637	2	4 200
1939	1 536	366		794	1 183	1	4 800
1940	2 487	397		750	1 761	1	4 900
1941	1 825	132		364	1 348	67	5 500
1942	2 272	42		72	717	253	4 400
1943	2 069	88		3	1 008	368	3 800
1944	3 086	18		238	1 040	366	4 600
1945	3 370	55		110	1 078	414	4 300
1946	3 927	289		220	963	550	5 200
1947	4 764	38		408	609	259	3 800
1948	4 853	773		306	463	323	5 750
1949	5 695	310		230	405	344	6 800
1950	6 300	292		463	739	261	7 900
1951	7 530	476		102	747	405	9 300
1952	9 125	711	1	661	645	451	10 900
1953	9 443	801		811	746	629	12 500
1954	10 019	1 126		834	871	998	14 400
1955	8 945	1 758		710	1 205	305	14 700
1956	7 166	1 961		500	1 583	2 072	15 900
1957	9 294	1 355		1 330	2 270	2 422	16 600
1958	8 083	1 665		1 401	2 036	1 497	17 300
1959						(4)	16 700
1960							

¹ Estimated.² Not available.³ Less than 1 ton.⁴ Omitted to avoid revealing company confidential data.

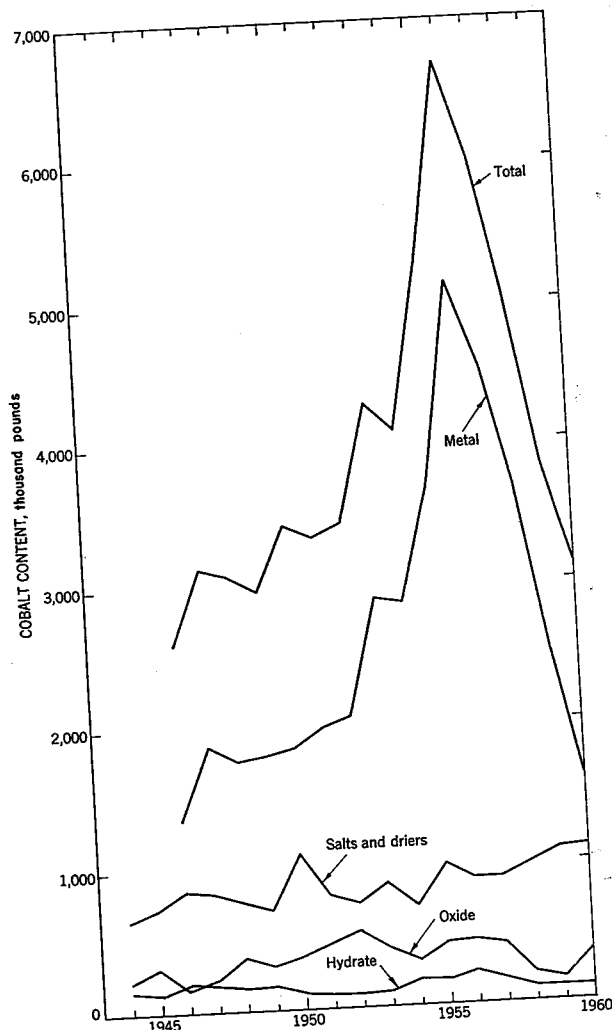


FIGURE 18.—Cobalt Products Produced by Refiners and Processors in the United States, 1944-60.

The black cobalt oxide of commerce is composed mainly of cobaltous oxide, Co_3O_4 . Pure Co_3O_4 contains 73.43 percent cobalt, but the commercial product usually contains slightly less.

Union Minière du Haut-Katanga has the following grades of oxide on its sales list of cobalt products:

	Percent cobalt
Black cobalt oxide.....	71
Black cobalt oxide.....	72.5-73.5
Grey cobalt oxide.....	75-76
Hydrated oxide.....	60-61

Salts

The cobalt salts of commerce are all in the cobaltous state. Only five salts are widely used. These are listed below together with their theoretical cobalt contents:

	Percent cobalt
Cobalt acetate, $\text{Co}(\text{C}_2\text{H}_3\text{O}_2)_2 \cdot 4\text{H}_2\text{O}$	23.66
Cobalt carbonate, CoCO_3	49.55
Cobalt chloride, $\text{CoCl}_2 \cdot 6\text{H}_2\text{O}$	24.77
Cobalt nitrate, $\text{Co}(\text{NO}_3)_2 \cdot 6\text{H}_2\text{O}$	20.25
Cobalt sulfate, $\text{CoSO}_4 \cdot 7\text{H}_2\text{O}$	20.97

Union Minière lists its commercial salts as follows:

	Percent cobalt
Cobalt acetate.....	23-24
Cobalt carbonate.....	45-47
Cobalt chloride.....	24-25
Cobalt nitrate.....	20-21
Cobalt sulfate.....	21

A wide variety of cobaltous and cobaltic salts is manufactured for use in the chemical laboratory, but the quantity is negligible compared to that of the commercial salts.

Consumption

Data are lacking on consumption of cobalt in countries other than the United States. It is known, however, that since 1947 the United States has taken more than one-half of the free-world production of cobalt for stockpiling and consumption. Data on total consumption of cobalt within the United States have been collected by the Federal Bureau of Mines since 1943. These data are presented in tables 17 and 18. Data on consumption of cobalt materials by refiners and processors within the United States have been compiled by the Federal Bureau of Mines since 1945. These data are presented in table 19.

World Trade

IMPORTS AND EXPORTS

Imports of cobalt and cobalt-bearing materials into the United States since 1901 are given in table 20. Corresponding figures for earlier years are not available. A graph showing estimated total cobalt content of imports over the same period is given in figure 19.

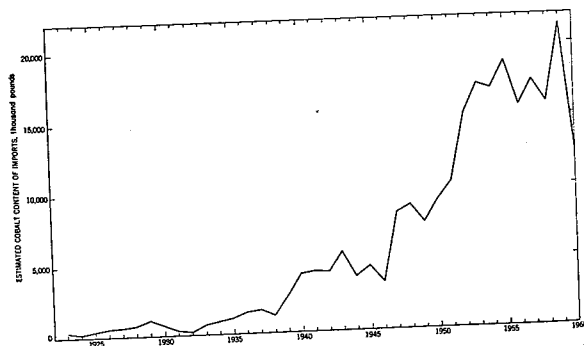


FIGURE 19.—Cobalt Imported for Consumption in the United States.

TABLE 14.—Cobalt products produced by refiners and processors in the United States, 1944-60, in thousands of pounds

TABLE 14.—Cobalt products produced by refiners and processors in the U. S.																		
Year	Metal, gross weight	Oxide		Hydrate		Salts								Driers		Total salts and driers		Total cobalt content
		Gross weight	Cobalt content	Gross weight	Cobalt content	Acetate		Carbonate		Sulfate		Other		Gross weight	Cobalt content	Gross weight	Cobalt content	
						Gross weight	Cobalt content	Gross weight	Cobalt content	Gross weight	Cobalt content	Gross weight	Cobalt content					
1944.....	(1)	365	226	417	155	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	8,634	653	2,598
1945.....	(1)	451	317	329	126	209	49	126	59	243	50	26	6	11,530	693	10,535	729	3,128
1946.....	1,385	229	169	480	197	191	45	165	77	489	101	64	15	9,702	598	12,131	837	3,083
1947.....	1,881	325	229	461	182	165	39	117	63	386	80	31	8	9,870	591	10,701	771	2,978
1948.....	1,772	547	386	399	184	159	37	135	62	497	178	25	6	8,301	490	10,569	699	3,427
1949.....	1,801	439	311	410	167	199	47	206	95	840	144	48	11	12,473	767	13,765	1,098	3,450
1950.....	1,850	523	371	262	108	198	47	206	69	675	144	123	28	8,740	542	9,778	594	3,438
1951.....	1,990	637	458	242	98	87	21	163	59	609	128	197	44	9,925	481	8,969	738	4,200
1952.....	2,065	746	539	245	109	110	26	128	79	638	139	246	55	9,140	568	10,348	699	4,080
1953.....	2,887	579	416	239	133	153	37	171	83	638	135	179	40	6,791	588	7,914	1,007	5,271
1954.....	2,870	490	328	347	183	128	30	178	93	676	144	314	68	9,792	550	10,816	885	6,678
1955.....	3,655	610	439	323	170	74	17	381	190	638	134	247	54	9,645	550	11,559	959	6,909
1956.....	5,123	628	448	422	222	57	13	299	146	568	100	263	62	10,552	617	12,402	982	6,002
1957.....	4,515	595	425	323	172	64	15	214	101	479	107	262	54	11,262	649	14,664	1,163	3,833
1958.....	3,702	292	202	227	116	112	26	297	138	466	125	176	46	13,361	768	13,589	1,096	3,114
1959.....	2,477	233	163	200	114	115	27	246	113	561	95	242	60	12,333	711			
1960.....	1,549	517	362	189	107	241	57	372	173	401								

1 Not available.

TABLE 15.—*Refiners or processors of cobalt in the United States in 1960*

Refiner or processor	Location of plant	Cobalt product ¹ made	Cobalt raw material ¹ used
Allied Chemical Corp., General Chemical Division	Marcus Hook, Pa.	B, D	A
Baker Chemical Co., J. T.	Phillipsburgh, N.J.	B, D	A
Carlisle Chemical Works, Inc.	Reading, Ohio	E	A, D
Carlisle Chemical Works, Inc., Advance Solvents and Chemical Division	New Brunswick, N.J.	E	A, D
Ceramic Color & Chemical Manufacturing Co.	New Brighton, Pa.	C, D	A
Chase Chemical Corp.	Pittsburgh, Pa.	E	C
Ferro Chemical Corp.	Bedford, Ohio	C, D, E	A, C
Hall Chemical Co.	Wickliffe, Ohio	B, C, D	A, G
Harshaw Chemical Co.	Cleveland, Ohio	C, D, E	A
Mallinckrodt Chemical Works	Gloucester, N.J.	D	A, D
McGean Chemical Co.	St. Louis, Mo.	C, D, E	A
Metallurgical Resources, Inc.	Cleveland, Ohio		A, F
Mooney Chemicals, Inc.	Newburgh, N.Y.	E	A
National Lead Co.	Cleveland, Ohio	A	F
Nuodex Products, Co., Inc.	Fredericktown, Mo.	E	A, C
	Elizabeth, N.J.	E	
	Long Beach, Calif.	E	F
	Wilmington, Del.	A, B, C	A, C, D, G
	Cincinnati, Ohio	D, E	
	Chicago, Ill.	E	A, C
	Richmond, Calif.	E	A
	Bensenville, Ill.	C, D, E	A, C
	Newark, N.J.	E	A
	Canonsburg, Pa.	B, C, D	G
	Myerstown, Pa.	D	A, C
	Chicago, Ill.	C, E	A

¹ Code: A, metal; B, oxide; C, hydrate; D, salts; E, driers; F, concentrate; G, scrap.

TABLE 16.—*Major primary plants producing cobalt metal*

Company	Plant location	Types of metal produced	Notes
Calera Mining Co.	Garfield, Utah	Powder, briquettes, broken cathodes.	Permanently closed in 1960.
Deloro Smelting and Refining Co. Ltd.	Deloro, Ontario		To be closed early in 1961.
Falconbridge Mines Ltd.	Kristiansand S., Norway	Broken cathodes	Produced from matte made in Canada.
Freeport Nickel Co.	Port Nickel, La.	Powder, briquettes	Closed early in 1960 due to inability to get concentrate from Cuba.
International Nickel Co. of Canada, Ltd.	Port Colborne, Canada	Electrolytic squares	
Mond Nickel Company	Clydach, Wales		Produced from crude oxide made in Canada.
National Lead Co.	Fredericktown, Mo.	Powder, briquettes	To be closed in 1961.
Pyrites Co.	Wilmington, Del.		
Sheritt Gordon Mines, Ltd.	Fort Saskatchewan, Canada	Powder, briquettes	Produced from Moroccan concentrate.
Société d'Électro-Chimie, d'Électrometallurgie et des Acières Électriques d'Ugine.	Pomblière St. Marcel, France		
Société Générale Métallurgique de Hoboken.	Olen, Belgium	Rondelles, powder	Produced from white alloy from Katanga.
Union Minière du Haut-Katanga.	Jadotville-Shituru Plant, Katanga	Granules	
Union Minière du Haut-Katanga.	Luilu Plant, Katanga	Electrolytic	New plant—did not produce in 1960.

TABLE 17.—Cobalt consumed in the United States, 1943-60, by forms, in thousands of pounds of contained cobalt

Year	Metal	Oxide	Cobalt-nickel compound	Ore and alloy	Purchased scrap	Salts and driers	Total
1943	3,570	137	46	118	44	(1)	3,915
1944	3,598	223	48	74	46	(1)	3,989
1945	3,231	353	67	29	31	(1)	3,711
1946	2,599	511	94	8	8	885	4,105
1947	2,542	794	14	2	5	797	4,154
1948	3,322	850	9	8	20	818	5,019
1949	3,311	607	4	—	15	765	4,702
1950	6,087	681	3	(2)	126	1,102	8,283
1951	7,535	681	2	3	894	818	9,933
1952	8,328	418	—	3	1,368	701	10,818
1953	7,727	524	—	2	1,542	953	10,748
1954	5,120	588	—	(2)	514	853	7,350
1955	7,226	906	—	(2)	395	1,094	9,562
1956	7,321	857	—	—	363	989	9,740
1957	7,028	755	—	—	355	1,030	9,157
1958	5,403	754	—	—	261	1,131	7,542
1959	7,630	877	—	—	204	1,172	9,899
1960	6,761	757	—	—	—	—	8,930

¹ Data not available. ² Less than 500 pounds.

TABLE 18.—Cobalt consumed in the United States, 1943-60, by uses, in thousands of pounds of contained cobalt

	1943	1944	1945	1946	1947	1948	1949	1950	1951
Metallic:									
High-speed steel	400	361	335	224	223	289	283	235	316
Other steel	30	37	26	202	88	133	133	253	80
Permanent-magnet alloys	1,032	1,322	1,106	1,463	1,016	1,353	1,195	2,834	2,052
Soft-magnetic alloys								38	59
Cutting and wear-resisting alloys	12,041	11,758	11,617	527	941	1,197	1,238	2,226	4,899
High-temperature alloys								83	260
Hard-facing rods and materials	70	89	31	54	72	116	83	260	575
Cemented carbides	(1)	(1)	(1)	45	52	85	119	137	298
Other	137	234	319	82	99	115	116	209	276
Total metallic	3,760	3,301	3,434	2,597	2,491	3,288	3,240	6,102	8,555
Nonmetallic:									
Ground-coat frit	81	117	473	412	608	613	424	683	449
Pigments	39	54	101	171	208	233	189	262	50
Other	35	17	26	40	51	67	84	44	61
Total nonmetallic	155	288	300	623	897	913	697	989	560
Salts and driers (estimated)	(2)	(2)	(2)	885	797	818	765	1,102	818
Grand total	3,915	3,589	3,734	4,105	4,155	5,019	4,702	8,283	9,933
Metallic:									
High-speed steel	223	218	169	209	259	237	88	214	155
Other steel	116	152	112	151	123	100	100	619	627
Permanent-magnet alloys	1,665	2,337	2,124	2,818	2,787	2,927	2,340	2,979	2,387
Soft-magnetic alloys									
Cutting and wear-resisting alloys	6,408	5,015	4,931	194	270	264	161	139	263
High-temperature alloys	505	511	2,571	3,221	3,019	2,755	2,193	2,423	2,024
Hard-facing rods and materials	611	592	432	536	501	501	363	404	447
Cemented carbides	133	233	167	291	253	249	148	339	320
Other			113	291	384	237	252	654	602
Total metallic	9,680	9,234	5,872	7,727	7,701	7,279	5,643	7,771	6,825
Nonmetallic:									
Ground-coat frit	309	374	404	568	525	474	457	543	465
Pigments	85	103	146	236	232	205	251	230	190
Other	43	84	75	115	115	188	161	254	278
Total nonmetallic	437	561	625	919	872	867	869	997	933
Salts and driers (estimated)	701	953	853	1,094	989	1,011	1,030	1,131	1,172
Grand total	10,818	10,748	7,330	9,740	9,562	9,157	7,542	9,899	8,930

¹ Cobalt for cemented carbides included under "cutting and wear-² Data for salts and driers not available.³ Figures do not include an estimate for salts and driers.

COBALT—A MATERIALS SURVEY

TABLE 19.—Cobalt materials consumed by refiners and processors in the United States, 1945-60, in thousands of pounds of contained cobalt¹

Year	Alloy, ore, and concentrate	Metal	Hydrate	Carbonate	Purchased scrap	Other
1945	4,809	518	134	18		
1946	2,009	648	129	19		
1947	2,673	657	152	7		
1948	2,716	501	151	5		
1949	2,607	518	129	3	(²)	² 18
1950	2,527	994	80	14	(²)	² 48
1951	2,857	718	82	7	(²)	² 49
1952	3,002	643	80	(³)	(²)	² 53
1953	3,059	801	75	(³)	109	9
1954	3,951	592	57	(³)	173	57
1955	4,880	884	79	(³)	114	63
1956	6,399	884	91	1	96	61
1957	5,793	877	82		93	93
1958	4,645	999	57		250	56
1959	3,342	1,098	24	3		55
1960	2,062	961	18	2		28

¹ Total consumption is not shown because some metal, hydrate, and carbonate originated from alloy, ore, and concentrate.

² Purchased scrap included in "other" category prior to 1953.

³ Less than 500 pounds.

TABLE 20.—Cobalt imported for consumption in the United States, 1901–60, in thousand pounds and thousand dollars

Year	Metal		Oxide		Cobalt-bearing materials not separately classified		White alloy		Ore and concentrate		Salts and compounds		Cobalt content (estimated)
	Gross weight	Value	Gross weight	Value	Gross weight	Value	Gross weight	Value	Gross weight	Value	Gross weight	Value	
1901.....					172	124	9,971	4,330					
1902.....					180	151	10,314	3,971					
1903.....					173	145	10,111	(e)					
1904.....					142	87	8,501	(e)					
1905.....					170	139	8,397	(e)					
1906.....					141	83	1,649	(e)					
1907.....					25	2	3,751	(e)					
1908.....					218	14	4,879	(e)					
1909.....					2	1	3,691	(e)					
1910.....					11	1	3,979	(e)					
1911.....					11	48	4,804	(e)					
1912.....					23	15	6,113	(e)					
1913.....					45	26	5,250	(e)					
1914.....					228	221	5,465	(e)					
1915.....					135	149	5,646	(e)					
1916.....					207	192	4,708	(e)					
1917.....					276	276	1,883	(e)					
1918.....					209	202			17	3			
1919.....	61	141	131	185	209	628			13	5			
1920.....	144	327	203	400					8	3			
1921.....	38	106	104	202					5	7			
1922.....	126	321	218	436					46	56	27	1	426
1923.....	226	552	239	441					59	37	13	8	283
1924.....	119	265	227	446					29	31	37	22	408
1925.....	199	422	287	566					35	56	55	29	642
1926.....	387	821	333	632					154	68	68	40	680
1927.....	407	841	370	684					60	3	65	38	819
1928.....	536	1,145	403	985					107	26	68	40	1,212
1929.....	807	1,743	476	985					434	52	55	24	1,794
1930.....	480	984	426	860					200	19	55	24	
1931.....	165	255	322	391					84	8	46	19	410
1932.....	123	148	226	301					27	13	92	31	303
1933.....	282	332	226	424					117	99	99	28	769
1934.....	506	600	329	454					556	47	44	12	1,000
1935.....	564	630	353	493					749	47	44	24	1,167
1936.....	883	1,015	814	868					419	81	81	17	1,580
1937.....	1,073	1,342	843	1,069					1,040	78	44	22	1,784
1938.....	1,147	1,342	373	519					1,587	44	57	22	1,249
1939.....	2,130	2,712	681	945					611	32	42	18	2,665
1940.....	554	842	767	1,125					450	32	77	38	4,200
1941 ¹	267	374	38	55					3,660	11	15	5	4,328
1942.....	267	374	59	95					10,498	3,660			4,280
1943.....	73	102	226	400					2,444	258			5,626
1944.....	946	1,053	121	210					835	100			3,798
1945.....	1,936	2,749	1,075	1,450					1,621	1,621			4,615
1946.....	6,035	7,994	752	794					92	60			3,451
1947.....	5,257	7,744	790	829					658	59			8,206
1948.....	5,588	9,026	360	363					751	59			8,821
1949.....	6,707	11,211	905	1,009					8,109	647			7,458
1950.....	8,119	16,302	437	604					164	9			10,338
1951.....	12,015	27,291	387	621					537	54			9,095
1952.....	14,432	33,203	610	490					216	2			15,031
1953.....	14,228	36,391	430	723					445	88			17,237
1954.....	15,535	38,585	1,073	1,732					27	6			16,865
1955.....	12,974	32,910	823	1,413					(4)	2			18,732
1956.....	16,173	32,431	647	853					140	15			15,577
1957.....	14,538	28,664	837	1,116					77	6			17,379
1958.....	20,987	35,926	1,557	1,851					772	35			15,149
1959.....	10,801	17,093	1,459	1,520					6,462	314			21,245
1960.....													12,170

¹ Cobalt oxide, cobalt ore, and zaffer.² Cobalt, cobalt ore, and zaffer.³ In addition to above classes, 4,796,000 pounds of Burmese spels containing 335,721 pounds of cobalt was imported.⁴ Less than 1,000 pounds.⁵ Less than 1,000 dollars.⁶ Figure unavailable.

TABLE 21.—Cobalt metal imported for consumption in the United States, 1935-60, by country of origin, in thousands of pounds

Year	Belgian Congo	Belgium	Canada	Finland	France	Germany	Norway	Rhodesia and Nyasaland, Federation of	United Kingdom	Other
1935		499				63			2	(1 2)
1936		871				4			8	(1 2)
1937		917	8	148						(1 2)
1938		617	81	241						
1939		1,911		220						
1940		100	30							
1941				554						
1942			148							
1943			257							
1944			73						(1)	
1945			40				439			
1946	1	466							(1)	3 131
1947	250	1,685							(1)	
1948	3,178	2,726							(1)	
1949	3,542	1,725							(1)	
1950	3,397	2,181		11					(1)	
1951	3,918	2,789				7				4 1
1952	4,930	3,001	183						(1)	
1953	8,120	3,539	354							
1954	9,291	3,615	727		(1)	590	208		37	
1955	9,215	2,515	1,220			918	322			
1956	10,164	3,164	1,347			607	250			
1957	9,422	1,361	1,277			498	407			
1958	8,580	1,436	2,231			856	762	530	1,732	5 5
1959	11,887	4,477	539			712	737	818	13	
1960	4,735	3,276	525			25	746	983	(1)	6 10
						68	1,106	718	(1)	
						101				

1 Less than 1,000 pounds.
2 From Austria.

3 129 from Japan, 2 from Sweden.
4 From Switzerland.

5 From Denmark.
6 From Japan.

Imports by country or origin are given in tables 21, 22, and 23.

Exports of cobalt-bearing materials from the United States are shown in table 24. Since exports of cobalt oxide and cobalt-bearing salts

TABLE 22.—*Cobalt ore and concentrate imported for consumption in the United States, 1936-60, by country of origin, in thousands of pounds*

Year	Canada		Other	
	Gross weight	Content	Gross weight	Content
1936	1, 026	(¹)	² 13	(¹)
1937	579	(¹)	³ 8	(¹)
1938	432	(¹)	⁴ 18	(¹)
1939	573	(¹)	⁴ 38	(¹)
1940	2, 654	(¹)		(¹)
1941	2, 388	262	⁵ 56	1
1942	835	92		
1943	1, 693	268	⁵ 8, 873	1, 098
1944	288	33	⁵ 185	28
1945	860	109		
1946	668	74		
1947	751	78		
1948	8, 168	871		
1949	107	17	⁶ 2	(⁷)
1950	164	19		
1951	345	36	⁸ 192	4
1952			⁹ 215	17
1953	445	51		
1954	27	3		
1955			⁵ 2	(⁷)
1956	77	6		
1957	140	15		
1958				
1959			¹⁰ 772	35
1960			¹⁰ 6, 462	314

¹ Information not available.

² From India.

³ From Australia.

⁴ From Chile.

⁵ From French Morocco.

⁶ From Denmark.

⁷ Less than 1,000 pounds.

⁸ From Mexico.

⁹ 214 from Mexico, 1 from Morocco.

¹⁰ From Cuba.

and driers were not separately recorded by the U.S. Department of Commerce after 1945, figures for these materials are not included in the gross-weight figures in table 24. The very large increase in exports after 1953 was caused by the

TABLE 23.—*Cobalt oxide imported for consumption in the United States, 1936-60, by country of origin, in thousands of pounds*

Year	Belgium	Canada	Finland	France	Germany	United Kingdom	Other
1936	555		9	23	225	2	
1937	301	90	110	74	268		
1938	22		89	121	141		
1939	243		118	128	191		
1940	489	177	21	53			17
1941	18	16				4	
1942							
1943		59					
1944		227					
1945		121					
1946	1, 074					1	
1947	752						
1948	790						
1949	360	(²)				41	
1950	864	(²)	5				
1951	432	(²)		1	1	(²)	(³) 42
1952	385	(²)			2	6	
1953	591	10			8		
1954	422				2		
1955	1, 071						
1956	828						
1957	647						
1958	773	64					
1959	1, 433	124					
1960	1, 419	40					

¹ From Australia.

² Less than 1,000 pounds.

³ 185 pounds from Mexico, 100 pounds from the Netherlands.

⁴ From Mexico.

TABLE 24.—*Exports of cobalt-bearing material from the United States, in thousands of pounds (Gross weight)*

Year	Gross weight	Value (thousands)
1941 (7 months)	34	38
1942	119	162
1943	443	643
1944	481	734
1945	85	53
1946	17	28
1947	1	2
1948	135	184
1949	165	56
1950	159	82
1951	10	64
1952	61	209
1953	383	361
1954	3, 067	1, 173
1955	3, 823	1, 231
1956	3, 054	1, 958
1957	1, 443	1, 919
1958	1, 785	(¹)
1959	705	(¹)
1960	1, 829	(¹)

¹ Not available.

exportation of large quantities of cobalt-bearing scrap. A high percentage of the scrap went to West Germany, where the cobalt was recovered.

PRICES

The price of cobalt metal has remained remarkably stable for the past 50 years. Except for a few months during 1920-21, when the price rose to \$6 a pound, the price has generally remained within the range \$1.50 to \$3 a pound. It is difficult to list actual prices for the metal previous to 1940, since large discounts from the listed price, in some instances as high as 45 percent, were often given for large purchases. Since 1940 the listed prices have more closely reflected the actual cost to the consumer. Table 25 shows the variations in prices of cobalt metal and ceramic-grade oxide over the period 1940-60.

TABLE 25.—*Prices per pound of cobalt metal and cobalt oxides in the United States, 1940-60*¹

Year	Date of change in price	Cobalt metal f.o.b. Niagara Falls, N.Y., or New York, N.Y.	Cobalt oxide, ceramic grade east of Mississippi River (gross weight)
1940-46.....		\$1.50	\$1.16
1947.....	July 1	1.65	1.27½
1948.....		1.65	1.27½
1949.....	Apr. 1	1.80	1.38
1950.....		1.80	1.38
1951.....	Jan. 1	2.10	1.60
	Oct. 1	2.40	1.76 ²
1952.....		2.40	1.82
1953.....	Nov. 1	2.60	1.96
1954.....		2.60	1.96
1955.....		2.60	1.96
1956.....	Dec. 1	2.85	1.78
1957.....	Feb. 1	2.00	1.52
1958.....		2.00	1.52
1959.....	Feb. 1	1.75	1.33
1960.....	Mar. 1	1.50	1.12

¹ E&MJ Metal and Mineral Markets.

² Price change, Nov. 1, 1951.

CHAPTER 7. STRUCTURE OF THE INDUSTRY

Mining

AFRICA

Cobalt mining in Africa is confined mainly to the copper-cobalt deposits of Katanga and Northern Rhodesia, where copper is the major product. The other cobalt mining activities on the continent center around the cobalt-gold deposits at the edge of the Anti-Atlas mountains in Morocco, and the copper-cobalt deposits in western Uganda.

In Katanga the sole producer of cobalt is the Union Minière du Haut-Katanga, which currently operates several copper mines along the southern edge of the country close to the border with Northern Rhodesia. The principal copper-cobalt mines in operation are Kambove, Musonoi, and Kamoto, the last two lying within a few miles of each other in what Union Minière calls its western zone. All the mines are of the open-pit type, but underground works are in preparation in two of them, Kambove and Kamoto, where sulfide ores exist at depth.

In Northern Rhodesia two copper mines, Nkana and Chibuluma, also produce cobalt. Nkana, the mine of the Rhokana Corporation, Ltd., and the older and larger of the two, is near the northern border, about 75 miles south of the Union Minière mines at Elizabethville. Rhokana has been producing cobalt since 1932. Chibuluma is a relatively small copper-cobalt mine which has been operating only since 1955. The mine is about 7 miles west of Kitwe.

The only other cobalt mine in Africa is that of La Société Minière de Bou Azzer et du Graara, near Bou Azzer in Morocco. Cobalt production was started in 1932.

The Kilembe Mines, Ltd., in western Uganda, British East Africa, mines a large copper-cobalt deposit on the slopes of the Ruwenzori Mountains. As of 1960, the company was only producing copper, but a cobalt concentrate was being stockpiled for possible future refining.

EUROPE

Very little cobalt is now mined in Europe. The major cobalt-bearing deposit is the cupiferous pyrite mined by the Outokumpu mine in Finland. Some small amounts of cobalt are also recovered from pyrite mined in Spain.

NORTH AMERICA

Cobalt mines in Canada are of two types, those in which cobalt is a byproduct of nickel mining and those in which cobalt is a byproduct of silver mining. In the former class are the mines of the International Nickel Co. and Falconbridge in the Sudbury area, and the International Nickel Co. and Sherritt Gordon mines in Manitoba. In the latter class are the numerous small silver mines in the Cobalt-Gowganda area. The International Nickel Co. operates five mines in the Sudbury District. Four of these, Creighton, Murray, Frood-Stobie (essentially two mines operated as one) and Garson, are distributed along the southeast edge of the Sudbury basin, and the fifth, Levack, is on the northwest edge. In 1960, Inco was developing a sixth mine, the Crean Hill, near the western end of the southeast edge of the Sudbury basin. In addition, Inco announced plans to open a new open-pit mine, the Clarabelle, in 1961.

Falconbridge operates seven mines in the Sudbury District. Three of these, McKim, Falconbridge, and East, are located along the southeastern edge of the Sudbury basin; the other four, Hardy, Boundary, Fecunis, and Longvack, are concentrated in a 5-mile strip along the northwestern edge of the basin. In addition to the seven mines mentioned, Falconbridge is developing the Onaping mine, which lies between the Hardy and Fecunis mines.

The two remaining cobalt-producing nickel mines in Canada are the recently developed Thompson mine of the International Nickel Co. at Thompson, Manitoba, and the Lynn Lake mine of Sherritt Gordon at Lynn Lake, Manitoba.

In the Cobalt-Gowganda area, a number of small mines produce silver ore from which cobalt is recovered. The major mining companies in this area are: Agnico Mines, Ltd., Deer Horn Mines, Ltd., Langis Silver and Cobalt Mining Co., Ltd., McIntyre Porcupine Mines, Ltd., Castle Division, Silver-Miller Mines, Ltd., and Siscoe Metals of Ontario, Ltd.

In the United States, cobalt is recovered as a byproduct of iron ore mined by the Bethlehem Cornwall Corp. at Cornwall, Pa., and of lead ore mined by the National Lead Co. near Fredricktown, Mo.

CUBA

In Cuba, cobalt was recovered from the laterite ore mined principally for its nickel content by the Moa Bay Mining Co. (a subsidiary of Freeport Sulphur Co.) at Moa Bay, Cuba. The Moa Bay plant was seized by the Cuban Government in 1960.

PACIFIC AREA

The only cobalt deposits in the Pacific area which are being mined are the cobalt-bearing laterites of Société le Nickel in New Caledonia, where very small-scale work is being done on an experimental basis.

Processing

AFRICA

About two-thirds of the cobalt in ore produced in Katanga is refined to electrolytic cobalt at local refineries, and the other third is partially refined to white alloy. All cobalt-bearing ore is concentrated at the plant at Kolwezi, and concentrates are electrolytically refined at the Jadotville-Shituru and Luilu plants.

In Northern Rhodesia, the Rhokana Corp. operates a concentrating plant, a smelter, and an electrolytic cobalt refinery at Nkana. Cobalt-bearing ores from the Chibuluma mine are handled at concentrating and smelting plants at Ndola. The product from the Ndola smelter is a cobalt matte which is exported for further refining. The company is currently considering the construction of a cobalt refinery at Ndola, but no definite plans have been announced.

La Société Minière de Bou Azzer et du Graara operates a washing plant at Bou Azzer which produces cobalt concentrates which are exported for further refining.

EUROPE

Much of the crude cobalt produced elsewhere in the world is refined in European plants. One of the major refining plants is that of the Société Générale Métallurgique de Hoboken in Olen, Belgium, which refines all the white alloy produced by Union Minière as well as all the cobalt matte produced by Chibuluma and some of the concentrate from Bou Azzer. In France, the Société d'Électro-Chemie, d'Électrometallurgie et des Aciéries Électriques d'Ugine maintains a refinery at Pomblière St. Marcel which handles a large part of the concentrates from Bou Azzer. Germany has two refineries, Duisburger Kupferhütte in Duisburg and Gebrüders

Borchers in Goslar. The only other cobalt refineries in Europe are those of the International Nickel Co. at Clydach, South Wales, and Falconbridge Nikkelverk Aktieselskap in Kristiansand S., Norway.

NORTH AMERICA AND CUBA

Canada has more plants for treating cobalt-bearing ores than any other country, although many of them, particularly in the Cobalt-Gowganda area, are relatively small. The International Nickel Co., Ltd., has small cobalt-refining sections in its nickel refineries in Port Colborne, Ontario, and Thompson, Manitoba. Sherritt Gordon produces a nickel-copper-cobalt concentrate at its concentrating plant in Lynn Lake, Manitoba; its refinery at Fort Saskatchewan, Alberta, contains a cobalt-recovery section capable of producing up to 1,000 pounds of cobalt metal per day. Falconbridge operates three mills and a smelter in the Sudbury district which treat the nickel-copper-cobalt ore from its mines in the same area. A number of mining companies in the Cobalt-Gowganda area operate mills which produce silver-cobalt concentrates. These concentrates are refined at the plant of the Deloro Smelting and Refining Co., Ltd., at Deloro, Ontario.

In the United States, cobalt concentrates are produced at the mills of the National Lead Co. at Fredericktown, Mo., and the Bethlehem Cornwall Co. in Cornwall, Pa. Cobalt is recovered from Bethlehem concentrate by the Pyrites Co. at Wilmington, Del. The Calera Mining Co. mill at Cobalt, Idaho, and refinery at Magna, Utah, were closed in 1959 and later sold. The largest cobalt refinery in the United States is the one built by the Freeport Nickel Co. at Port Nickel, La., which has a production capacity of 4.4 million pounds of cobalt metal per year.

Marketing

Complete details of the world cobalt-marketing structure are not available, but a brief summary of the major sales outlets for the major producers is given below.

EUROPE

Cobalt produced in Katanga by Union Minière is sold throughout Europe by Société Générale des Minerais. Cobalt produced by the International Nickel Co. is sold in Great Britain either directly by the Mond Nickel Co. or by Imperial Chemical Industries. Sales on the Continent are handled by Imperial Chemical Industries.

European sales agents for Sherritt Gordon cobalt are the International Minerals and Metals Corp., 11 Broadway, New York 4, N.Y., and Klockner and Company, Mulheimer Strasse 54, Duisburg, Germany.

NORTH AMERICA

U.S. sales of cobalt produced by Union Minière are handled by African Metals Corp., 25 Broad Street, New York, N.Y. Sales for the remainder of North America are handled through the Société Générale des Minerais. Cobalt produced in Canada by the International

Nickel Company of Canada, Ltd., is sold by that company in Canada and by the International Nickel Co., Inc., in the United States. With a few exceptions, sales in the remainder of North America are handled by Imperial Chemical Industries.

Sherritt cobalt is distributed in Canada and the United States by Sherritt Gordon Mines, Limited, 25 King Street West, Toronto 1, Canada. Falconbridge Nickel Mines Limited, also handles its own sales in these countries.

German cobalt is sold in the United States by Phillip Brothers and subsidiaries, 70 Pine St., New York, N.Y.

CHAPTER 8. RESEARCH AND DEVELOPMENT

Government Sponsored

A complete listing of research conducted under Government sponsorship cannot be given since many projects are classified and no reports are made for public distribution on other projects. Much Government research has been performed in Government-owned laboratories, but most of the projects have been carried out at universities, research institutes, and company laboratories. Table 26 indicates the scope of Government-supported research projects carried out from 1950 to 1960.

Industry Sponsored

It is difficult to estimate the extent of industry-sponsored research on cobalt metallurgy. Before 1957, much work was done on product development in such fields as magnetic materials, high-temperature alloys, catalysts, and carbides, but apparently little or no fundamental research was sponsored.

In 1957, the major producers of cobalt, recognizing the need for more research, formed the Cobalt Development Institute. The Centre d'Information du Cobalt, S.A., the executive organization of the institute, was created to develop the uses of cobalt and to disseminate information on cobalt to interested persons.

The Centre d'Information du Cobalt, in Brussels, has undertaken an extensive research program to find new applications for cobalt and to increase its known uses. The center is represented in the United States by its branch office, the Cobalt Information Center, a project at Battelle Memorial Institute. Basic studies are being carried out in the fields of magnetic properties, physical properties, catalysis, and phase diagrams, as well as applied research on materials such as cermets, heat-resisting alloys, and creep-resistant steels. The Cobalt Information Center at Battelle, in addition to gathering and making available information on cobalt and its uses to industry, prepares special reports and assists users of cobalt with their technical problems.

In December 1958, the center started publication of a quarterly review entitled "Cobalt." The publication contains papers contributed by scientists conducting investigations for the center and by specialists working for cobalt producer or consumer companies, as well as abstracts of current literature on cobalt. The research supported by the center probably represents the largest part of the non-Government-sponsored cobalt research now underway. However, cobalt producers and consumers also carry out much research work, as is evidenced by the new cobalt-bearing alloys and products which regularly appear on the market.

TABLE 26.—Summary of Government-sponsored research projects dealing with cobalt, 1950-60

Research facility	Category being investigated										
	Properties	Cobalt-base alloys	Cobalt-bearing alloys	High-temperature alloys	Magnetic alloys	Corrosion and protection	Fabrication and heat-treatment	Powder metallurgy and cermets	Chemical analysis	Applications	Other
Alfred University						X		X		X	X
Allegheny-Ludlum Steel Corp.		X	X	X	X					X	
American Brake Shoe				X		X		X			
American Electro Metal Corp.											X
Armour Research Foundation		X									
Arnold Engineering Co.			X		X						
Babcock & Wilcox Co.	X		X								X
Battelle Memorial Institute	X	X	X	X		X	X	X			X
Brown University			X					X			X
California Institute of Technology											
Carnegie Institute of Technology	X	X	X		X	X					X
Case Institute of Technology				X		X					
Climax Molybdenum Co.			X				X				
Combustion Engineering, Inc.											X
Cornell Aeronautical Labs. Inc.	X		X	X							X
Crucible Steel Co.	X	X	X	X		X					
Defense Metals Information Center	X	X	X								
Duke University					X						
Federal Bureau of Mines					X		X	X			X
Franklin Institute											
General Electric Co.		X	X						X		
General Motors Corp.	X			X							
Georgia Institute of Technology						X					
Hamilton Watch Co.										X	
Howe Sound Co.					X						X
Indiana Steel Products Co.											X
Iowa State College											X
James Forrestal Research Center											X
Kentucky Research Foundation											X
Lehigh University		X			X	X					X
Manufacturing Labs. Inc.			X								X
Massachusetts Institute of Technology						X	X	X			X
National Advisory Committee for Aeronautics	X	X	X	X		X	X	X			
National Bureau of Standards			X								
National Research Corp.					X						X
National Research Council					X						
Naval Ordnance Laboratories											
Northwestern Technological Institute	X										
New York University											X
Ohio State University	X	X				X		X			X
Pennsylvania State University						X		X			
Penn-Texas Corp.			X	X				X			
Republic Steel Corp.											
Rutgers University		X					X	X			
Sciaky Brothers, Inc.								X			
Sintercast Corp. of America				X				X			
Southern Research Institute	X	X						X			
Sylvania Electric Products, Inc.				X							
Syracuse University	X			X							
Sam Tour & Co., Inc.							X				X
Trans-Tech., Inc.									X		X
U.S. Atomic Energy Commission	X		X			X					X
U.S. Naval Research Laboratories	X	X	X	X		X					X
Universal-Cyclops Steel Corp.	X						X				X
University of California											X
University of Chicago											X
University of Kentucky						X					
University of Michigan	X	X	X	X			X				X
University of Minnesota	X	X	X	X							X
University of Notre Dame											X
University of Pennsylvania			X								X
University of Tennessee						X					
University of Utah						X					
Virginia Institute for Scientific Research						X					
Watertown Arsenal									X	X	X
Westinghouse Electric Corp.	X	X	X	X		X					X
Wright-Patterson Air Force Base	X	X	X	X		X					X

CHAPTER 9. LEGISLATION AND GOVERNMENT PROGRAMS⁵

World War II Controls

During the defense buildup prior to the entry of the United States into World War II, shortages in materials necessary for military use began to develop. It soon became evident that some form of Government control was necessary to achieve optimum utilization of the limited supply of critical materials.

INVENTORY, CONSERVATION, AND DISTRIBUTION CONTROLS

The first Government order issued to cope with the problem of shortages was General Metals Order No. 1 (6 FR 2239),⁶ which was issued on May 1, 1941, by the Office of Production Management, Division of Priorities. The order imposed a form of inventory control on a number of metals, including cobalt, and was designed to prevent accumulation of excessive inventories. The substance of General Metals Order No. 1 was codified into Section 944.14 of the Code of Federal Regulations, Title 32, Chapter IX. The order itself was terminated September 23, 1941 (6 FR 4866).

To meet the need for more stringent controls, a number of orders dealing with individual commodities were put into effect. The order specifically controlling cobalt was General Preference Order M-39 (6 FR 5621), which was issued on November 4, 1941. The order covered cobalt and its alloys and compounds, including scrap, and in addition to setting up a priority system for the delivery of cobalt in all forms, it limited deliveries and manufacture of all cobalt compounds not commercially convertible into metal to 90 percent of the aggregate weight of such compounds delivered or produced during the first 6 months of 1941. These restrictions were relaxed slightly by Supplementary Order No. M-39-a (6 FR 6271), December 5, 1941, which authorized any person to receive delivery of cobalt in any of the forms defined in order M-39 in amounts up to 50 pounds of contained cobalt during any calendar month without filing the priority forms required by order M-39.

⁵ The information contained in this chapter was compiled by Miss C. Marie Bain, Editorial clerk (research), Branch of Ferrous Metals, Washington, D.C.
⁶ Federal Register, vol. 6, p. 2239.

On February 7, 1942, General Preference Order M-39 was revised (7 FR 900) to place cobalt deliveries completely under the control of the Director of Industry Operations. The 50-pound-per-month exemption was written into the amendment, and Supplementary Order M-39-a was revoked. On the same date, Conservation Order No. M-39-b (7 FR 901) was issued. This order prohibited or severely limited the use of cobalt in a long list of items including alloys, driers, pigments, frit, catalysts, and many others.

Apparently the restrictions applied to the use of cobalt in the manufacture of ground-coat frit by Conservation Order M-39-b were too harsh, since the order was amended on June 9, 1942, (7 FR 4326) to remove ground-coat frit from the list of restricted uses, but a provision was added which confined the use of cobalt in the manufacture of ground-coat frit to cobalt-nickel oxide which could not be advantageously separated into cobalt and nickel. All restrictions on the sale of existing inventories of ground-coat frit were removed. On August 21, 1942, the provision restricting the use of cobalt to cobalt-nickel oxide in ground-coat frit manufacture was removed by a second amendment (7 FR 6637).

General Preference Order M-39 was revoked on June 5, 1945, (10 FR 6794) with the qualifying provision: "Transactions relating to cobalt remain subject to all other applicable rules and regulations of the War Production Board. This revocation does not affect any liabilities incurred under the order." Conservation Order M-39-b was revoked December 11, 1942 (7 FR 10376).

PRICE CONTROL

On November 2, 1943, the Office of Price Administration issued Maximum Price Regulation 489 (8 FR 15182), which set a maximum price for a number of metals including cobalt. The maximum contract price for metal to metallurgical users was set at \$1.50 per pound in lots over 500 pounds, whereas the maximum price for other cobalt products and metal to other users was set as the maximum price charged for such products by a seller on a delivery or quote for delivery during January, February, or March 1942. Cobalt ores, concentrates, and

crudes were exempted from the provisions of the regulation. Price control over cobalt was suspended on June 12, 1946, by Amendment 26 to Supplemental Order 129 (11 FR 6490).

Post-World War II Controls

Government regulations on critical and strategic materials were relaxed after the conclusion of World War II. However, increased industrial demands plus large stockpiling requirements caused continuing shortages of many metals, including cobalt. The advent of the war in Korea intensified these shortages and brought about the need for new controls.

INVENTORY, CONSERVATION, AND DISTRIBUTION CONTROLS

On September 18, 1950, the National Production Authority, Department of Commerce, issued NPA Regulation 1 (15 FR 6253), which had as its purpose the prevention of accumulation of excessive inventories of materials in short supply by limiting the quantities of such materials that could be ordered, received, or delivered. The regulation covered cobalt metal and all cobalt materials in which cobalt was an essential element, including scrap and secondary materials containing commercially recoverable cobalt. Cobalt concentrates, cemented carbide tipped tools, cast cobalt-chromium-tungsten-molybdenum tools, alloy hard-facing welding rods and materials, and products containing cobalt driers were excepted.

Regulations on cobalt inventories were further tightened on November 30, 1950, by NPA Order M-10 (15 FR 8186), which specifically limited inventories of cobalt materials covered by NPA Regulation 1 to a 20-day supply.

Restrictions were again increased on December 30, 1950, by the amendment of NPA Order M-10 (16 FR 11). The amended order increased restrictions on deliveries and, in addition, added restrictions on uses and required substitutions of cobalt-nickel oxide for cobalt oxide under certain conditions.

Section 14 of NPA Order M-1, as amended April 6, 1951 (16 FR 3114), superseded the inventory limitation provisions of NPA Order M-10 insofar as ferroalloys used for alloying purposes were concerned. The 20-day-supply limit of NPA Order M-10 was replaced with a 45-day-supply limit. This order had very little effect on cobalt since it was not normally used as a ferroalloy.

NPA Notice 1, Designation of Scarce Materials (15 FR 9398), issued December 27, 1950, was a further attempt to prevent hoarding of a number of scarce materials. It provided that "no person shall accumulate (1) in excess of

the reasonable demands of business, personal, or home consumption, or (2) for the purpose of resale at prices in excess of prevailing market prices, materials which have been designated as scarce materials or materials the supply of which would be threatened by such accumulation." The forms of cobalt covered by this notice were identical to those listed in NPA Regulation 1. Cobalt salts and driers were added to the list of scarce materials in the amendment of NPA Notice 1 which was issued on November 7, 1951 (16 FR 11341). (In December 1951, NPA Notice 1 was retitled DSM-1 (16 FR 13132), and the entire regulation was revoked November 2, 1953 (18 FR 6966)).

Cobalt was placed under complete allocation on August 15, 1951, under the terms of NPA Order M-80, Iron and Steel-Alloying Materials and Alloying Products (16 FR 8171) and the accompanying Schedule 2—Cobalt (16 FR 8180). Effective September 1, 1951, Order M-80 superseded order M-10. The provisions of the schedule did not apply to persons whose total receipts of cobalt from all sources were less than 25 pounds per calendar month. Schedule 2 also contained a long list of prohibited uses for cobalt. NPA Order M-80, Schedule 2 was revoked June 30, 1953 (18 FR 3756).

PRICE CONTROL

Ceiling prices were established for cobalt and cobalt products on January 26, 1951, under the provisions of General Ceiling Price Regulation (16 FR 808) issued by the Office of Price Stabilization. Prices in effect during the period December 19, 1950, to January 25, 1951, were used as a basis in setting the ceiling prices. On August 10, 1951, cobalt ores and metal were exempted from price control by the issuance of General Overriding Regulation 9, Amendment 4 (16 FR 7987). The exemption was made in the belief that allowing higher prices might increase the supply. The regulation contained the statement: "Although there may be some increase in costs to domestic consumers as a result of this action, any such increase will have far less an effect upon the stabilization program than the reduction in supply which might result if the exemption was not granted." Cobalt oxide was exempted from price control on October 12, 1951, by the eighth amendment to General Overriding Regulation 9 (16 FR 10489).

Government Aid to Exploration

In order to encourage exploration for certain critical and strategic minerals and metals, including cobalt, the Defense Minerals Administration (DMA), Department of the Interior,

issued MO-5, Regulations Governing Government Aid in Defense Exploration Projects (16 FR 3183), on April 11, 1951. The regulations set procedures under which Government aid could be obtained in financing exploration projects for unknown or undeveloped sources of strategic or critical metals and minerals. Various ratios of Government participation were set for various minerals and metals. For cobalt, Government participation was set at 90 percent of the total cost of the project. If the project were certified, that is, if the Administrator considered that a discovery was made from which commercial production of ore was possible, the operator was obligated to repay the Government through a percentage royalty on the smelter returns or other proceeds. No repayment was necessary in cases where there was no production from the property. The name of DMA was changed to the more descriptive title of Defense Minerals Exploration Administration (DMEA) by Amendment 6 to Secretary of the Interior Order 2605, dated November 20, 1951.

The former DMA order MO-5 was superseded by DMEA Order-1, Government Aid in Defense Exploration Projects (17 FR 2090), on March 7, 1952. A number of new items were added to the list of minerals and metals for which Government aid could be obtained, but the general terms of the order remained the same as in MO-5. Cobalt continued to be on the list of materials for which 90-percent Government participation could be obtained.

The amount of Government participation for cobalt exploration was reduced to 75 percent by the issuance of Amendment 3 to DMEA Order-1 (18 FR 6941) on November 2, 1953. On March 19, 1954, a complete restatement and revision of DMEA Order 1 was issued (19 FR 1563). A second complete revision was issued on October 18, 1957 (22 FR 8304). In both revisions, the amount of Government participation available for cobalt exploration projects remained unchanged at 75 percent.

The DMEA program for providing Government aid for exploration was terminated on June 30, 1958 (23 FR 4003). The termination order provided that DMEA Order 1, Revised, was to continue in force insofar as its provisions related to contracts in effect on June 30, 1958. Administrative expenses for the period July 1, 1958, through August 27, 1958, were paid from DMEA funds.

Public Law 85-701 (72 Stat. 700; 30 U.S.C. sec. 642), which was approved on August 21, 1958, authorized the Department of the Interior to conduct a program for the discovery of domestic mineral reserves, excluding organic fuels, by providing financial assistance to

private industry. On September 11, 1958, the Office of Minerals Exploration (OME) of the Department of the Interior was established by the Secretary of the Interior. DMEA contracts in force were transferred to the OME on September 27, 1958, by order of the Acting Secretary of the Interior (23 FR 7554).

The OME regulations for obtaining Federal assistance for exploration were published in the Federal Register on December 23, 1958 (30 CFR Chap. III, Part 301) (23 FR 9918). The maximum Government participation was set at 50 percent under the regulations. The regulations were revised and published in the Federal Register on August 22, 1959 (24 FR 6757).

Twelve contracts involving exploration for cobalt were negotiated under the minerals exploration program. Of the 12, 1 was cancelled (no work performed and no Government money spent), and the remaining 11 have been terminated. Only four were certified as being possible producers. A list of the cobalt contracts negotiated is given in table 27.

Stockpiling and Expansion Goals

The need to establish a stockpile of critical and strategic materials was recognized before the entry of the United States into World War II. The Strategic Materials Act of June 7, 1939, authorized the appropriation of \$100 million between that date and June 30, 1943, to purchase, move, and store stocks of strategic and critical materials. A stockpile objective of 2,500 short tons of cobalt, to be acquired over a 3-year period, was established in mid-1941, but by the end of the year, none of this objective had been obtained.

To accelerate the acquisition of materials for the stockpile, the Metals Reserve Company was created on June 28, 1940, by an amendment to the Reconstruction Finance Corporation (RFC) Act of 1933. The Metals Reserve Company was empowered to produce, procure, and store strategic and critical materials necessary in the defense program. At the same time, new purchasing authority was given to the Procurement Division of the Treasury.

By October 31, 1944, the Metals Reserve Company had acquired, at a cost of \$2,489,303, a cobalt inventory valued at \$1,193,101.

The Metals Reserve Company was dissolved, and its functions, records, and assets were transferred to the RFC under the provisions of Public Law 109, 79th Congress, approved June 30, 1945. By October 31, 1945, the Office of Metals Reserve of the RFC held 3,295,421 pounds of cobalt stocks for the Government in the United States and Canada.

TABLE 27.—*Exploration contracts for cobalt from beginning of DMA program through December 31, 1960*

Date of execution of contracts	Name of company	Location	Total value of contract	Government participation	Status of contract
July 1951-----	National Lead Co.-----	Madison County, Mo.--	739, 800	448, 208	Certified.
July 1951-----	L. W. King and C. K. Scott.	Bradley and Hamilton Counties, Tenn.	7, 520	6, 768	Terminated.
September 1951---	Admiralty-Alaska Gold Mining Co.	Juneau, Alaska-----	142, 692	120, 536	Do.
December 1, 1951.	Olivine Products Corp.	Jackson County, N.C.--	15, 392	13, 852	Do.
June 1952-----	Montana Coal & Iron Co.	Lemhi County, Idaho--	134, 600	85, 034	Certified.
June 1952-----	Northfield Mines, Inc.	-----do-----	233, 150	163, 205	Do.
December 1953---	Calera Mining Co.-----	-----do-----	407, 340	285, 138	Do.
July 1954-----	Valle's Mining Syndicate.	San Diego County, Calif.	31, 460	23, 595	Terminated.
September 1955---	Idaho Metallurgical Industries.	Lemhi County, Idaho--	345, 558	215, 974	Do.
April 1956-----	Julian Nickel Mines----	San Diego County, Calif.	28, 600	17, 875	Do.
June 24, 1958----	Capital Seaboard Corp.	Lemhi County, Idaho--	65, 200	40, 750	Canceled.
June 27, 1958----	Calera Mining Co.-----	-----do-----	104, 200	65, 125	Terminated.

NATIONAL STOCKPILE

The Strategic and Critical Materials Stock Piling Act (Public Law 520, 79th Congress) (60 Stat. 596) was enacted on July 23, 1946. It provides for the establishment and maintenance of a national stockpile of strategic and critical materials to meet the needs of the Nation during time of war. Originally, the Secretaries of the Army, Navy, and Interior, acting through the Munitions Board, were authorized to determine which materials should be stockpiled. However, under the terms of Reorganization Plan No. 3 (18 FR 3375), effective June 12, 1953, this function was transferred to the Director of the Office of Defense Mobilization (which later became the Office of Civil and Defense Mobilization (OCDM)). Under the act, as amended, the Director of OCDM directs the General Services Administration (GSA) to: (1) Make purchases; (2) provide for storage, security, and maintenance of stockpiled materials; (3) provide for refining or processing of transferred materials where necessary; (4) provide for rotation of stocks where necessary to prevent deterioration; and (5) dispose of materials no longer needed.

The stockpile was planned to be the Nation's reserve of critical materials to meet estimated shortages during time of war. Sufficient supplies were to be obtained to meet expected wartime deficits. Two objectives were established for procurement of materials, a basic objective and a maximum objective. The basic objective, which was the smaller of the two, assumed that some supplies could be obtained from sources outside of North America during the emergency. The maximum objective was set assum-

ing no supply from sources beyond North America and comparably accessible areas. The original objectives were set under the assumption that the emergency situation would last for 5 years.

By Defense Mobilization Order V-7, published in the Federal Register of June 14, 1958 (23 FR 4333), the stockpile objectives were limited to meeting estimated shortages of materials for a 3-year emergency period. As far as cobalt is concerned, the basic stockpile objective was achieved by June 30, 1958, and the maximum objective by December 31, 1958.

Planning of stockpile objectives was altered slightly by a revision of DMO V-7 which required that the maximum objective should be not less than 6-months usage by industry in the United States in periods of active demand.

The quantity of cobalt in the national stockpile is classified security information, but it is known to be well above the maximum stockpile objective.

DEFENSE PRODUCTION ACT INVENTORY

Under section 303 of the Defense Production Act of 1950 (50 U.S.C. App. 2093) and Executive Order 10480 (18 FR 4939) as amended, GSA is authorized, subject to the direction and control of the Director of OCDM, to purchase, or make commitments to purchase, metals, minerals, and other materials for Government use or resale, in order to expand productive capacity and supply. GSA is also authorized to store this material. As of December 31, 1960, the DPA inventory contained 25,187,000 pounds of cobalt acquired at a cost of \$52,063,000.

SUPPLEMENTAL STOCKPILE

Under the terms of the Agricultural Trade Development and Assistance Act (Public Law 480, 83d Congress) of July 10, 1954, the Department of Agriculture, through the Commodity Credit Corporation (CCC), was authorized to barter agricultural commodities for foreign currencies which could then be used to purchase materials for a supplemental stockpile. Section 206 of the Agricultural Act of 1956 (7 U.S.C. 1856) provided that the strategic and other materials acquired by the CCC as a result of barter or exchange of agricultural products, unless acquired for the national stockpile or for other purposes, should be transferred to the supplemental stockpile. As a result of delegation of authority from OCDM (32A CFR, Chap I. DMO V-4), GSA is responsible for the storage and maintenance of materials placed in the supplemental stockpile. As of December 31, 1960, the supplemental stockpile contained 1,077,000 pounds of cobalt, acquired at a cost of \$2,169,000.

EXPANSION GOALS

In order to secure a supply of critical materials sufficient to meet the need of the country, expansion goals were set by the Defense Production Administration for a number of materials, including cobalt. Statutory authority for the expansion goal program came from the Defense Production Act of 1950 (64 Stat. 798), as amended. The Defense Production Administration (DPA), established by Executive Order 10200, January 3, 1951 (16 FR 61), exercised

general direction of the defense production program. (The functions of DPA were later transferred to the Office of Defense Mobilization (ODM) by Executive Order 10433, February 4, 1953 (18 FR 761)).

The first expansion goal for cobalt was established by DPA on January 4, 1952. It set a goal of an annual supply from foreign and domestic sources of 18 million pounds per year in 1954. The goal was revised upward by DPA on March 10, 1952, to 21 million pounds per year in 1955. On December 1, 1952, a second revision was made by DPA which further increased the goal to an annual supply of 27 million pounds in 1955.

The expansion goal for cobalt was suspended by Supplement 1 to DMO VII-6, August 13, 1955 (20 FR 5898) and closed by Supplement 3 to DMO VII-6, October 4, 1955 (20 FR 7370). Table 28 gives details of the contracts entered into by the Government to assist toward fulfillment of the cobalt expansion goal.

Export Controls and Tariffs

EXPORT CONTROLS

During the defense buildup shortly before the entry of the United States into World War II, it became apparent that shortages were developing in a number of strategic and critical materials. Among the measures taken to alleviate the shortages was the imposition of controls on export of these materials.

Cobalt was first brought under export control by Presidential Proclamation No. 2451, dated

TABLE 28.—Summary of Defense Production Act Borrowing Authority transactions on cobalt as of December 31, 1960 (dollars in thousands) ¹

Contractor	Contract number	Gross transactions contracted					
		Contract total		Completed transactions			Incom- pleted trans- actions
		Quantity, pounds	Value	Delivered to Govern- ment	Put rights not used ²	Total	
Active Raw Materials Contracts:							
Rhodesian Congo Border Power Corp.....	DMP-III-11	4,080,000	\$7,171	\$5,108	509	\$5,617	\$1,554
Falconbridge Nickel Mines, Ltd.....	DMP-60	250,000	513	280	-----	280	233
Falconbridge Nickel Mines, Ltd.....	D-12205	1,500,000	3,480	3,004	-----	3,004	476
Freeport Nickel Company.....	DMP-134	23,835,000	47,747	617	-----	617	47,130
Accessorial and termination costs.....			273	107	-----	107	166
Total active.....		29,665,000	59,184	9,116	509	9,625	49,559
Terminated:							
African Metals Corp.....	DMP-123	13,602,147	25,427	25,427	-----	25,427	-----
Calera Mining Co.....	D-18104	6,501,500	14,801	14,801	273	14,801	-----
National Lead Company.....	DMP-131	3,762,000	9,822	7,544	2,278	9,822	-----
Total terminated.....		23,865,647	50,050	47,499	2,551	50,050	-----
Grand total.....		53,530,647	109,234	56,615	3,060	59,675	49,559

¹Source: Report on Borrowing Authority Dec. 31, 1960, prepared by General Services Administration.

²"Put rights not used" is the value of contractor options that have expired either through mutual agreement with the contractor or expiration of options through the passage of time.

December 20, 1940, effective January 6, 1941. The proclamation prohibited the export of cobalt unless authorized by a license. Many other regulations and amendments were issued during the war and later, and there has been some form of export control over cobalt since the original proclamation.

Present (1960) statutory authority for regulation of exports is found in the Export Control Act of 1949, as extended to June 30, 1962, by Public Law 86-464, Eighty-sixth Congress. The regulations issued under this authority appear in Title 15, Chapter III of the Code of Federal Regulations, Parts 368 to 399 inclusive.

Export controls are administered by the Department of Commerce, and are of two basic types: Short supply and security type. The manner in which the controls operate is as follows: A list of commodity groups, called the Positive List, contains those commodities which are to be controlled. Two lists of countries, called the general license country groups, contain the names of all of the countries for which export licenses are required. The two lists are referred to as Country Group O and Country Group R. Within Country Group R, there is established a subgroup of Communist-dominated countries, entitled Subgroup A. A list of the country groups as of the end of 1960 is given below.

(1) Country Group O consists of the following countries and other destinations:

NORTH AMERICA

Northern Area:

Greenland
Miquelon and St. Pierre Islands

Southern Area:

Mexico (including Cozumel and Revilla Gigedo Islands)

Central America:

Guatemala
British Honduras
El Salvador
Honduras (including the Bay Islands)
Nicaragua
Costa Rica
Panama, Republic of

Bermuda and Caribbean:

Bermuda
Bahamas
Cuba (including Isle of Pines)
Jamaica
Haiti (including Gonave and Tortuga Islands)
Dominican Republic
Leeward and Windward Islands
Barbados
Trinidad and Tobago
Netherlands Antilles (formerly Curacao, N.W.I.)
French West Indies

SOUTH AMERICA

Northern Area:

Colombia
Venezuela
British Guiana
Surinam (Netherlands Guiana)
French Guiana (including Inini)

Western Area:

Ecuador (including the Galapagos Islands)
Peru
Bolivia
Chile (including the islands Sala-y-Gomez, Juan Fernandez, San Felix, San Ambrosio, and Easter)

Eastern Area:

Brazil (including the islands St. Paul, Fernando Noronha, and Trinidad (in South Atlantic))
Uruguay
Paraguay
Argentina
Falkland Islands

(2) Country Group R includes and consists of all countries and other destinations not included in Country Group O, except Canada. Within Country Group R there is established Subgroup A, which includes and consists of the following countries and other destinations:

Albania

Bulgaria

China, including Manchuria (and excluding Taiwan (Formosa)) (includes Inner Mongolia; the provinces of Tsinghai and Sikang; Sinkiang; Tibet; the former Kwantung Leased Territory, the present Port Arthur Naval Base Area and Liaoning Province)

Communist-controlled area of Viet-Nam

Czechoslovakia

East Germany (Soviet Zone of Germany and the Soviet Sector of Berlin)

Estonia

Hungary

Latvia

Lithuania

North Korea

Outer Mongolia

Rumania

U.S.S.R.

(Since exportations to United States territories, dependencies, and possessions, The Canal Zone, Puerto Rico, Trust Territory of the Pacific Islands, and Canada do not require export licenses from the Department of Commerce, these destinations are not included in these country groups).

All commodities on the Positive List require validated licenses for export to stated destinations. In addition, all non-Positive List goods except specified commodities require validated licenses for shipment to the U.S.S.R. and other Eastern European destinations (not including Poland and Yugoslavia); to Communist China, North Korea, and other Communist-controlled areas in the Far East; and to Hong Kong, Macao, and Cuba.

In July, 1950, a complete embargo was placed on shipments of all types of goods to North Korea, and shipments to Communist China, Manchuria, and Outer Mongolia were embargoed in December 1950. As of the end of 1960, these embargoes were still in effect.

Although exporters may apply for validated licenses for shipments of Positive List commodities to Subgroup A destinations, nearly all such applications have been denied. In addition, certain commodities, designated by an "A" in the Commodity List column of the Positive List,

cannot be exported to non-Communist countries until the exporter has obtained a certificate from the importing country certifying that the material will not be transshipped, sold, or diverted in any way to a Communist bloc country. Table 29 is a reproduction of those sections of the Positive List which deal with cobalt and cobalt-bearing materials. A complete Positive

List may be found in the Comprehensive Export Schedule issued by the Department of Commerce, Bureau of Foreign Commerce.

TARIFFS

No attempt has been made in this section to trace the tariffs on cobalt and cobalt-bearing materials back beyond the 1930 Tariff Act.

TABLE 29.—Positive list—Cobalt and cobalt-bearing materials

Dept. of Commerce schedule B No.	Commodity description	Unit	Processing code and related commodity group	GLV dollar value limits	Validated license required	Commodity lists
Group 6—METALS AND MANUFACTURES, EXCEPT MACHINERY AND VEHICLES						
Iron Products and Steel Mill Products, Semifinished						
60178-----	Steel ingots, blooms, billets, slabs, sheet bars, and tinplate bars: Other billets, blooms, slabs, and sheet bars, alloy steel, as follows: (a) high-speed tool steels containing 6 up to and including 10 percent cobalt, less than 5 percent chromium, and no nickel, or (b) glass-to-metal sealing alloys containing 6 up to and including 20 percent cobalt.	Short ton	STEE 4..	100	RO-----	E-7
60187-----	Other wire rods, alloy steel, as follows: (a) high-speed tool steels containing 6 up to and including 10 percent cobalt, less than 5 percent chromium, and no nickel, or (b) glass-to-metal sealing alloys containing 6 up to and including 20 percent cobalt.	Lb-----	STEE 4..	100	RO-----	E-8
Iron Products and Steel Mill Products, Rolled and Finished						
60220-----	Iron and steel bars and bar-size rods and shapes, hot-rolled, except tool steel and concrete-reinforcement bars: Other alloy-steel bars, hot-rolled, except stainless, as follows: (a) high-speed tool steels containing 6 up to and including 10 percent cobalt, less than 5 percent chromium, and no nickel, or (b) glass-to-metal sealing alloys containing 6 up to and including 20 percent cobalt.	Lb-----	STEE 4..	100	RO-----	E-8
60255-----	Steel bars and bar-size rods and shapes, cold-finished, except tool steel and concrete-reinforcement bars: Other alloy-steel bars, cold-finished, except stainless, as follows: (a) high-speed tool steels containing 6 up to and including 10 percent cobalt, less than 5 percent chromium, and no nickel, or (b) glass-to-metal sealing alloys containing 6 up to and including 20 percent cobalt.	Lb-----	STEE 4..	100	RO-----	E-8
60270-----	Other tool-steel bars, alloy steel, as follows: high-speed tool steel containing 6 up to and including 10 percent cobalt, less than 5 percent chromium, and no nickel.	Lb-----	STEE 4..	100	RO-----	E-8
60813-----	Steel wire, n.e.c.: Other uncoated alloy-steel wire (except stainless), as follows: glass-to-metal sealing alloys containing 6 up to and including 20 percent cobalt.	Lb-----	STEE 4..	100	RO-----	E-8
Metal Manufactures						
61938-----	Welding rods and wires, including brazing rods: Other welding rods and wires, electric, iron and steel, as follows: (a) high-speed tool steels containing 6 up to and including 10 percent cobalt, less than 5 percent chromium, and no nickel, or (b) glass-to-metal sealing alloys containing 6 up to and including 20 percent cobalt.	Lb-----	STEE 4..	100	RO-----	E-8
61940-----	Other welding rods and wires, nonelectric, iron and steel, as follows: (a) high-speed tool steels containing 6 up to and including 10 percent cobalt, less than 5 percent chromium, and no nickel, or (b) glass-to-metal sealing alloys containing 6 up to and including 20 percent cobalt.	Lb-----	STEE 4..	100	RO-----	E-8
61944-----	Cobalt-metal welding rods, wires, and electrodes (including brazing rods).	Lb-----	MINL 5..	100	RO-----	A E-8
61944-----	Cobalt-alloy welding rods, wires, and electrodes (including brazing rods), special types only. ¹	Lb-----	MINL 5..	100	RO-----	A E-8
61987-----	Metal powders, n.e.c.: Cobalt-metal powders.	Lb-----	MINL 5..	100	RO-----	A E-7
61987-----	Cobalt-alloy metal powders, special types only. ¹	Lb-----	MINL 5..	100	RO-----	A E-7
61995-----	Metal manufactures, n.e.c., and parts, n.e.c.: Metal manufactures, n.e.c., and parts, n.e.c., except iron and steel and except precious metals: Cobalt-metal foil.	Lb-----	MINL 5..	100	RO-----	A E-8
61995-----	Cobalt-alloy metal foil, special types only. ¹	Lb-----	MINL 5..	100	RO-----	A E-8
61995-----	Metal manufactures, n.e.c., and parts, n.e.c.: Permanent magnets with a composition capable of an energy product greater than 6 times 10 ⁶ gauss/oersteds, or containing more than 25 percent cobalt. (Specify characteristics)	No-----	FINP 3..	25	RO-----	A E-8

See footnote at end of table.

TABLE 29.—*Positive list—Cobalt and cobalt-bearing materials—Continued*

Dept. of Commerce schedule B No.	Commodity description	Unit	Processing code and related commodity group	GLV dollar value limits	Validated license required	Commodity lists
Group 6—METALS AND MANUFACTURES, EXCEPT MACHINERY AND VEHICLES—Continued						
Other Nonferrous Ores, Concentrates, Scrap and Semifabricated Forms (Except Precious)						
66429	Cobalt dental alloys	Lb	MINL 5	100	RO	A E-8
66429	Cobalt ores and concentrates (including red and white alloys)	Lb	MINL 5	100	RO	A E-7
66429	Cobalt metal in crude forms	Lb	MINL 5	100	RO	A E-8
66429	Cobalt-alloy metal in crude forms, special types only ¹	Lb	MINL 5	100	RO	A E-8
66429	Cobalt-metal scrap and residues	Lb	MINL 5	100	RO	A
66429	Cobalt-alloy scrap and residues, special types only ¹	Lb	MINL 5	100	RO	A
66429	Alloy-steel scrap of magnetic materials containing more than 25 percent cobalt by weight	Lb	STEE 3	100	RO	A
66429	Other alloy-steel scrap containing 5 percent or more cobalt by weight	Lb	STEE 2	100	RO	
66429	Alloy-steel scrap containing 5 percent or more cobalt by weight	Lb	STEE 2	100	RO	
66431	Cobalt metal in semifabricated forms, n.e.c. (Specify by name)	Lb	MINL 5	100	RO	A E-8
66431	Cobalt-alloy metal in semifabricated forms, n.e.c., special types only ¹ (Specify by name)	Lb	MINL 5	100	RO	A E-8
66431	Alloy-steel metal in semifabricated forms, n.e.c., containing 6 percent or more cobalt, except (a) permanent magnetic metals with a cobalt content of 25 percent or less, and (b) high-speed tool steels containing less than 10 percent cobalt, less than 5 percent chromium, and no nickel. (Specify by names)	Lb	STEE 3	100	RO	A
Group 8—CHEMICALS AND RELATED PRODUCTS						
Industrial Chemicals (Exclusive of Medicinal Chemicals, U.S.P. and N.F.)						
83990	Cobalt carbonate, cobalt hydroxides, cobalt oxalate, cobalt oxides, cobalt sulfide, and cobalt phosphide	Lb	SALT 2	100	RO	E-13
Pigments, Paints, Varnishes, and Related Materials						
84290	Pigments: Cobalt oxide	Lb	SALT 2	100	RO	E-13

¹ For export control purposes, "special types" of cobalt alloy include alloys containing any of the following: (a) 50 percent or more cobalt; or (b) 19 percent or more cobalt and 14 percent or more chromium and less than 1 percent carbon; or (c) 19 percent or more cobalt and 14 percent or more chromium and 3 percent or more molybdenum.

Table 30 is a reproduction of that part of the U.S. Department of Commerce Schedule A, Statistical Classification of Commodities Imported into the United States with Rates of Duty and Tariff Paragraphs, which concerns cobalt. Table 30 gives the rate under the 1930 Tariff Act and the 1960 effective rate of duty

with the date on which the 1960 rate became effective.

Duty rates on cobalt oxide and cobalt sulfate underwent a number of changes between the 1930 Tariff Act and the date of the last change noted in table 30. These changes are summarized in table 31.

TABLE 30.—*Sections on cobalt from U.S. Department of Commerce Schedule A*

TABLE 30.—Sections on cobalt from U.S. Department of Commerce					
Schedule A commodity number	Commodity description	Rate of Duty			Tariff paragraph
		Unit of quantity	1930 Tariff Act (except as noted)	Effective trade agreement rate (GATT, except as noted)	
Group 6—METALS					
Ferroalloys, Ores, and Metals, N.E.S.					
6250 695----- 6250 699-----	Alloys, n.s.p.f., of one or more of the metals specified in 6250 590, 6250 600 ^{1/43} 6250 610 ^{1/43} , 6250 620 ^{1/43} , 6250 630 ^{6/51} , 6250 650 ^{6/51} , 6250 655 ^{6/51} with one or more of the metals aluminum, chromium, cobalt, copper, manganese, nickel, or silicon:-----	Lb.-----	25 pct.-----	20 pct. ^{9/51} -----	302(n)
	Of titanium (formerly part of 6250 690)-----	Lb.-----	25 pct.-----	17 pct. ^{1 6/53} -----	302(n)
	Other (formerly part of 6250 690)-----				
Miscellaneous Metal Manufactures, Nonferrous Ores, Metals, and Alloys, N.E.S. (Except Precious)					
6660 000----- 6661 000----- 6740 060-----	Cobalt:-----	Lb.-----	Free-----	Free (B)-----	1652
	Ore and concentrates (include crude ingots)-----	Lb.-----	Free-----	Free (B)-----	1652
	Cobalt content-----	Lb.-----	Free-----	Free (B)-----	1814
	Metal (include scrap)-----	Lb.-----	Free-----		
	Zaffer-----				
Group 8—CHEMICALS					
Industrial Chemicals					
8261 000----- 8380 340----- 8380 350----- 8380 360-----	Cobalt oxide-----	Lb.-----	20¢ Lb.-----	4¢ Lb. ^{6/53} -----	29
	Cobalt compounds, n.e.s.:-----	Lb.-----	10¢ Lb.-----	5¢ Lb. ^{6/51} -----	29
	Linoleate-----	Lb.-----	10¢ Lb.-----	2½¢ Lb. ^{6/51} -----	29
	Sulphate-----	Lb.-----	30 pct.-----	15 pct. ^{9/53} -----	29
	Salts and compounds of cobalt, n.s.p.f. (Specify by name)-----				

¹ Not applicable if containing uranium; then dutiable at 25 percent ad valorem.

TABLE 31.—*Changes in duty rates on cobalt oxide and sulfate, 1930-60*

Schedule A commodity No.	Commodity description	Rate of duty	Effective date
8261 000.....	Cobalt oxide.....	20¢ lb.....	1930 Tariff Act—Jan. 20, 1936.
		10¢ lb.....	Jan. 20, 1936—June 7, 1951.
		5¢ lb.....	June 7, 1951—June 30, 1956.
		4¾¢ lb.....	June 30, 1956—July 1, 1957.
		4½¢ lb.....	July 1, 1957—June 30, 1958.
		4¢ lb.....	June 30, 1958.
8380 350.....	Cobalt sulfate.....	10¢ lb.....	1930 Tariff Act—Apr. 30, 1935.
		5¢ lb.....	Apr. 30, 1935—June 7, 1951.
		2½¢ lb.....	June 7, 1951.

Appendix to Chapter 9

TITLE 3—THE PRESIDENT

PROCLAMATION 2451

Control of the Export of Certain Articles and Materials

WHEREAS section 6 of the Act of Congress entitled "AN ACT To expedite the strengthening of the national defense," approved July 2, 1940, provides as follows:

"Sec. 6. Whenever the President determines that it is necessary in the interest of national defense to prohibit or curtail the exportation of any military equipment or munitions, or component parts thereof, or machinery, tools, or

material, or supplies necessary for the manufacture, servicing, or operation thereof, he may by proclamation prohibit or curtail such exportation, except under such rules and regulations as he shall prescribe. Any such proclamation shall describe the articles or materials included in the prohibition of curtailment contained therein. In case of the violation of any provision of any proclamation, or of any rule or regulation, issued hereunder, such violator or violators, upon conviction, shall be punished by a fine of not more than \$10,000.00 or by imprisonment for not more than two years, or by both such fine and imprisonment. The authority granted in this section shall terminate, June 30, 1942, unless the Congress shall otherwise provide."

NOW, THEREFORE, I, FRANKLIN D. ROOSEVELT, President of the United States of America, acting under and by virtue of the authority vested in me by the aforesaid Act of Congress, do hereby pro-

claim that upon the recommendation of the Administrator of Export Control I have determined that it is necessary in the interest of the national defense that on and after January 6, 1941, the following-described articles and materials shall not be exported from the United States except when authorized in each case by a license as provided for in Proclamation No. 2413 of July 2, 1940, entitled "Administration of section 6 of the Act entitled 'AN Act to expedite the strengthening of the national defense' approved July 2, 1940.":

1. Bromine.
2. Ethylene.
3. Ethylene dibromide.
4. Methylamine.
5. Strontium Metals and Ores.
6. Cobalt.
7. Abrasives and abrasive products containing emery, corundum, or garnet, as well as abrasive paper and cloth.
8. Plastic molding machines and presses.
9. Measuring Machines.
10. Gauges.
11. Testing Machines.
12. Balancing Machines.
13. Hydraulic Pumps.
14. Tools incorporating industrial diamonds.
15. Equipment and plans for the production of aviation lubricating oil.

IN WITNESS WHEREOF, I have hereunto set my hand and caused the seal of the United States of America to be affixed.

DONE at the City of Washington this 20th day of December, in the year of our Lord nineteen hundred and forty, and of the Independence of the United States of America the one hundred and sixty-fifth.

FRANKLIN D ROOSEVELT

By the President:
CORDELL HULL
Secretary of State.

TITLE 32—NATIONAL DEFENSE

Chapter IX—Office of Production Management

SUBCHAPTER B—PRIORITIES DIVISION

[General Metals Order No. 1]

PART 928—TO RESTRICT INVENTORY ACCUMULATION OF CERTAIN SPECIFIED MATERIALS

To all producers, smelters (primary and secondary), re-melters, brokers, distributors (warehouse or wholesale), processors and fabricators of the following materials (herein called "Suppliers"):

- Antimony.
- Cadmium.
- Chromium.
- Cobalt.
- Copper.
- Ferrous Alloys, all types.
- Iridium.
- Iron and Steel products, including rolled, drawn, forgings, castings and pig iron.
- Lead.
- Manganese or Spiegeleisen.
- Mercury.
- Molybdenum.
- Non-ferrous alloys, all types.
- Tin.
- Vanadium.

Secondary materials, or scrap, containing any of the metals listed herein or any metals already subject to an order of the Director of Priorities, prepared for sale in order to recover the metal content thereof.

AND

To all customers of such Suppliers receiving deliveries of any of the above-specified materials, or of any material which is known to contain substantial quantities of any of such specified materials and which is in semi-processed or pre-manufacturing form (herein called "Customers").

Whereas, it is found (1) that the available supply of the foregoing materials is being diminished at a rate in excess of that necessary for production, as a result of over-buying for unnecessary inventories, and increased manufacturing for unnecessary stocks, (2) that the total future requirements, direct and indirect, of such materials for the fulfillment of Army and Navy contracts or orders and for other essential purposes of national defense, and for civilian purposes, is likely to exceed the requirements definitely ascertainable at the present time, (3) that the available supplies are in danger of such diminution from the aforesaid causes that these may soon be insufficient to fulfill promptly the requirements for such purposes, and therefore (4) in order to insure adequate supplies for defense purposes it is necessary to conserve the existing supplies of said materials from further unnecessary diminution, until determination of the total requirements therefor, and until the means of insuring adequate supplies can be more definitely provided; and

Whereas, it is necessary, as a preliminary step toward such conservation for the present to restrict inventory accumulation, and hereafter to obtain complete information regarding inventories, and, on the basis of such information, to eliminate excessive inventories by restricting deliveries to the extent necessary to reduce such excessive inventories.

Now therefore, it is hereby ordered:

§ 928.1 *General metals order.* (a) (1) No Supplier shall make to any Customer any delivery which such Supplier knows, or has reason to believe, will effect an increase for any calendar month in inventories, in the hands of such Customer, of any such material in the form delivered, or in other forms than that delivered, in excess of the quantity necessary, on the basis of such Customer's usual method and rate of operation, efficiently to meet required deliveries of such Customer's products.

(2) Further, after the 10th day of each calendar month, commencing June 10, 1941, no Supplier shall make any delivery to any Customer unless such Supplier shall have received from such Customer a sworn statement covering inventories during the preceding calendar month, in the form attached to this Order and marked PD-19A.¹

(3) Each Supplier shall mail to the Director of Priorities, Office of Production Management, Washington, D.C., on or before June 1, 1941, a statement of compliance with the requirements of this Order, in the form attached to this Order and marked Form PD-19B.¹

(b) (1) No Customer shall accept any delivery from any Supplier which will effect an increase for any month in the inventories, in the hands of such Customer, of any such material in the form delivered, or other forms than that delivered, in excess of that necessary, on the basis of such Customer's usual method and rate of operation, efficiently to meet required deliveries of such Customer's products.

(2) Further, on or before the 10th day of each month, commencing June 10, 1941, each Customer who shall

¹ Filed as part of the original document.

have accepted deliveries from any Supplier during the preceding calendar month, and each other Customer before receiving any deliveries from any Supplier during such current month, shall file with such Supplier a sworn statement, in the form attached to this Order and marked PD-19A,¹ covering such preceding calendar month, and shall file with the Director of Priorities, Office of Production Management, Washington, D.C., a copy of such sworn statement.

(c) *Provided, however*, That the requirements of this Order shall not apply to deliveries by any Supplier of

(1) ores or concentrates of any of the above-specified materials to any Customer who is a primary processor or smelter of such ores or concentrates; or

(2) any of the above-specified materials in any form to any person importing the same, whether directly or through an agent; or

(3) any of the above-specified secondary materials or scrap to any smelter or re-melter who produces such secondary materials therefrom for sale as such.

(d) This Order shall take effect on the 1st day of May 1941, and unless it be extended or sooner revoked shall expire on the 15th day of July 1941. (O.P.M. Reg. 3, March 7, 1941, 6 F.R. 1596; E.O. 8629, January 7, 1941, 6 F.R. 191; sec. 2(a) Public No. 671, 76th Congress)

Issued this 1st day of May 1941.

E. R. STETTINIUS, Jr.,

Director of Priorities.

[F.R. Doc. 41-3187; Filed, May 1, 1941; 10:45 a.m.]

TITLE 32—NATIONAL DEFENSE

Chapter IX—Office of Production Management

SUBCHAPTER B—PRIORITIES DIVISION

PART 987—COBALT

General Preference Order M-39 to Conserve the Supply and Direct the Distribution of Cobalt

Whereas the uncertainty of shipments of Cobalt from abroad, and the national defense requirements for Cobalt have created a shortage thereof, for defense, for private account, and for export and it is necessary in the public interest and to promote the defense of the United States, to conserve the supply and direct the distribution thereof;

Now, therefore, it is hereby ordered, That:

§ 987.1 *General preference order M-39—(a) Definitions.* For the purposes of this order:

(1) "Cobalt" means and includes:

(i) Ores, concentrates and residues, including beneficiated or treated forms containing Cobalt (commercially recognized).

(ii) The element Cobalt in any form, and combinations with other elements in which Cobalt is an essential constituent.

(iii) All chemical compounds in which Cobalt is an essential and recognizable component.

(iv) All scrap or secondary material containing commercially recoverable Cobalt as defined in (i), (ii), and (iii) above.

(2) "Producer" means any person who mines or otherwise produces natural materials containing recoverable quantities of Cobalt.

(3) "Processor" means any person who uses Cobalt in any form for the manufacture of or conversion into Cobalt chemical compounds or metallurgical forms of Cobalt.

(4) "Dealer" means any person who procures Cobalt either by importing or from domestic sources for resale without change in form, whether or not such person receives title to or physical delivery of the material, and includes selling agents, warehousemen, and brokers.

(b) *Regulations incorporated.* Except as modified by the terms of this order and as otherwise specifically provided herein, all of the provisions and definitions of Priorities Regulation No. 1, issued by the Director of Priorities on August 27, 1941 (Part 944), as amended from time to time, are hereby included as a part of this order with the same effect as if specifically set forth herein.

(c) *Assignment of preference rating to certain defense orders.* Deliveries of Cobalt under all defense orders (as defined in Regulation No. 1) to which a preference rating of A-10 or higher has not been specifically assigned are hereby assigned a preference rating of A-10.

(d) *Forms to be filed before receiving delivery.* Hereafter any person seeking delivery of Cobalt shall file with the Division of Priorities, not later than the 20th day of the month next preceding the month in which delivery is specified, Forms PD-152 and PD-153 or such other form or forms as the Division of Priorities may from time to time prescribe. The Director of Priorities may in his discretion from time to time issue specific directions exempting particular customers or classes of customers from the provisions of this paragraph (d) on the basis of the limited character of their requirements for Cobalt.

(e) *Allocation of deliveries of certain forms of cobalt.* In addition to all other limitations and restrictions contained in this order, beginning November 1, 1941, no person shall make or accept delivery of Cobalt in any of the forms specified in paragraphs (a)(1)(i) and (a)(1)(ii) above, or of Cobalt chemical compounds to be processed into Cobalt metal, except as specifically authorized by the Director of Priorities. During each calendar month, the Director of Priorities will at such time or times as he may determine allocate the supply of Cobalt in the forms specified in paragraphs (a)(1)(i) and (a)(1)(ii) above, and of Cobalt chemical compounds to be processed into Cobalt metal, among persons seeking deliveries thereof, and specifically direct the manner and quantities in which deliveries may be made and accepted. In making any such allocations and directions, the Director of Priorities may take into consideration any person's stocks on hand and supply otherwise available to him, of Cobalt in the forms mentioned, and of scrap or secondary material containing commercially recoverable Cobalt. Such allocations and directions will be made primarily to insure satisfaction of all defense requirements of the United States, both direct and indirect, and they may be made, in the discretion of the Director of Priorities without regard to any preference ratings assigned to particular contracts or purchase orders.

(f) *Limitations on deliveries and manufacture of certain cobalt chemical compounds.* Unless otherwise ordered by the Director of Priorities:

(i) Beginning October 1, 1941, the aggregate weight of Cobalt chemical compounds delivered by any processor or dealer during any calendar month which will be used for purposes other than manufacturing Cobalt metal shall not exceed 90% of the average monthly aggregate weight of such compounds delivered by such processor or dealer for such purposes during the first six months of 1941;

(ii) During the period from October 1, 1941, to March 31, 1942, inclusive, the aggregate weight of Cobalt chemical compounds not commercially convertible into Cobalt metal, which may be processed or man-

ufactured by any processor, shall be limited to 90% of the aggregate weight of such compounds processed or manufactured by him during the first six months of 1941.

(g) *Violations.* Any person affected by this order who violates any of its provisions or a provision of any other order issued by the Director of Priorities, may be prohibited by the Director from making or receiving deliveries of Cobalt, or he may be subjected to such other or further action as the Director may deem appropriate.

(h) *Effective date.* This order shall take effect immediately upon its issuance, and unless sooner terminated by direction of the Director of Priorities, shall expire on the 31st day of March 1942. (P.D. Reg. 1, Aug. 27, 1941, 6 F.R. 4489; OPM Reg. 3, as amended Sept. 2, 1941; E.O. 8629, Jan. 7, 1941, 6 F.R. 191, E.O. 8875, Aug. 28, 1941, 6 F.R. 4483; sec. 2(a), Public No. 671, 76th Congress, Third Session, as amended by Public No. 89, 77th Congress, First Session; sec. 9, Public No. 783, 76th Congress, Third Session)

Issued this 4th day of November 1941.

DONALD M. NELSON,
Director of Priorities.

[F.R. Doc. 41-8264; Filed, November 4, 1941; 9:49 a.m.]
Supplementary Order No. M-39-a

SEC. 987.2 Supplementary order No. M-39-a. (a) It is hereby ordered by the Director of Priorities that, subject to all the other provisions, restrictions and limitations of General Preference Order M-39, issued November 4, 1941, any person is authorized to receive delivery of cobalt in any of the forms included in the definition thereof, as set forth in paragraph (a) (1) of General Preference Order M-39, up to but not exceeding an aggregate of 50 pounds contained cobalt during any calendar month without filling the forms required by the provisions of paragraph (d) of said order.

(b) This order shall take effect immediately upon its issuance, and unless sooner terminated by direction of the Director of Priorities, shall expire on the 31st day of March 1942. (P.D. Reg. 1, Aug. 27, 1941, 6 F.R. 4489; O.P.M. Reg. 3, as amended September 2, 1941, 6 F.R. 4865; E.O. 8629, Jan. 7, 1941, 6 F.R. 191; E.O. 8875, Aug. 28, 1941, 6 F.R. 4483; sec. 2(a), Public No. 671, 76th Congress, Third Session; as amended by Public No. 89, 77th Congress, First Session; sec. 9, Public No. 783, 76th Congress, Third Session.)

Issued this 5th day of December 1941.

J. S. KNOWLSON,
Acting Director of Priorities.

[F.R. Doc. 41-9152; Filed, December 5, 1941; 11:09 a.m.]

TITLE 32—NATIONAL DEFENSE

Chapter IX—War Production Board

SUBCHAPTER B—DIVISION OF INDUSTRY OPERATIONS

PART 987—COBALT

General Preference Order M-39 to Conserve the Supply and Direct the Distribution of Cobalt (as amended February 7, 1942)

Section 987.1 is hereby amended to read as follows:
Whereas, the uncertainty of shipments of cobalt from abroad, and the national defense requirements for cobalt have created a shortage thereof, for defense,

in the public interest and to promote the defense of the United States, to conserve the supply and direct the for private account, and for export and it is necessary distribution thereof;

Now therefore, it is hereby ordered that:

§ 987.1 *General Preference Order M-39—(a) Definitions.* For the purposes of this order:

(1) "Cobalt" means and includes:

(i) Ores, concentrates, crudes, and residues, including beneficiated or treated forms containing cobalt (commercially recognized).

(ii) The element cobalt in any form, and combinations with other elements in which cobalt is an essential constituent.

(iii) All chemical compounds in which cobalt is an essential and recognizable component.

(iv) All scrap or secondary material containing commercially recoverable cobalt as defined in (i), (ii) and (iii) above, excluding cobalt-bearing iron and steel scrap.

(b) *Applicability of Priorities Regulation No. 1.* This order and all transactions affected thereby are subject to the provisions of Priorities Regulation No. 1, (Part 944), as amended from time to time, except to the extent that any provision hereof may be inconsistent therewith, in which case the provisions of this order shall govern.

(c) *Restrictions on deliveries—(1) Allocations.* Hereafter, no person shall make or accept delivery of cobalt except as specifically authorized by the Director of Industry Operations. The Director will from time to time allocate the supply of cobalt and specifically direct the manner and quantities in which deliveries to particular persons or for particular uses shall be made or withheld. The Director may also, in his discretion, require any person seeking to place a purchase order for cobalt to place the same with one or more particular suppliers. Such allocations and directions will be made to insure satisfaction of all defense requirements of the United States, both direct and indirect, and they may be made in the discretion of the Director of Industry Operations without regard to any preference ratings assigned to particular contracts or purchase orders. The Director may also take into consideration the possible dislocation of labor and the necessity of keeping a plant in operation so that it may be able to fulfill defense orders and essential civilian requirements.

(2) *Reports.* Unless otherwise ordered by the Director of Industry Operations, no person shall be entitled to receive an allocation of cobalt unless, not later than the 20th day of the month next preceding the month in which delivery is desired, he shall have filed with the War Production Board and with any supplier with whom he may have placed a purchase order for cobalt, a report in the manner and form prescribed from time to time by the War Production Board: *Provided, however,* That subject to all the other provisions, restrictions, and limitations of this order and until further order by the Director of Industry Operations any person may receive deliveries during any calendar month up to but not exceeding an aggregate of 50 pounds contained cobalt without filing the reports required by this paragraph. Failure by any person to file a report in the manner and on the date required by this paragraph may be construed as notice to the Director of Industry Operations and to all suppliers of cobalt that such person does not desire an allocation of cobalt during the period to which such report would have been applicable.

(d) *Violations.* Any person who wilfully violates any provision of this order, or who by any act or omission falsifies records to be kept or information to be furnished pursuant to this order, may be prohibited

from receiving further deliveries of any material subject to allocation, and such further action may be taken as is deemed appropriate, including a recommendation for prosecution under section 35 (A) of the Criminal Code (18 U.S.C. 80).

(e) *Communications to War Production Board.* All reports required to be filed hereunder, and all communications concerning this order, shall, unless otherwise directed, be addressed to the Cobalt Branch, War Production Board, Social Security Building, Washington, D.C., Reference: M-39.

(f) *Revocation of Supplementary Order M-39-a.* Supplementary Order M-39-a, issued by the Director of Priorities December 5, 1941, is hereby revoked.

(g) *Effective date.* This order shall take effect immediately upon its issuance, and unless sooner terminated by direction of the Director of Industry Operations, shall expire on the 30th day of June, 1942. (P.D. Reg. 1, amended December 23, 1941, 6 F.R. 6630; W.P.B. Reg. 1, Jan. 26, 1942, 7 F.R. 561, E.O. 9024, Jan. 16, 1942, 7 F.R. 329; E.O. 9040, Jan. 24, 1942, 7 F.R. 527; sec. 2 (a), Public No. 671, 76th Congress, Third Session, as amended by Public No. 89, 77th Congress, First Session)

Issued this 7th day of February 1942.

J. S. KNOWLSON,
Director of Industry Operations.

[F.R. Doc. 42-1148; Filed, February 7, 1942; 10:34 a.m.]

PART 987—COBALT

Conservation Order No. M-39-b Curtailing the Use of Cobalt in Certain Items

Whereas, national defense requirements have created a shortage of cobalt for the combined needs of defense, private account, and export; and the supply now is and will be insufficient for defense and essential civilian requirements unless its use in the manufacture of many products where such use is not absolutely necessary for the defense or essential civilian requirements is curtailed or prohibited as hereinafter provided;

Now, therefore, it is hereby ordered that:

§ 987.3 Conservation Order M-39-b—(a) *Prohibition on use of cobalt in articles appearing on List A.*

(1) Between February 1 and April 30, 1942, inclusive, no person shall use in the manufacture of any item on List A more cobalt than 40% of the cobalt used by him for such item during the first six months of 1941.

(2) Effective May 1, 1942, no cobalt shall be used in the manufacture of any item on List A.

(b) *Limitation on all other uses of cobalt.* (1) Between February 1 and March 31, 1942, inclusive, no person shall use in the manufacture of any article not covered by paragraphs (a) or (c) of this section more cobalt than 23% of the cobalt used by him for such article during the first six months of 1941.

(2) Beginning April 1, 1942, no person shall use during any calendar quarter in the manufacture of any article not covered by paragraphs (a) or (c) of this section more cobalt than 35% of the cobalt used by him for such article during the first six months of 1941.

(c) *General exceptions.* Where and to the extent the use of any less scarce material is impracticable, the prohibitions, limitations and restrictions contained in paragraphs (a) and (b) of this section shall not apply to the use of cobalt in the manufacture of any item, or for any of the uses set forth on List B attached, nor in the manufacture of any item which is being produced:

(1) For delivery under a specific contract or sub-contract for the Army or Navy of the United States,

the United States Maritime Commission, the Panama Canal, the Coast and Geodetic Survey, the Coast Guard, the Civil Aeronautics Authority, the National Advisory Commission for Aeronautics, the Office of Scientific Research and Development or for any foreign country pursuant to the Act of March 11, 1941, entitled "An Act to Promote the Defense of the United States." (Lend-Lease Act) if in any such case the use of cobalt to the extent employed is required by the specifications of the prime contract, or

(2) To comply with Safety Regulations issued under government authority, provided the pertinent provisions of such regulations were in effect both on December 1, 1941, and on the date of such use, and specifically and exclusively require the use of cobalt to the extent employed;

(3) With the assistance of a preference rating of A-1-j or higher.

(d) *Prohibitions against sales or deliveries.* No person shall hereafter sell or deliver cobalt to any person if he knows, or has reason to believe, such material is to be used in violation of the terms of this order.

(e) *Limitation of inventories.* No manufacturer shall receive delivery of cobalt, (including scrap), or products thereof, in the form of raw materials, semi-processed materials, finished parts or sub-assemblies nor shall he put into process any raw material, in quantities which in either case shall result in an inventory of such raw, semi-processed or finished material, in excess of a minimum practicable working inventory, taking into consideration the limitations placed upon the production of cobalt products by this order.

(f) *Miscellaneous Provisions—(1) Applicability of Priorities Regulation No. 1.* This order and all transactions affected thereby are subject to the provisions of Priorities Regulation No. 1, (Part 944), as amended from time to time, except to the extent that any provision hereof may be inconsistent therewith, in which case the provisions of this order shall govern.

(2) *Appeal.* Any person affected by this order who considers that compliance therewith would work an exceptional and unreasonable hardship upon him, or that it would result in a degree of unemployment which would be unreasonably disproportionate compared with the amount of cobalt conserved, or that compliance with this order would disrupt or impair a program of conversion from non-defense work to defense work, may appeal to the War Production Board, Reference M-39-b, on such forms as may be prescribed by said Board, setting forth the pertinent facts and the reasons he considers he is entitled to relief. The Director of Industry Operations may thereupon take such action as he deems appropriate.

(3) *Applicability of order.* The prohibitions and restrictions contained in this order shall apply to the use of material in all articles hereafter manufactured irrespective of whether such articles are manufactured pursuant to a contract made prior or subsequent to the effective date hereof, or pursuant to a contract supported by a preference rating. Insofar as any other order may have the effect of limiting or curtailing to a greater extent than herein provided the use of cobalt in the production of any article, the limitations of such other order shall be observed. In the absence of a specific direction by the Director of Industry Operations to the contrary, insofar as this order may have the effect of limiting or curtailing to a greater extent than is provided in General Preference Order M-39 or any other order or any preference rating certificate, the use of cobalt in the production of any article, the limitations imposed by this order shall be observed.

(4) *Violations or false statements.* Any person who wilfully violates any provision of this order, or who by any act or omission falsifies records to be kept or

information to be furnished pursuant to this order, may be prohibited from receiving further deliveries of any material subject to allocation, and such further action may be taken as is deemed appropriate, including a recommendation for prosecution under section 35 (A) of the Criminal Code (18 U.S.C. 80).

(5) *Definitions.* For the purposes of this order:

(i) "Cobalt" means and includes:

(a) Ores, concentrates, crudes and residues, including beneficiated or treated forms containing cobalt (commercially recognizable).

(b) The element cobalt in any form, and combinations with other elements in which cobalt is an essential constituent.

(c) All chemical compounds in which cobalt is an essential and recognizable component.

(d) All scrap or secondary material containing commercially recoverable cobalt as defined in (a), (b), and (c) above, excluding cobalt-bearing iron and steel scrap.

(ii) "Inventory" of a person includes the inventory of affiliates and subsidiaries of such person, and the inventory of others where such inventory is under the control of or under common control with or available for the use of such person.

(iii) "Manufacture" means to fabricate, assemble, mix or process in any other way, but does not include installation of a finished product for the ultimate consumer.

(iv) "Item" means any article or any component part thereof.

(v) "Use" means both (1) the act of putting cobalt into process in the manufacture of any item and (2) the act of completing the manufacture of any such item. (Where a person is limited to a percentage of the material used in a base period, this limitation applies respectively to (1) the amount of material put into process during the base period and (2) the total amount of material contained in a completed item multiplied by the number of such items completed during the base period. Each restriction must be applied separately.)

(vi) "Put into Process" means the first change by a manufacturer in the form of material from that form in which it is received by him.

(6) *Effective date.* This order shall take effect upon the date of issuance and shall continue in effect until revoked by the Director of Industry Operations. (P.D. Reg. 1, amended December 23, 1941, 6 F.R. 6680; W.P.B. Reg. 1, Jan. 26, 1942, 7 F.R. 581, E.O. 9024, Jan. 16, 1942, 7 F.R. 329; E.O. 9040, Jan. 24, 1942, 7 F.R. 527; sec. 2(a), Public No. 671, 76th Congress, Third Session, as amended by Public No. 89, 77th Congress, First Session.)

Issued this 7th day of February 1942.

J. S. KNOWLSON,
Director of Industry Operations.

List A of Conservation Order M-39-b

The use of cobalt in the items listed below and in all component parts thereof is prohibited except to the extent permitted by the foregoing Conservation Order.

Pigments in any form for any use whatsoever, including

Ceramics
Glass
Enamelware
Inks
Paints
Stains
Pottery

except where blue glass is necessary for safety or optical properties.

List B of Conservation Order M-39-b

The uses, and the items listed below and parts thereof are excepted from the prohibitions and restrictions contained in paragraphs (a) and (b) of the foregoing Conservation Order, but only to the extent indicated below and only to the extent that the use of any less scarce material is impractical.

Catalysts
Cattle & Plant Food
Chemical Reagents
Cobalt alloys of all types including cobalt alloys steels, all types cobalt magnet steel and alloys, cobalt nonferrous alloys, hard cutting alloys, all types
Decolorizer for glass
Dryers
Ground Coat Frit
Hard Facing Compounds
Laboratory and Research Equipment
Pharmaceuticals
Plating
Pigment for glass wherever needed for optical or safety purposes.
Health Supplies (as defined in Preference Rating Order P-29 as the same may be amended, to the extent a preference rating of A-10, or higher, is assigned under said Order for the delivery of Cobalt in the manufacture of any such supplies.)

[F.R. Doc. 42-1149; Filed, February 7, 1942; 10:34 a.m.]

TITLE 32—NATIONAL DEFENSE

Chapter IX—War Production Board

SUBCHAPTER B—DIVISION OF INDUSTRY OPERATIONS

PART 987—COBALT

[Amendment 1 to Conservation Order M-39-b]

CURTAILING THE USE OF COBALT IN CERTAIN ITEMS

1. Paragraph (a) of Conservation Order M-39-b¹ (§ 987.3) is hereby amended by adding thereto paragraph (a) (3) to read as follows:

(3) Ground coat frit. No person shall use in the manufacture of ground coat frit any cobalt except cobalt-nickel oxide which cannot be advantageously separated into cobalt and nickel. Notwithstanding this provision or any provision in General Preference Order M-39, there shall be no restriction on the sale and use of existing inventories of ground coat frit containing cobalt in a commercially non-recoverable form unless otherwise directed by the Director of Industry Operations.

2. List B of said order is hereby amended to omit therefrom the following item:

Ground Coat Frit.

(P. D. Reg. 1, as amended, 6 F.R. 6680; W.P.B. Reg. 1, 7 F.R. 561; E.O. 9024, 7 F.R. 329; E.O. 9040, 7 F.R. 527; E.O. 9125, 7 F.R. 2719; sec. 2 (a), Pub. Law 671, 76th Cong., as amended by Pub. Laws 89 and 507, 77th Cong.)

Issued this 6th day of June 1942.

J. S. KNOWLSON,
Director of Industry Operations.

[F.R. Doc. 42-5313; Filed, June 6, 1942; 10:42 a.m.]

¹ 7 F.R. 901.

TITLE 32—NATIONAL DEFENSE

Chapter IX—War Production Board

SUBCHAPTER B—DIRECTOR GENERAL FOR OPERATIONS

PART 987—COBALT

[Amendment 2 to Conservation Order M-39-b]

Section 987.3 *Conservation Order M-39-b*¹ as heretofore amended, is hereby further amended as follows:

(a) By revoking paragraph (a)(3) as added to said order by the provisions of Amendment No. 1, issued June 6, 1942.

(b) Except to the extent provided in paragraph (a), nothing herein shall be construed as revoking or modifying Amendment No. 1 issued June 6, 1942.

(P.D. Reg. 1, as amended, 6 F.R. 6680; W.P.B. Reg. 1, 7 F.R. 567; E.O. 9024, 7 F.R. 329; E.O. 9040, 7 F.R. 527; E.O. 9125, 7 F.R. 2719; sec. 2(a), Pub. Law 671, 76th Cong., as amended by Pub. Laws 89 and 507, 77th Cong.).

Issued this 21st day of August 1942.

AMORY HOUGHTON,
Director General for Operations.

[F.R. Dec. 42-8188; Filed, August 21, 1942; 12:00 m.]

TITLE 32—NATIONAL DEFENSE

Chapter XI—Office of Price Administration

PART 1405—FERRO ALLOYS

[MPR 489]

TUNGSTEN, MOLYBDENUM, VANADIUM, COBALT, AND CERTAIN OTHER ALLOYS AND METALS

In the judgment of the Price Administrator it is necessary and proper to establish maximum prices for sales of tungsten, molybdenum, vanadium, cobalt, and certain other alloys and metals by a specific maximum price regulation. The Price Administrator has ascertained and given due consideration to the prices of tungsten, molybdenum, vanadium, cobalt, and certain other alloys and metals covered by this regulation prevailing between October 1 and October 15, 1941, and has made adjustments for such relevant factors as he has determined and deemed to be of general applicability. So far as practicable, the Price Administrator has advised and consulted with representative members of the industries which will be affected by this regulation.

In the judgment of the Price Administrator the maximum prices established by this regulation are and will be generally fair and equitable and will effectuate the purposes of the Emergency Price Control Act of 1942, as amended. A statement of the considerations involved in the issuance of this regulation is issued simultaneously herewith and has been filed with the Division of the Federal Register.*

Such specifications and standards as are used in this regulation were, prior to such use, in general use in the trade or industry affected.

¹ 7 F.R. 901, 4326.

§ 1405.154 *Maximum prices for tungsten, molybdenum, vanadium, cobalt, and certain other alloys and metals.* Under the authority vested in the Price Administrator by the Emergency Price Control Act of 1942, as amended, and Executive Order No. 9250 and 9328, Maximum Price Regulation No. 489 (Tungsten, Molybdenum, Vanadium, Cobalt, and Certain Other Alloys and Metals), which is annexed hereto and made a part hereof, is hereby issued.

AUTHORITY: § 1405.154 issued under Pub. Laws 421 and 729, 77th Cong.; E.O. 9250, 7 F.R. 7871; E.O. 9328, 8 F.R. 4681.

MAXIMUM PRICE REGULATION 489—TUNGSTEN, MOLYBDENUM, VANADIUM, COBALT, AND CERTAIN OTHER ALLOYS AND METALS

CONTENTS

- Sec. 1. Maximum prices for tungsten.
2. Maximum prices for molybdenum.
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5. Maximum prices for ferrophosphorus.
6. Maximum prices for certain special alloys and metals.
7. Maximum prices for types, grades and sizes of alloys and metals for which maximum prices cannot be established by sections 1 through 6 of this regulation.
8. Terms of general applicability.
9. Exemption of sales for laboratory and experimental purposes.
10. Sales by independent warehousemen.
11. Maximum prices for certain sellers.
12. Applicability of regulation.
13. Records and reports.
14. Adjustable pricing.
15. Applications for adjustment.
16. Petitions for amendment.
17. Prohibition against dealing in tungsten, molybdenum, vanadium, cobalt, and certain other alloys and metals at prices above the maximum.
18. Enforcement.
19. Licensing.
20. Definitions.

SEC. 4. *Maximum prices for cobalt—(a) Cobalt metal sold to a metallurgical user.* The maximum price per pound of cobalt metal containing a minimum of 97% cobalt, packed f.o.b. producer's plant, with freight allowed to destination on quantities of 25 pounds or more, up to but not in excess of the freight rate from producer's plant to Chicago, Illinois, shall be as follows when sold to a metallurgical user:

	Contract	Spot
Kegs, 500 to 550 lbs.-----	\$1.50	\$1.60
Cases, 100 lbs.-----	1.52	1.62
Less than 100 lbs.-----	1.57	1.67

For the purposes of this section "metallurgical user" means a person whose principal use of cobalt metal is in the production of steels, carbides and ferrous or non-ferrous alloys.

(b) *Other cobalt products and cobalt metal sold to other users.* The maximum prices for the cobalt products listed below, and for cobalt metal sold to persons other than metallurgical users, shall be, except as otherwise provided in section 11, (1) the highest prices charged for such products or metal by a seller on a delivery made during January, February or March 1942 to a purchaser of the same class, or (2) if the seller cannot make this determination on the basis of a delivery, the highest prices which the seller quoted for delivery of such products during January, February, or March 1942 to a purchaser of the same class.

If the seller cannot determine his maximum prices under either of the above provisions, his maximum price shall be subject to the approval of the Administrator, as set forth in section 7 of this regulation.

The following cobalt products are covered by this paragraph:

- Cobalt metal fines
- Cobalt metal powder
- Cobalt oxides
- Other alloys and compounds of cobalt which are consumed principally by the metallurgical industry.

(c) *Cobalt ores, concentrates and crudes.* Cobalt ores, concentrates and crudes are exempt from the provisions of this regulation and the General Maximum Price Regulation.

N.B.: For general terms see section 8 below.

SEC. 7. *Maximum prices for types, grades and sizes of alloys and metals for which maximum prices cannot be established by sections 1 through 6 of this regulation.* If the seller of any type, grade or size of alloy or metal listed in this regulation cannot determine his maximum prices under the provisions of sections 1 through 6, inclusive, he shall submit his proposed maximum price for the approval of the Administrator. This price and an analysis of the material shall be reported within 15 days after delivery and, pending approval, such price may be paid and received subject to adjustment between the parties if the price is disapproved. A price once reported and approved need not thereafter be reported by the same seller.

Reports called for by this provision shall be made by letter addressed to the Non-Ferrous Metals Branch, Office of Price Administration, Washington, D.C. In approving or disapproving a price submitted for approval, the Office of Price Administration will consider whether the price submitted is in line with other maximum prices established by this regulation.

SEC. 8. *Terms of general applicability—(a) Credit.* No charge shall be made for extension of credit when payment is made within 30 days of date of invoice.

(b) *No spot premiums on sales to the United States or any agency thereof.* No spot premium may be added on any sale or delivery to the United States or any agency thereof of tungsten, molybdenum, vanadium, cobalt or any of the other alloys or metals covered by this regulation.

SEC. 9. *Exemption of sales for laboratory and experimental purposes.* Sales of tungsten, molybdenum, vanadium, cobalt, and the other alloys and metals covered by this regulation shall be exempt from this regulation and the General Maximum Price Regulation when such sales are made for laboratory and experimental uses. For the purpose of this section "sales for laboratory and experimental purposes" means sales of relatively small amounts used for testing, research, sampling or experimental use and covers alloys, metals and compounds already being produced commercially, as well as those produced experimentally and in the process of development.

SEC. 10. *Sales by independent warehousemen.* The maximum price at which an independent warehouseman may sell tungsten, molybdenum, vanadium, cobalt or any of the other alloys or metals covered by this regulation shall be the maximum price at which the quantity and grade sold by him could be sold by a producer for delivery to his warehouse, plus the following differentials or premiums:

	Percent
500 lbs. and over-----	10
Less than 500 lbs. down to 100 lbs.-----	15
100 lbs. and less-----	20

The maximum price for independent warehousemen is f.o.b. warehouse with no allowance for freight.

For the purpose of this section "independent warehouseman" means a private seller, other than a manufacturer of tungsten, molybdenum, vanadium, cobalt and other alloys and metals or a subsidiary or affiliate thereof, who renders the service of maintaining a stock of tungsten, molybdenum, vanadium, cobalt, or other alloys or metals for the convenience of buyers who desire to purchase small quantities or to receive quick delivery.

SEC. 11. *Maximum prices for certain sellers.* (a) Cleveland Tungsten, Inc., Cleveland, Ohio, may sell or deliver, and any person may buy or receive from Cleveland Tungsten, Inc. tungsten metal powder, con-

taining a minimum of 99.7% tungsten and a maximum of .20% alkalis and .02% molybdenum, at a price not in excess of \$5.40 per pound f.o.b. seller's plant.

(b) The S. W. Shattuck Chemical Company of Chicago, Illinois, may sell and deliver, and any person may buy and receive in the course of trade or business from the S. W. Shattuck Chemical Company, technical grade tungstic oxide (WO_3) at a price not in excess of \$2.58 per pound delivered.

SEC. 12. *Applicability of regulation—(a) Geographical.* The maximum prices established by this regulation shall apply to the forty-eight states and the District of Columbia.

(b) *Export sales.* The maximum price at which any person may export tungsten, molybdenum, vanadium, cobalt or any other alloy or metal covered by this regulation shall be determined in accordance with the provisions of the Second Revised Maximum Export Regulation,⁴ issued by the Office of Price Administration.

(c) *Import sales and sales of imported tungsten, molybdenum, vanadium, cobalt, and other alloys and metals.* Neither this regulation nor the General Maximum Price Regulation⁵ shall apply to the importation of tungsten, molybdenum, vanadium, cobalt, and the other alloys and metals listed in this regulation. This regulation shall apply, however, to the sale of all tungsten, molybdenum, vanadium, cobalt, and other alloys and metals listed in this regulation after they shall have been imported into the forty-eight states and the District of Columbia.

(d) *Relation to General Maximum Price Regulation.* This regulation supersedes the General Maximum Price Regulation as to sales and deliveries which are covered by, or expressly excluded from, this regulation.

SEC. 13. *Records and reports.* (a) On and after November 8, 1943, every person making a purchase or sale of tungsten, molybdenum, vanadium, cobalt, and other alloys and metals covered by this regulation shall keep for inspection by the Office of Price Administration, for so long as the Emergency Price Control Act of 1942 remains in effect, complete and accurate records of each such purchase or sale showing (1) the date thereof, (2) the name and address of the buyer and the seller, (3) the quantity and analysis of each grade and size purchased or sold, (4) the date of delivery of each shipment, and (5) the price paid or received. The invoice or any other customary record containing the required data may be retained for the purposes of this section.

(b) Persons subject to this regulation shall submit such reports, subject to the approval of the Bureau of the Budget in accordance with the Federal Reports Act of 1942, as the Office of Price Administration may from time to time require.

SEC. 14. *Adjustable pricing.* Any person may agree to sell at a price which can be increased up to the maximum price in effect at the time of delivery; but no person may, unless authorized by the Office of Price Administration, deliver or agree to deliver at prices to be adjusted upward in accordance with action taken by the Office of Price Administration after delivery. Such authorization may be given when a request for a change in the applicable maximum price is pending, but only if the authorization is necessary to promote distribution or production and if it will not interfere with the purposes of the Emergency Price Control Act of 1942, as amended. The authorization may be given by the Administrator or by any official of the Office of Price Administration to whom the authority to grant such authorization has been delegated. The authorization will be given by order, except that it may be given

⁴ 8 F.R. 4132, 5987, 7662, 5987, 9998.

⁵ 8 F.R. 3096, 3449, 4347, 4486, 4724, 4848, 4974, 6047, 6962, 8511, 9025, 9991, 11955, 13724.

by letter or telegram when the contemplated revision will be the granting of an individual application for adjustment.

SEC. 15. *Applications for adjustment*—(a) *When available.* The Office of Price Administration will adjust any maximum price established by this regulation whenever it finds, from an application or adjustment or on its own motion, that the price impedes or threatens to impede any seller's production of any commodity and that the seller's production is necessary for essential war or civilian purposes.

(b) *Considerations.* In considering whether production is impeded or threatened, among other factors, consideration will be given to: (1) costs of and revenue from the commodity in question; (2) the relative importance of the commodity in the seller's overall business; (3) the profitability of the seller's business; and (4) any special facts which the seller calls to the attention of the Office of Price Administration.

(c) *Amount of adjustment.* Increase in price will be permitted in an amount which the Office of Price Administration considers sufficient to avoid the impeding of production or the threat of impeding production.

(d) *Form of application.* An original and one copy of an application for adjustment must be filed with the Office of Price Administration, Washington, D.C. It is suggested that, before filing an application for adjustment under the provisions of this section, the seller obtain from the Non-Ferrous Metals Branch, Office of Price Administration, Washington, D.C., a statement of the specific information that will be necessary in order that his application may receive prompt action.

SEC. 16. *Petitions for amendment.* Any person seeking an amendment of any provision of this regulation may file a petition for amendment in accordance with the provisions of the Revised Procedural Regulation No. 1,⁶ issued by the Office of Price Administration.

SEC. 17. *Prohibition against dealing in tungsten, molybdenum, vanadium, cobalt, ferrophosphorus and other alloys and metals at prices above maximum.*

(a) On and after November 8, 1943, regardless of any contract, agreement, or other obligation, no person shall sell or deliver tungsten, molybdenum, vanadium, cobalt, ferrophosphorus or any other alloys or metals covered by this regulation and no person in the course of trade or business shall buy or receive tungsten, molybdenum, vanadium, cobalt, ferrophosphorus or any other alloys or metals covered by this regulation at prices higher than the maximum prices set out in this regulation; and no person shall agree, offer, solicit, or attempt to do any of the foregoing.

(b) Any practice or device which is an attempt to get the effect of a price higher than the maximum without actually charging a higher price is prohibited and is as much a violation of this regulation as an outright excessive price. This applies to devices involving commissions, services, transportation arrangements, premiums, special privileges, tying-agreements, trade understandings and the like.

(c) Prices lower than those set out in this regulation may be charged, demanded, paid or offered.

SEC. 18. *Enforcement.* (a) Persons violating any provision of this regulation are subject to the criminal penalties, civil enforcement actions and suits for treble damages provided for by the Emergency Price Control Act of 1942, as amended.

(b) No war procurement agency, nor any contracting or paying finance office thereof, shall be subject to any liability, civil or criminal, imposed by this regulation or the Emergency Price Control Act of 1942, as amended. "War procurement agency" includes the War Department, the Navy Department, the United

States Maritime Commission and the Lend-Lease Section in the Procurement Division of the Treasury Department, or any agency of the foregoing.

SEC. 19. *Licensing.* The provisions of Licensing Order No. 1, licensing all persons who make sales under price control, are applicable to all sellers subject to this regulation. A seller's license may be suspended for violation of the license or of any one or more maximum price regulations. A person whose license is suspended may not, during the period of suspension, make any sale for which his license has been suspended.

SEC. 20. *Definitions.* (a) When used in this regulation the term:

(1) "Person" includes an individual, corporation, partnership, association, or any other organized group of persons, or legal successor or representative of any of the foregoing, and includes the United States or any agency thereof, or any other government or any of its political subdivisions, or any agency of any of the foregoing.

(2) "Purchaser of the same class" refers to the practice adopted by the seller in setting different prices for sales to different purchasers or kinds of purchasers or for purchasers located in different areas or for different quantities or grades or under different conditions of sale.

(3) "Contract price" means that price determined by a written contract calling for delivery or deliveries of an estimated amount at some future date or dates within a specified period of time, not less than three months.

(4) "Gross ton" means 2,240 pounds.

(5) "Spot price" means the price for a single or isolated sale for delivery within three months.

(6) "Carload lots" means not less than the minimum quantity which may be shipped by the seller to the particular buyer at the carload tariff rate.

(7) "Freight" means the charge for transportation not in excess of the charge made by railroads and includes the federal tax on such railroad transportation charge.

(8) "Tungsten" means any one of the materials which are specifically listed in section 1 and any other alloy or compound of tungsten which is consumed principally by the metallurgical industry.

(9) "Molybdenum" means any one of the materials which are specifically listed in section 2 and any other alloy or compound of molybdenum which is consumed principally by the metallurgical industry.

(10) "Vanadium" means any one of the materials which are specifically listed in section 3 and any other alloy or compound of vanadium which is consumed principally by the metallurgical industry.

(11) "Cobalt" means any one of the materials which are specifically listed in section 4 and any other alloy or compound of cobalt which is consumed principally by the metallurgical industry.

(12) "Ferrophosphorus" means an alloy of phosphorus as described in section 5.

(13) "Other alloys and metals" means any of the materials covered in section 6.

(14) "Alloy of compound of a particular element" (as tungsten) means an alloy or compound, consumed principally by the metallurgical industry, in which the particular element accounts for a larger part of the material cost than any other constituent element.

(15) "Metallurgical industry" means the group of industries which produce metals, steels, carbides and ferrous and non-ferrous alloys.

(b) Unless the context otherwise requires, the definitions set forth in section 302 of the Emergency Price Control Act of 1942 shall apply to other terms used in this regulation.

⁶ 7 F.R. 8961; 8 F.R. 3313, 3533, 6173, 11806.

This regulation shall become effective November 8, 1943.

NOTE: All reporting and record-keeping requirements of this regulation have been approved by the Bureau of the Budget in accordance with the Federal Reports Act of 1942.

Issued this 2d day of November 1943.

CHESTER BOWLES,
Acting Administrator.

[F.R. Doc. 43-17725; Filed, November 2, 1943; 5:05 p.m.]

Chapter XI—Office of Price Administration

TITLE 32—NATIONAL DEFENSE

PART 1305—ADMINISTRATION

[Supp. Order 129]

EXEMPTION AND SUSPENSION FROM PRICE CONTROL OF MACHINES, PARTS, INDUSTRIAL MATERIALS AND SERVICES

A statement of the considerations involved in the issuance of this supplementary order, issued simultaneously herewith, has been filed with the Division of the Federal Register.

AUTHORITY: § 1305.157 issued under 56 Stat. 23, 765; 57 Stat. 566; Pub. Law 383, 78th Cong.; Pub. Law 108, 79th Cong.; E.O. 9250, 7 F.R. 7871; E.O. 9328, 8 F.R. 4681; E.O. 9599, 10 F.R. 10155; Directive 68 of the Director of Economic Stabilization.

ARTICLE I—EXEMPTIONS

SECTION 1. *Articles exempted from price control.* Notwithstanding the provisions of any price regulation or order heretofore issued by the Office of Price Administration, or any price regulation or order hereafter issued by the Office of Price Administration, except an amendment of this order, all purchases, sales and deliveries, unless otherwise stated below, of any of the machines, parts, industrial materials and services listed in the sections appearing under this Article are exempt from price control.

SEC. 2. *Building materials—(a) Construction materials and refractories as follows.*

Architectural terra cotta.

(b) *Mechanical building equipment as follows.*

Cast iron cornices.
Continuous stove wood pipe.
Machine-banded wood pressure pipe.
Ornamental iron brackets.
Solid bored wood pressure pipe, machine-banded or wire-bound.
Wire-bound wood pressure pipe.
Wood-lined pressure pipe.
Wrought iron balustrades.
Wrought iron fences.

SEC. 3. *Lumber and primary forest products—(a) Miscellaneous primary forest products as follows.*

Florist foliage.

SEC. 4. *Machines and parts and machinery services—(a) Electrical equipment as follows.*

Batteries, wet-cell electric storage, when sold by a manufacturer to a brand owner, pursuant to a cost-plus-a-fixed-fee or a cost-plus-a-percentage-of-cost contract.
Bi-metallic strips.
Lighting fixtures, especially designed and built for individual installation, excluding modifications of standard items.
X-ray equipment and supplies, exclusive of X-ray tubes.

(b) *Miscellaneous equipment as follows.*

Gas meters, tin-cased.
Voting machines, and parts.

(c) *Processing machinery and parts as follows.*
Broom sewing machines and parts.

(d) *Transportation equipment and services as follows.*

Repair to ships and boats when undertaken for a war procurement agency.

SEC. 7. *Paper and paper products—(a) Miscellaneous paper products as follows.*

Stamped envelopes sold to and by the Post Office Department of the United States Government.

SEC. 8. *Rubber, chemicals and drugs—(a) (1) Chemicals and drugs when sold for the purposes of scientific and medical research, for analytical and educational uses or for quality control of industrial products as follows.*

Laboratory reagent specialty solutions.
Prepared culture media.
Reagent chemicals.

(2) *Chemicals and drugs as follows.*

Guinea pig complement.
Crude botanical drugs imported from Canada.

(b) *Miscellaneous commodities made in whole or in part of rubber, synthetic or substitute rubber as follows:*

Bust forms and fillers (other than surgical bust forms and fillers).

ARTICLE II—SUSPENSIONS

SEC. 9. Notwithstanding the provisions of any price regulation or order heretofore issued by the Office of Price Administration, or any price regulation or order hereafter issued by the Office of Price Administration, except an amendment of this order, price control is suspended as to all purchases, sales and deliveries, unless otherwise stated below, of any of the machines, parts, industrial materials and services listed in the sections appearing under this Article. These suspensions are for an indefinite period of time except when it is otherwise specifically provided by the Administrator.

SEC. 10. *Building materials—(a) Construction materials and refractories as follows:*

Architectural dimension stone, monuments and memorials.

SEC. 11. *Lumber and primary forest products.*

SEC. 12. *Machines and parts and machinery services—(a) Electrical equipment as follows:*

Searchlights, military, completely assembled.

(b) *Machine tools and parts as follows:*

Spring-winding and wire-forming machinery.

(c) *Miscellaneous equipment as follows:*

Clockwork systems, industrial.

Engines, Army tank.

Furnaces and ovens, industrial and laboratory, except space heating, warm air furnaces, stoves, blast furnaces and industrial furnaces and ovens used solely for the manufacture of coke, pig iron and steel, or used for food processing.

Heating, melting, burning and thawing equipment, portable, for industrial and transportation uses, excluding fire pots and blow torches.

Gauges, standard industrial and special purpose, including plug, ring, snap, height, length and location gauges, but not testing machines.

Gyroscopes.

Marine instruments.

Numbering and marking machines for use on metal, except office machines.

Optical processing machinery, manufacturers, except BX optical and laboratory machinery.

Pipe wrapping and coating machinery.

Reproduction machinery, architectural and engineering, such as blue printing, brown printing and white printing, but not photographic process machinery.

Siren blowers, designed for air raid precautionary use.

Steam engines, except railroad locomotives.

(d) *Transportation equipment and services as follows.*

Heavier and lighter than air aircraft.

Parts for heavier and lighter than air aircraft, including any product upon which further fabrication need not be performed in order to complete its identification as a part specially designed for the production or repair of aircraft, but excluding specifically:

- (1) Lumber requiring further fabrication.
 - (2) Any part whose end use cannot be determined by the seller.
 - (3) Airplane tires and tubes.
 - (4) Die castings covered by Maximum Price Regulation 377 (Die Castings).
 - (5) Iron and steel castings covered by Revised Price Schedule 41 (Steel Castings and Railroad Specialties), Maximum Price Regulation 214 (High Alloy Castings), Maximum Price Regulation 235 (Manganese Steel Castings and Manganese Steel Castings Products), Maximum Price Regulation 241 (Malleable Iron Castings), or Maximum Price Regulation 244 (Gray Iron Castings).
 - (6) Non-ferrous castings covered by Revised Maximum Price Regulation 125 (Non-ferrous Castings).
 - (7) Plywood (except that molded specially for airplanes).
- Marine equipment listed in Revised Maximum Price Regulation 136 (Machines, Parts and Industrial Equipment). Ships and boats, new or used, over twenty-five feet in length, excluding stock boats built to the manufacturer's specifications and selling at a price of not more than \$3,000 to the user, and excluding parts, subassemblies or fittings for such ships and boats when sold separately.

SEC. 13. *Metals*—(a) *Non-ferrous metals and products as follows:*

Primary aluminum ingot and pig.
Aluminum castings subject to Revised Maximum Price Regulation 125 (Non-ferrous Castings).
Magnesium scrap.
Remelt magnesium ingot.
Magnesium and magnesium alloy ingot.
Magnesium castings subject to Revised Maximum Price Regulation 125 (Non-ferrous Castings).
Mercury.
Die castings subject to Maximum Price Regulation 377 (Die Castings).

ARTICLE III—GENERAL PROVISIONS

SEC. 17. *Articles not affected by this order.* The provisions of this order do not exempt or suspend from price control articles which are not listed, although such articles may have incorporated in them or be sold with articles which are exempted or suspended from price control.

SEC. 18. *Records and reporting.*—(a) *Exemption or suspension from price control shall not affect the responsibility of a person to preserve records which, on the date of exemption or suspension, he was required to keep under the provisions of the applicable price regulation or regulations.* Records of individual transactions after exemption or during a period of suspension need not be retained or reports need not be made except as may be provided by paragraph (b) of this section.

(b) *Special records and reporting requirements.*

SEC. 19. *Definitions for the purpose of this supplementary order.* (a) "Person" means an individual, corporation, partnership, association, or any other organized group of persons, legal successor or representative of the foregoing.

(b) "Price regulation" means the price schedule effective in accordance with section 206 of the Emergency Price Control Act of 1942, as amended, a maximum price regulation or temporary maximum price regulation, heretofore or hereafter issued, or any amendment or supplement thereto or order thereunder heretofore or hereafter issued.

(c) "War procurement agency" means the War Department, the Department of the Navy, the United States Maritime Commission, the War Shipping Administration, the Lend-Lease Section of the Procurement Division of the Treasury Department, and any agency of any of the foregoing.

SEC. 20. *Relationship between this order and Supplementary Order 45 and Supplementary Order 123.*

The provision of this Supplementary Order supersedes the provisions of Supplementary Order 45 and Supplementary Order 123 as to any article listed in this order.

SEC. 21. *Geographical applicability.* The provisions of this order shall be applicable to purchases, sales and deliveries in the forty-eight States of the United States and the District of Columbia.

This Supplementary Order No. 129 shall become effective August 31, 1945.

Issued this 29th day of August 1945.

CHESTER BOWLES,
Administrator.

[F.R. Doc. 45-16229; Filed, Aug. 29, 1945; 4:27 p.m.]

TITLE 32—NATIONAL DEFENSE

Chapter XI—Office of Price Administration

PART 1305—ADMINISTRATION

[SO 129, Amdt. 26]

EXEMPTION AND SUSPENSION FROM PRICE CONTROL OF MACHINES, PARTS, INDUSTRIAL MATERIALS AND SERVICES

A statement of the considerations involved in the issuance of this amendment, issued simultaneously herewith, has been filed with the Division of the Federal Register.

Supplementary Order 129 is amended in the following respects:

1. Section 2(c) is amended to read as follows:

(c) *Millwork as follows:*

Wooden picture frame mouldings.

2. Section 3 is amended to read as follows:

SEC. 3. *Lumber, primary forest products, and containers and accessories*—(a) *Miscellaneous forest products as follows:*

Domestically grown bamboo poles.

Florist foliage.

Imported briarwood.

(b) *Containers and accessories as follows:*

Wooden cooperage dowels.

3. In section 10, paragraph (c) is deleted and paragraphs (d) and (e) are redesignated (c) and (d), respectively.

4. Section 11 is amended to read as follows:

SEC. 11. *Lumber, primary forest products and containers and accessories*—(a) *Lumber and primary forest products as follows:*

Bourbon grade stave and heading bolts priced in section 12 of Maximum Price Regulation 535-6.
Sitka spruce cigar box lumber.

(b) *Containers and accessories as follows:*

Cigar boxes, wooden, or combination wood and paper.

Milk bottle crates of metal or metal and wood in combination, used for the delivery of milk in glass bottles and for the return of empty glass bottles to the dairy.

New white oak bourbon cooperage and new bourbon cooperage stock which meet the grade requirements specified in the "Grade Rules and Specifications" of the Associated Cooperage Industries of America, Inc., and are priced in Maximum Price Regulation 424 or the General Maximum Price Regulation.

Post and rail (hurdle type) fencing made from split or round locust, chestnut, Tennessee red cedar or white cedar.

Sitka spruce cigar box shooks.

(c) *Services performed on primary forest products as follows:*

The dehydrating or artificial seasoning of any primary forest product by the Tenger process, also known as "Tengerizing".

5. Section 13 (a) is amended by adding the following to the list of commodities thereunder:

Chrome ores.
Cobalt.
Ferroalloys, metals and products covered by MPR 489.
Ferrochromium and chromium metal.
Ferrosilicon and silicon metal.
Molybdenum.
Tungsten.
Vanadium.

This amendment shall become effective June 12, 1946.
Issued this 12th day of June 1946.

PAUL A. PORTER,
Administrator.

[F.R. Doc. 46-9969; Filed, June 12, 1946; 11:52 a.m.]

TITLE 32A—NATIONAL DEFENSE, APPENDIX

Chapter I—National Production Authority, Department of Commerce

[NPA Reg. 1]

PART 10—INVENTORY CONTROL

This regulation is found necessary and appropriate to promote the national defense and is issued pursuant to the authority granted by section 101 of the Defense Production Act of 1950. Consultation with industry representatives in advance of the issuance of this regulation has been rendered impracticable by the fact that the regulation applies to all trades and industries.

Sec.	Purpose.
10.1	Materials covered.
10.2	Persons affected.
10.3	Practicable minimum working inventory.
10.4	Restriction on receipts.
10.5	Restriction on delivery.
10.6	Restriction on ordering.
10.7	Adjustment of orders.
10.8	Receipts permitted after adjustment of orders.
10.9	Separate operating units.
10.10	Imported materials.
10.11	Minimum sales quantity.
10.12	Defense against claims for damages.
10.13	Records, reports and audits.
10.14	Applications for adjustment or exception.
10.15	Violations.

AUTHORITY: §§ 10.1 to 10.16 Issued under sec. 704, Pub. Law 774, 81st Cong. Interpret or apply sec. 101, Pub. Law 774, 81st Cong., sec. 101, E.O. 10161, Sept. 12, 1950, 15 F.R. 6105.

§ 10.1 *Purpose.* The purpose of this part is to prevent the accumulation of excessive inventories of materials in short supply. It does this by limiting the quantities of such materials that can be ordered, received, or delivered.

§ 10.2 *Materials covered.* This part applies only to those materials listed in the attached Table I in the shapes and forms therein specified.

§ 10.3 *Persons affected.* This part does not apply to ultimate consumers buying for personal or household use but does apply to everyone else buying or selling either for use or for resale (including resale in export trade).

§ 10.4 *Practicable minimum working inventory.* As used in this part, the term "practicable minimum working inventory" means the smallest quantity of material from which a person can reasonably meet his deliveries or supply his services on the basis of his currently scheduled method and rate of operation. In the absence of unusual circumstances, if the ratio of a person's inventory to his currently scheduled operations is substantially greater than the ratio which he found it necessary to maintain between inventory and operations during the recent past, his inventory will be considered excessive.

§ 10.5 *Restriction on receipts.* (a) No person may receive or accept delivery of material listed in table I if his inventory of that material is, or by such receipt would become, more than a practicable minimum working inventory.

(b) In figuring his inventory, a person must include all such material in his possession or held for his account by others but not that held by him for the account of others. Material is considered to be in inventory until actually put into process or actually installed or assembled.

(c) This part does not provide for disposal of excess inventory which may be on hand. Excess inventory may, however, be subject to requisition, under certain circumstances, as provided in section 201(a) of Title II of the Defense Production Act of 1950.

(d) Any person engaged in a seasonal business or industry who normally stocks inventory in advance of the season may, notwithstanding the restriction in paragraph (a) of this section, accept such advance delivery of his seasonal requirements provided that the deliveries accepted are no greater and no further in advance than those which he would normally accept in the ordinary course of this business to meet reasonably anticipated seasonal requirements.

§ 10.6 *Restriction on delivery.* No person may deliver any material if he knows or has reason to believe that his customer is not permitted to receive it under this part.

§ 10.7 *Restriction on ordering.* (a) No person may place any order calling for delivery of any material earlier or in larger amounts than he would be permitted to receive under this part.

(b) A person may not place orders with different suppliers totalling more than he is permitted to receive even though he intends to cancel one or more of the orders before delivery.

§ 10.8 *Adjustment of orders.* (a) Outstanding orders, placed before the effective date of this part, for delivery earlier or in greater quantities than a person is permitted to receive, must be promptly cancelled, reduced or deferred to the extent that the original scheduled delivery would result in his exceeding his practicable minimum working inventory.

(b) A person whose requirements change, either because of an alteration in operations, slowing or stoppage of production, delayed delivery by suppliers, or otherwise, must promptly cancel, reduce or defer his outstanding orders to the extent that the original scheduled delivery would result in his exceeding his practicable minimum working inventory.

§ 10.9 *Receipts permitted after adjustment of orders.* Where a person has promptly adjusted his outstanding orders as required by § 10.8, delivery of the material involved may be made and received and the restrictions on receipts may be exceeded to the following extent only:

(a) Delivery may be made and accepted if the supplier has shipped the material or loaded it for shipment before receipt of the instruction to adjust.

(b) Delivery may be made and accepted of any special item which the supplier actually has in stock or in production, or for the production of which he has acquired special components or special materials. For the purpose of this part, a special item is one that the supplier does not usually make, stock, or sell, and which cannot readily be disposed of to others.

(c) Delivery may be made by, and accepted from a producer, if the material has already been produced or is in production before receipt of the instruction to adjust and cannot be used to fill other orders on the producer's books.

§ 10.10 *Separate operating units.* In the case of a person who keeps separate inventory records for them, this part applies to each such operating unit independently.

§ 10.11 *Imported materials.* A person may import any material acquired prior to landing without regard to the inventory restrictions of this part. However, if his inventory of a material thereby becomes in excess of the amount permitted, he may not receive further deliveries of it from domestic sources until his inventory is reduced to permitted levels. The inventory restrictions of this part do apply to any deliveries of the imported material he makes, and to the amount of it that any person accepting delivery from him is permitted to receive.

§ 10.12 *Minimum sales quantities.* In the case of materials that are mass produced or are normally marketed only in minimum sales quantities, a person may order and receive from a producer a minimum production run of such a material, or from any other supplier a minimum sales quantity, provided it is not practicable for him to procure his needs from other suppliers in smaller quantities, even though his inventory of such material is thereby increased beyond a practicable minimum working inventory. He may not receive additional quantities, however, until his inventory is reduced below a practicable minimum working inventory.

§ 10.13 *Defense against claims for damages.* Persons complying with this part are entitled to the protection afforded by section 707 of the Defense Production Act of 1950, which provides in part that "No person shall be held liable for damages or penalties for any act or failure to act resulting directly or indirectly from his compliance with a rule, regulation, or order issued pursuant to this act, notwithstanding that any such rule, regulation, or order shall thereafter be declared by judicial or other competent authority to be invalid."

§ 10.14 *Records, reports and audits.* (a) From the date of issuance of this part, each person subject to its provisions shall retain in his possession the records which he customarily maintains of inventories, receipts, deliveries and use. This does not require any addition to present accounting records and methods and does not specify any particular accounting method.

(b) Persons subject to this part shall make such records and submit such reports to the National Production Authority as it shall require, subject to the terms of the Federal Reports Act.

(c) All records required shall be made available at the usual place of business where maintained, for inspection and audit by duly authorized representatives of the National Production Authority.

§ 10.15 *Applications for adjustment or exception.* Any person affected by any provision of this part may file an application for an adjustment or exception upon the ground that such provision works an exceptional and unreasonable hardship upon him not suffered generally by others in the same trade or industry or that its enforcement against him would not be in the interest of the national defense program. All such applications, as well as any other letters or questions, should be addressed to the National Production Authority, Washington 25, D.C., Ref: R-I.

§ 10.16 *Violations.* Any person who wilfully violates any provision of this part, or furnishes false information or conceals any material fact in the course of operation under it, is guilty of a crime and upon conviction may be punished by fine or imprisonment or both. In addition, administrative action may be taken against any such person to compel necessary adjustment of his inventories or to suspend his privilege of making or receiving further deliveries of materials subject to this part.

NOTE: All reporting and record-keeping requirements of this part have been approved by the Bureau of the Budget in accordance with the Federal Reports Act of 1942.

This regulation shall take effect on September 18th, 1950.

NATIONAL PRODUCTION
AUTHORITY,
WILLIAM H. HARRISON,
Administrator.

[SEAL]

TABLE I—MATERIALS TO WHICH THIS REGULATION APPLIES

BUILDING MATERIALS	
Portland cement.	
Gypsum board, sheathing and lath.	
CHEMICALS	
Alcohol, industrial (ethyl alcohol).	
Benzene (benzol).	
Caustic soda, all grades, liquid and solid.	
Chlorine, gaseous and liquid.	
Glycerine, crude and refined.	
Soda ash (sodium carbonate), all grades.	
FOREST PRODUCTS	
Lumber:	
Softwood and hardwood, rough-sawn, dressed, or worked to a pattern, including: box, crates and package shooks manufactured from sawed lumber; softwood cut stock, and hardwood small dimension stock; but not including railway cross ties, mine ties and hardwood flooring.	
Softwood plywood:	
Softwood plywood including: softwood plywood made in hardwood plywood mills; plywood which has a softwood face; and softwood plywood which has been overlaid with paper, plastic, metal, or other material, but not including hardwood veneer.	
Wood pulp.	
IRON AND STEEL	
Iron:	
Pig iron.	
Gray iron castings, rough and semifinished; malleable iron castings, rough and semifinished.	
Steel (Carbon and alloy, including stainless).	
Ingots and semifinished steel, including skelp; steel castings, rough and semifinished; structural shapes and piling; plates; rails and track accessories; wheels and axles; bars, including reinforcing and cold finished bars; standard pipe and tubing; wire, wire rods and wire products; tin plate,terne plate and black plate; hot rolled sheet and strip; cold rolled sheet and strip; galvanized sheet and strip; electrical sheet and strip; and other mill shapes and forms.	
Forgings, rough.	
Iron and steel scrap.	
METALS AND MINERALS	
Aluminum:	
Primary and secondary in crude form.	
Semifabricated shapes: castings (including die); plate, sheet and strip; rolled structural shapes, rod, bar and wire; extruded shapes; tube blooms and tubings; powder, flake and paste.	
All aluminum and aluminum base scrap containing commercially recoverable aluminum.	
Columbium:	
Ferro-columbium, potassium columbium fluoride, columbium oxide, and columbium carbide.	
All scrap or secondary material containing commercially recoverable columbium.	
Cobalt:	
Cobalt, the element in any form and combination with other elements in which cobalt is an essential constituent, except: cobalt concentrates; cemented carbide tipped tools, cast cobalt-chrome-tungsten-molybdenum tools, alloy hard-facing welding rods and materials, and paints, varnishes, lacquers, inks, and similar products, containing cobalt driers.	
All scrap or secondary materials containing commercially recoverable cobalt.	
Copper:	
Refined copper (fire refined and electrolytic).	
Secondary copper and copper-base alloys.	
Copper and copper base alloys: alloy plate, sheet and strip alloy rod, bar and wire (including extruded shapes) alloy tube and pipe; unalloyed rod, bar and wire (including extruded shapes); unalloyed tube and pipe copper wire and wire products; copper and copper-base alloy castings.	
All copper and copper base alloy scrap containing commercially recoverable copper.	
Magnesium:	
Magnesium, primary and secondary ingots.	
Semifabricated shapes.	
All magnesium base alloy scrap containing commercially recoverable magnesium.	

Manganese:

Manganese metal, ferro-manganese, spiegeleisen and all other compounds and alloys in which manganese is an essential and recognizable component.
All scrap and material containing sufficient manganese to be of commercial value.

Nickel:

Nickel, alloyed or unalloyed.
Imported nickel matte.
Nickel and nickel alloy, metal (cathode nickel, pigs, shot, and other primary forms).
Nickel and nickel alloy, secondary.
Nickel and nickel alloy, semifinished; bars, rods, tubes, sheet bar, ingot, blooms, billets, sheet strip and similar mill products not further manufactured.
All nickel and nickel base alloy scrap and nickel silver scrap containing commercially recoverable nickel.

Tin:

Tin, primary and secondary.
All tin and tin base alloy scrap containing commercially recoverable tin.

Tungsten:

Tungsten, in any form or shape into which it may be fabricated: except such finished forms as are fabricated for installation (without further processing) into electrical communication systems, incandescent lamps, and electronic equipment such as radio, radar and similar products.

Tungsten, ferro, metal powder and any other ferrous combination of the element tungsten in semimanufactured or manufactured form, excluding alloy steel, high speed steel and tool steel.

Tungsten, all nonferrous mixtures or alloys containing tungsten, prepared for any purpose requiring further processing, whether the same or manufactured by means of melting, pressing, sintering, brazing, soldering or welding, including but not limited to mixtures or alloys to be used in the production of tools and tool blanks or as hard facing materials; but not including any finished tools.

Tungsten, all chemical compounds having tungsten as a recognizable and essential component.

Tungsten, all scrap or secondary material containing commercially recoverable tungsten.

Zinc:

Zinc, slab (all grades).
Zinc, base alloy in crude form.
Zinc, dust and oxide.
Zinc, and zinc-base alloy scrap containing commercially recoverable zinc.

Nonferrous scrap not covered above.

RUBBER MATERIALS

Natural rubber, dry latex.
Synthetic rubbers, including latices, GR-S, butyl, neoprene, and N-types.

TEXTILE MATERIALS

Burlap (Hessian).
Cotton pulp.
High tenacity rayon yarn.
Nylon staple and nylon filament yarn.

[F.R. Doc. 50-8241; Filed, Sept. 18, 1950; 8:45 a.m.]

TITLE 32A—NATIONAL DEFENSE, APPENDIX

Chapter VI—National Production Authority

[NPA Order M-10]

PART 30—COBALT

This order is found necessary and appropriate to promote the national defense and is issued pursuant to the authority granted by section 101 of the Defense Production Act of 1950. In the formulation of this order consultation with industry representatives has been rendered impracticable due to the necessity for immediate action and because the order affects a large number of users in different trades and industries.

Sec.
30.1 What this part does.
30.2 Cobalt to which this part applies.
30.3 Limitation on inventory.
30.4 Placing and adjusting orders.

AUTHORITY: §§ 30.1 to 30.4 issued under sec. 704, Pub. Law 774, 81st Cong. Interpret or apply sec. 101, Pub. Law 774, 81st Cong.; sec. 101, E.O. 10161, Sept. 9, 1950, 15 F.R. 6105.

§ 30.1 *What this part does.* This part establishes specific inventory limitations for cobalt. It thus supplements Part 10 of this chapter (NPA Reg. 1) but supersedes Part 10 only insofar as inconsistent therewith.

§ 30.2 *Cobalt to which this part applies.* This part applies to all kinds and forms of cobalt as described in Table I to Part 10 of this chapter (NPA Reg. 1). This part applies also to imported as well as domestic cobalt except where such imported cobalt remains in the hands of the person buying it directly from the foreign seller.

§ 30.3 *Limitation on inventory.* No person may receive delivery of cobalt if his inventory thereof exceeds, or by such receipt would be made to exceed, his minimum requirements for the succeeding 20 days at his then scheduled method and rate of operation.

§ 30.4 *Placing and adjusting orders.* No person shall place any order calling for delivery of cobalt earlier or in quantities greater than he would be permitted to receive under § 30.3. Any person who, on the effective date of this part or at any other time, has outstanding orders for cobalt calling for delivery earlier or in quantities greater than he would be permitted to receive under § 30.3 shall forthwith notify his supplier of the extent to which delivery cannot be accepted as scheduled, and such orders shall be accordingly adjusted.

This part shall take effect on November 30, 1950.

NATIONAL PRODUCTION
AUTHORITY,

W. H. HARRISON,
Administrator.

[SEAL]

[F.R. Doc. 50-10919; Filed, Nov. 29, 1950; 12:06 p.m.]

TITLE 32A—NATIONAL DEFENSE, APPENDIX

Chapter VI—National Production Authority

[NPA Order M-10, as Amended December 30, 1950]

PART 30—COBALT

This order, as amended, is found necessary and appropriate to promote the national defense and is issued pursuant to the authority granted by section 101 of the Defense Production Act of 1950. In the formulation of this order, as amended, there has been consultation with industry representatives, including trade association representatives, and consideration has been given to their recommendations.

This amendment constitutes, in effect, a completely new order, inasmuch as the former Order M-10, as issued on November 30, 1950, contained only inventory control provisions similar to those contained in § 30.8 of this amended order.

EXPLANATORY PROVISIONS

Sec.
30.1 What this part does.
30.2 Relation to other regulations.
30.3 Definitions.

RESTRICTIONS ON USE

30.4 Uses prohibited.
30.5 Substitution required.

RESTRICTIONS ON DELIVERIES

30.6 Allocation authorizations required.
30.7 Exceptions from allocation requirements.
30.8 Limitation on inventory.

RECORDS AND REPORTS

- 30.9 Records to be kept.
30.10 Audit and inspection.
30.11 Reports.

GENERAL PROVISIONS

- Sec.
30.12 Adjustments and exceptions.
30.13 Communications.
30.14 Violations.

AUTHORITY: §§ 30.1 to 30.14 issued under sec. 704, Pub. Law 774, 81st Cong. Interpret or apply sec. 101, Pub. Law 774, 81st Cong.; sec. 101, E.O. 10161, Sept. 9, 1950, 15 F.R. 6105.

EXPLANATORY PROVISIONS

§ 30.1 *What this part does.* The purpose of this part is to conserve and provide for the distribution of the limited supply of cobalt so as best to serve the interest of national defense and essential civilian production. This part prohibits the use of this strategic material in the manufacture of specified products which are relatively less essential or in which substitute materials may effectively be used. It establishes limits on additions to inventory and brings cobalt under allocation by prohibiting, subject to limited exceptions, any deliveries not covered by allocation authorizations to be issued monthly by the National Production Authority. Provision is thus made whereby the supply remaining after defense requirements are met may be equitably distributed through normal channels for essential civilian uses and with due regard for the needs of new and small businesses.

§ 30.2 *Relation to other regulations.* The provisions of this part supersede other National Production Authority regulations and orders with which they are in conflict but in all other respects such regulations and orders remain applicable to cobalt. In particular, Part 11 of this chapter (NPA Regulation 2) continues to apply to cobalt, but deliveries on DO rated orders, as well as on any other orders, may be made only in accordance with allocation authorizations, except as otherwise provided in this part. The National Production Authority may from time to time issue special directives as to deliveries of cobalt and, unless otherwise provided therein, such directives will prevail over the provisions of this part.

§ 30.3 *Definitions.* As used in this part:

(a) "Person" means any individual, corporation, partnership, association or any other organized group of persons and includes any agency of the United States or any other government.

(b) "Cobalt" means cobalt metal, cobalt alloys, cobalt oxide, cobalt salts, and all other primary chemical compounds which result from the processing of cobalt ores, concentrates, crudes, or cobalt residues and cobalt-bearing scrap.

(c) "Manufacture" means to melt, alloy, mix, fabricate or process in any other way, or assemble or incorporate in assemblies, or to consume or otherwise employ in the course of manufacture, any cobalt; but does not include the installation of a finished product or repair part for the ultimate consumer.

RESTRICTIONS ON USE

§ 30.4 *Uses prohibited.* (a) After January 31, 1951, no person shall use cobalt in the manufacture of pigments in any form: *Provided, however,* That this prohibition shall not apply to:

(1) The use of cobalt in the manufacture of driers, blue glass where necessary for optical or safety purposes, laboratory equipment, decalcomanias for decorating tableware, or artists' materials.

(2) The use of cobalt required by any person to fill an order that is rated under the priorities system established by Part 11 of this chapter (NPA Regulation

2) or to comply with any order or directive of the National Production Authority.

(3) The use by any person of a quantity of cobalt not in excess of 50 pounds (cobalt content), during any 3-month period beginning February 1, 1951, for all purposes otherwise prohibited under this section.

(b) During January 1951, no person shall use more cobalt for the purposes prohibited in paragraph (a) of this section than the average monthly amount he used for such purposes during the third calendar quarter of 1950.

§ 30.5 *Substitution required.* No cobalt oxide shall be used for any purpose where (a) there is available a mixed cobalt-nickel oxide which it is not economical or practicable to separate into cobalt oxide and nickel oxide and (b) the use of such material is not deleterious to the public health.

RESTRICTIONS ON DELIVERIES

§ 30.6 *Allocation authorizations required.* (a) After January 31, 1951, no person shall deliver cobalt or accept delivery of cobalt (including any person importing directly for his own use) in any month except in accordance with the terms of an allocation authorization issued for such month by the National Production Authority on Form NPAF-16.

(b) An application for an allocation authorization must be filed with the National Production Authority by the purchaser on Forms NPAF-15 and NPAF-16 not later than the 15th day of the month preceding the month in which delivery is sought. Such application must furnish all information required by the form.

(c) The authorization allocation (Form NPAF-16) issued will be sent by the National Production Authority to the appropriate supplier(s) and a copy furnished to the purchaser. The authorization requires the supplier to make delivery to the extent of the purchaser's orders within the limit of the authorization. In placing his orders, the purchaser shall specify the date and serial number of the applicable allocation authorization. The purchaser may only use cobalt received under an authorization by the National Production Authority for the uses specified in NPAF-16.

§ 30.7 *Exceptions from allocation requirements.* The provisions of § 30.6 shall not apply to—

(a) Deliveries of cobalt to the General Services Administration for the sole purpose of stockpiling.

(b) Deliveries of cobalt directly from a foreign source for the purpose of resale only.

(c) Deliveries of cobalt to any person whose total receipts from all sources during the current calendar month are not thereby made to exceed 25 pounds (cobalt content) and who so certifies to his supplier in substantially the following form on his order:

The undersigned certifies to the supplier, and to the National Production Authority, that receipt of this shipment in the month requested will not bring our total receipts of cobalt during that month above 25 pounds (cobalt content).

(d) Deliveries of cobalt bearing scrap, cobalt ores and concentrates.

§ 30.8 *Limitation on inventory.* No person (notwithstanding any allocation made to him) shall place an order for cobalt calling for delivery, and no person shall accept delivery of cobalt, at a time when his inventory thereof exceeds, or by acceptance of such delivery would be made to exceed, one month's minimum requirements at his then scheduled rate and method of operation, or a minimum practicable working inventory within the meaning of Part 10 of this chapter (NPA Regulation 1), whichever is smaller. Any person who, on the effective date of this part or at any other time, has outstanding orders for cobalt calling for delivery earlier or in quantities greater than he would be permitted to receive under this section, shall forthwith notify his supplier of the extent to which delivery can-

not be accepted as scheduled, and such orders shall be adjusted accordingly. Imported, as well as domestic cobalt, except when such imported cobalt remains in the hands of a person who has purchased it directly from a foreign seller, is subject to this section and so is to be included in computing inventory. Cobalt which has been processed to any degree, but has not yet been actually incorporated into a finished or partially-finished product, is likewise to be included in computing inventory.

RECORDS AND REPORTS

§ 30.9 *Records to be kept.* Each person participating in any transaction covered by this part shall retain in his possession for at least two years records of receipts, deliveries, inventories, and use, in sufficient detail to permit an audit that determines for each transaction that the provisions of this part have been met. This does not specify any particular accounting method and does not require alteration of the system of records customarily maintained, provided such records supply an adequate basis for audit. Records may be retained in the form of microfilm or other photographic copies instead of the originals.

§ 30.10 *Audit and inspection.* All records required by this part shall be made available at the usual place of business where maintained for inspection and audit by duly authorized representatives of the National Production Authority.

§ 30.11 *Reports.* (a) Every person who at any time in a calendar month had in his possession or under his control or during the month consumed more than 50 pounds of cobalt (i.e., cobalt content), shall report to the National Production Authority on Form NPAF-15 on or before the 15th day of the following month. However, if he applies on such form for an allocation of cobalt for delivery during the succeeding month, his application serves also as the required report.

(b) Persons subject to this part shall make such records and submit such reports to the National Production Authority as it shall require, subject to the terms of the Federal Reports Act (5 U.S.C. 139-139F).

NOTE: All record-keeping and reporting requirements of this part have been approved by the Bureau of the Budget in accordance with the Federal Reports Act.

GENERAL PROVISIONS

§ 30.12 *Adjustments and exceptions.* Any person affected by any provision of this part may file a request for adjustment or exception upon the ground that such provision works an undue or exceptional hardship upon him not suffered generally by others in the same trade or industry, or its enforcement against him would not be in the interest of the national defense or in the public interest. In considering requests for adjustment claiming that the public interest is prejudiced by the application of any provision of this part, consideration will be given to the requirements of the public health and safety, civilian defense, and dislocation of labor and resulting unemployment that would impair the defense program. Each request shall be in writing and shall set forth all pertinent facts and the nature of the relief sought and shall state the justification therefor.

§ 30.13 *Communications.* All communications concerning this part shall be addressed to the National Production Authority, Washington 25, D.C., Ref: M-10.

§ 30.14 *Violations.* Any person who wilfully violates any provision of this part, or furnishes false information or conceals any material fact in the course of operation under it, is guilty of a crime and upon conviction may be punished by fine or imprisonment, or both. In addition, administrative action may be taken against any such person to suspend his privilege of making or receiving further deliveries of ma-

terials or using facilities under priority or allocation control and to deprive him of further priorities assistance.

This part, as amended, shall take effect on December 30, 1950.

NATIONAL PRODUCTION
AUTHORITY,
W. H. HARRISON,
Administrator.

[SEAL]

[F.R. Doc. 51-150; Filed, Jan. 2, 1951; 12:07 P.M.]

TITLE 32A—NATIONAL DEFENSE, APPENDIX

Chapter VI—National Production Authority, Department of Commerce

[NPA Order M-1, as amended April 6, 1951]

M-1—IRON AND STEEL

This amendment to order M-1 is found necessary and appropriate to promote the national defense and is issued pursuant to authority granted by section 101 of the Defense Production Act of 1950. In the issuance of this amendment, consultation with industry representatives has been rendered impracticable due to the necessity for immediate action.

This amendment affects NPA Order M-1, as amended March 15, 1951, in the following respects:

It adds a sentence at the conclusion of section 8; redesignates sections 14 to 19 inclusive, as sections 15 to 20, inclusive; adds a new section designated section 14; designates the text of section 17 (as redesignated) as paragraph (a); adds to section 17 (as redesignated) a new paragraph designated paragraph (b); changes the word "Column" wherever it occurs to "Part"; and amends Table I, as set out at the end of the order, in its entirety.

Sec.

1. What this order does.
2. Forms of iron and steel products to which this order applies.
3. Required shipment dates.
4. Rejection of rated orders (lead time).
5. Product limitation for acceptance of rated orders.
6. Conditions for acceptance of rated orders.
7. Changes in lead time.
8. Allotments for further conversion.
9. Extension of ratings for further conversion of steel products.
10. NPA assistance in placing rated orders.
11. Scheduled programs.
12. Minimum orders.
13. Inventories.
14. Ferro-alloys.
15. Application for adjustment or exception.
16. Communications.
17. Reports.
18. Records.
19. Audits and inspection.
20. Violations.

AUTHORITY: Sections 1 to 20 issued under sec. 704, Pub. Law 774, 81st Cong. Interprets or applies sec. 101, Pub. Law 774, 81st Cong., sec. 101, E.O. 10161, Sept. 9, 1950, 15 F.R. 6105, 3 CFR 1950 Supp.; sec. 2, E.O. 10200, Jan. 3, 1951, 16 F.R. 61.

SECTION 1. *What this order does.* This order applies particularly to producers of iron and steel and provides rules for placing, accepting, and scheduling rated orders for iron and steel. Its purpose is to provide equitable distribution of rated orders among all iron and steel producers of the particular products in order to make possible maximum production and to reduce to a minimum disruption of normal distribution. It makes provision for required acceptance of rated orders based on a percentage of previous shipments, and provides for allotment and maximum inventories. It

supplements NPA Regs. 1 and 2, but only those provisions of Regs. 1 and 2 which are inconsistent with this order are superseded, and all other provisions of those regulations continue to apply to the iron and steel industry.

SEC. 2. Forms of iron and steel products to which this order applies. The iron and steel products to which this order applies are set out in Table I at the end of this order. Table I also sets out the lead time (days) and product limitation for acceptance of rated orders. This order also applies to all second quality materials and shearings and material sorted or salvaged from steel scrap and sold for other than remelting purposes.

SEC. 3. Required shipment dates. A rated order for iron or steel in any of the forms listed in Part A of Table I must specify shipment on a particular date or in a particular month, which, in no case, may be earlier than required by the person placing the order. The producer of iron or steel must schedule the order for shipment within the requested month as close to the requested shipment date as is practicable considering the need for maximum production.

SEC. 4. Rejection of rated orders (lead time). A producer of iron or steel in a form listed in Part A of Table I need not accept a rated order which is received by him less than the number of days (lead time) set forth in Part B of Table I prior to the first day of the month in which shipment is requested, unless specifically directed to accept such order by the National Production Authority.

SEC. 5. Product limitation for acceptance of rated orders. Unless specifically directed by NPA, no iron or steel producer shall be required to accept rated orders for shipment from any one producing unit regardless of location in any one month in excess of the percentages set forth in Part C of Table I, of his average monthly shipments of the products listed in said part, as made by him during the period from January 1, 1950, through August 31, 1950. Where no percentage limitation is set forth as to any product, it is expected that the amount of such product to be called for by rated orders will be relatively small.

SEC. 6. Conditions for acceptance of rated orders. Unless otherwise specifically directed by the National Production Authority, and subject to the provisions of NPA Reg. 2, each iron or steel producer shall be required to accept rated orders calling for shipment in any one month from any one of his producing units regardless of location, of products listed in Part A of Table I up to the amount of the percentages listed in Part C of Table I of his average monthly shipments of such products from that producing unit during the period from January 1, 1950, to August 31, 1950. Where no percentage is listed in Part C, in regard to any iron or steel product, each iron or steel producer shall be required to accept all rated orders served upon him, subject to the provisions of NPA Reg. 2, unless otherwise specifically directed by the National Production Authority.

SEC. 7. Changes in lead time. (a) If an iron or steel producer would have an open space on his production schedule created by the difference between the lead time of forty-five days as established by this order as originally issued or as subsequently amended, and a longer lead time as established by section 4 of this order, he shall continue to accept rated orders to fill such open space on his production schedule, on the basis of a lead time of forty-five days, before he applies the newly established longer lead time. In filling such open space on his production schedule, as above referred to, an iron or steel producer shall be governed by the product limitation percentage appearing in Part C of Table I.

Example: Under the previously established lead time of 45 days, a steel producer would, up to December 17, 1950, accept DO rated orders for shipment in February 1951. Where a lead time has been increased to 120 days, he would, up to January 31, 1951, accept DO rated orders for shipment in June 1951. In the application of this example, the steel producer would continue to accept DO rated orders for shipment in March and April 1951, on the 45-day lead time until he had arrived in any one month at the product limitation percentage of that product as set forth in Part C, of Table I. Thereafter, he would conform to the new lead time of 120 days for shipment in the succeeding months.

(b) In the example in paragraph (a) of this section, if the product limitation percentage under Part C of Table I as to that particular iron or steel product has been increased from 5 percent to 10 percent, the iron or steel producer should accept DO rated orders up to the amount of the new product limitation percentage figure, commencing with shipments for the month of March 1951, and should continue at that new figure thereafter.

SEC. 8. Allotments for further conversion. A steel producer who buys from another steel producer a steel product listed under the heading "Steel Mill Products" in Part A of Table I (herein called "steel mill products"), and by further processing converts, for resale, the purchased steel into another steel mill product is engaged in further conversion. For the purpose of this section, the steel producer who sells a steel mill product for further conversion shall be called a producer supplier and the steel producer engaged in further conversion shall be called a converter. Each producer supplier shall make a monthly allotment of his production of each steel mill product that remains after shipments on DO ratings and NPA directives to each of his converter customers. Such monthly allotment shall be at least equal to that percentage of his available production so remaining, as the producer supplier's shipments to each converter customer bore to his total shipments, during the base period, from January 1, 1950, through September 30, 1950. A producer supplier must accept orders placed by his converter customer up to the limit of his allotment: *Provided, however,* That such orders are placed in accordance with the lead times in Part B of Table I. Shipments under such allotments shall be made in addition to shipments to the same converter customer pursuant to authorized extension of DO ratings. Orders placed under the provisions hereof must be for substantially the same product as was supplied to each such converter during such period, except for minor variations in size and design. In determining the amount of the monthly allotments, adjustments may be made by a producer supplier, with the consent of the converter involved, to provide for any abnormal situations which affect any steel products. Producer converters in Canada shall be entitled to the benefits of this section, and producer suppliers in the United States shall make monthly allotments to Canadian producer converters in accordance with the provisions of this section.

SEC. 9. Extension of ratings for further conversion of steel products. All DO ratings extended for the purpose of further conversion of steel products shall have the symbol FC added to the two-digit designation following the prefix DO on the order.

SEC. 10. NPA assistance in placing rated orders. Any person who is unable to place a rated order for iron or steel due to the limitations imposed by sections 5 and 6 of this order should apply to the NPA, Iron and Steel Division, Ref.: M-1, specifying the producers who refused to accept the order. The NPA will arrange to assist him in locating other sources of supply.

SEC. 11. Scheduled programs. NPA will from time to time approve scheduled programs calling for the

production and delivery of iron and steel products for stated purposes, over specified periods of time. Upon approval of major programs of this type, supplements to this order will be issued describing such programs and specifying the manner in which they are to be carried out by the iron and steel industry. Thereafter, directives will be issued to individual concerns establishing schedules for their participation in such programs. Such directives shall be complied with by the recipients in accordance with the terms thereof, unless otherwise directed by NPA.

SEC. 12. Minimum orders. The minimum orders that may be placed with DO ratings or under NPA directives are set out in Table II at the end of this order. The minimum quantity for each size and grade of any item for shipment at any time to any one destination is listed opposite the appropriate item. If all other requirements of this order have been met, orders for such minimum quantities shall be accepted.

SEC. 13. Inventories. In addition to the provisions of NPA Reg. 1, relating to inventory control, it is considered that a more exact requirement applying to users of iron or steel products is necessary. No person obtaining iron or steel products for use in manufacture, processing, or construction, may receive or accept delivery of a quantity of iron or steel products if his inventory is, or by such receipt would become, in excess of that necessary to meet his deliveries or supply his services on the basis of his scheduled method and rate of operation pursuant to this order during the succeeding 45-day period, for steel products, gray and malleable iron castings, and 30-day period for pig iron, or in excess of a practicable minimum working inventory (as defined in NPA Reg. 1), whichever is less. For the purpose of this section, iron and steel products listed in Table I in which only minor changes or alterations have been effected shall be included in inventory. NPA Reg. 1 will apply to iron and steel products except as modified by this section. Said 45-day limitation does not apply to persons who order structure steel for use in construction (including buildings, bridges, and other structures of a like type) and who order it delivered cut to the specifications required for a specific project and who normally keep such steel segregated for the specific project. Instead, no such person may accept delivery of such steel more than 45 days before it is scheduled to be fabricated or, if it is not to be further fabricated, before it is scheduled to be assembled.

SEC. 14. Ferro-alloys. (a) As used in this section and in section 17 of this order, "ferro-alloys" means and includes, in such form or condition that the same may be used in the production of alloy iron, steel, or nonferrous products, the following elements and their compounds, and scrap containing usable quantities of any one or more of such elements or of any compound or compounds of any one or more of such elements: Boron, calcium, chromium, cobalt, columbium, manganese, molybdenum, nickel, silicon, tantalum, titanium, tungsten, vanadium, and zirconium.

(b) Every person shall comply with any direction or directions issued by NPA respecting the use, and restrictions and limitations on the use, of any ferro-alloy or alloys in the production of alloy iron, steel, or nonferrous products.

(c) No person shall receive or accept delivery of any ferro-alloy to be used for alloying purposes at a time when his inventory thereof exceeds, or by acceptance of such delivery would be made to exceed, 45 days' requirements on the basis of his then scheduled method and rate of operation or a practicable minimum working inventory (as defined in NPA Reg. 1), whichever

is less. The provisions of this paragraph shall be construed to supersede the inventory limitation provisions of NPA Orders M-10 (Cobalt), M-14 (Nickel), M-30 (Tungsten), M-33 (Molybdenum), and M-49 (Columbium and Tantalum), so far as the inventory limitation provisions of said orders apply to persons having in inventory any ferro-alloy to be used for alloying purposes.

SEC. 15. Application for adjustment or exception. Any person affected by any provision of this order may file a request for adjustment or exception upon the ground that his business operation was commenced during or after the base period, or because any provision otherwise works an undue or exceptional hardship upon him not suffered generally by others in the same trade or industry, or its enforcement against him would not be in the interest of the national defense or in the public interest. In considering requests for adjustment claiming that the public interest is prejudiced by the application of any provision of this order, consideration will be given to the requirements of the public health and safety, civilian defense, and dislocation of labor and resulting unemployment that would impair the defense program. Each request shall be in writing, shall set forth all pertinent facts and the nature of the relief sought, and shall state the justification therefor.

SEC. 16. Communications. All communications concerning this order shall be addressed to National Production Authority, Washington 25, D.C., Ref: M-1.

SEC. 17. Reports. (a) Persons subject to this order shall make such records and submit such reports to the NPA as it shall require, subject to the terms of the Federal Reports Act (P.L. 881, 77th Cong., 5 U.S.C. 139-139F). In accordance with this section all steel producers are required to report on "NPAF-13—Steel Producers' Report of Orders Accepted for DO Ratings and Programs" the orders accepted bearing DO ratings and orders resulting from programs made effective by NPA directives; and on "NPAF-17—Steel Producers' Monthly Report of Shipments and Past Due Orders" the record of the shipments and past due orders by DO ratings and programs made effective by NPA directives.

(b) Every person shall submit to NPA such reports as it shall require with respect to the receipt, consumption, shipment, and maintenance in inventory of any ferro-alloy as defined in section 14 (a) of this order: *Provided*, That no person shall be required to file, as to any ferro-alloy, any report in addition to such report with respect thereto as he files pursuant to any order of NPA establishing allocation or inventory control over the use of such ferro-alloy.

SEC. 18. Records. Each person participating in any transaction covered by this order shall retain in his possession for at least 2 years records of receipts, deliveries, inventories, and use, in sufficient detail to permit an audit that determines for each transaction that the provisions of this order have been met. This does not specify any particular accounting method and does not require alteration of the system of records customarily maintained, provided such records supply an adequate basis for audit. Records may be retained in the form of microfilm or other photographic copies instead of the originals.

SEC. 19. Audit and inspection. All records required by this order shall be made available at the usual place of business where maintained for inspection and audit by duly authorized representatives of the NPA.

SEC. 20. Violations. Any person who wilfully violates any provision of this order or any other order or regulation of NPA or who wilfully conceals a mate-

TABLE 1.—Iron and steel products to which this order applies—Refer to Section 5

Part A Name of product	Part B Lead times (days)				Part C Production limitation, required acceptance (percentage)		
	Carbon	Low alloy	Stainless	Full alloy	Carbon (including low alloy high strength)	Stainless	Full alloy
	(1)	(2)	(3)	(4)	(1)	(2)	(3)
Steel (including wrought iron) mill products:							
Ingot	45	75	75	75	10 ⁽¹⁵⁾	25	28
Billets, projectile and shell quality	45	75	75	45	12 25	XXXX ²	12 48
Blooms, slabs, billets (except projectile and shell quality)	45	75	75	75	35	50	63
Tube rounds	45	75	75	75	10	50	5
Sheet bars	45	75	75	75	5	XXXX	XXXX
Skelp	45	75	90	75	25		50
Wire rods	45	75	150	90	30	XXXX	XXXX
Structural shapes (heavy)	45				30	XXXX	(1)
Steel piling				(1)	XXXX	XXXX	25
Plates—rolled armor	45	75	90	75	4 30	XXXX	
Plates—other	45			90	10	XXXX	
Rails—standard (over 60 pounds)	45			90	10	XXXX	
Rails—all other	45			90	10	XXXX	
Joint bars	45				10	XXXX	XXXX
Tie plates	45				10	XXXX	XXXX
Track spikes	45			90	5	XXXX	5
Wheels (rolled and forged)	45			90	5	XXXX	5
Axles							
Bars—hot-rolled, projectile and shell quality (includes all projectile components such as fuzes, adapters, and base plugs)	45	75		75	(13)	XXXX	(14) (5)
Bars—hot-rolled, other (including light shapes)	45	75	90	75	35	50	50
Bars—reinforcing	45				20	XXXX	XXXX
Bars—cold-finished	60	105	105	105	25	50	40
Bars—tool steel	45		120	90	10	XXXX	
Standard pipe	45					XXXX	XXXX
Oil-country goods	45				10	XXXX	
Line pipe	45		120	120	35	50	60
Mechanical tubing	45		120	120	30	50	25
Pressure tubing	45	75	90	(10)		50	25
Wire—drawn	45				10	XXXX	XXXX
Wire—nails and staples	45				10	XXXX	XXXX
Wire—barbed and twisted	45				5	XXXX	XXXX
Wire—woven wire fence	45				5	XXXX	XXXX
Wire—bale ties	45				5	XXXX	XXXX
Tin mill black plate	45				5	XXXX	XXXX
Tin and terneplate, hot-dipped	45				5	XXXX	XXXX
Tin plate, electrolytic	45	75	90	75	30	40	5
Sheets—hot-rolled	45	75	105	90	16	40	5
Sheets—cold-rolled	45	75			20	XXXX	XXXX
Sheets—galvanized	45	75			16	XXXX	XXXX
Sheets—all other coated	45				5	XXXX	XXXX
Sheets—enameling	45						
Electrical sheets and strip	(7)	75	90	75	(7)	12	25
Strip—hot-rolled	45	75	105	90	16	25	5
Strip—cold-rolled							
Steel castings:					XXXX	20	20
High alloy, rough as cast (heat and corrosion resisting)	11 60	11 90		11 90	20	XXXX	XXXX
Carbon and low alloy					30	20	30
Steel products, fabricated:	90	120	120	120			
Forgings (rough as forged)	45				15	25	
Fence posts	45		105		5	15	XXXX
Wire rope and strand	45		105		5		XXXX
Welded wire mesh	45		105		10		
Netting	45				5		
Frogs and switches	45						
Track bolts							
Iron products:					15	XXXX	XXXX
Pig iron (not including iron with more than 6 percent silicon)	45				20	XXXX	XXXX
Malleable casting (rough as cast)	11 60				20	XXXX	XXXX
Gray iron, excluding pipes and fittings (rough as cast)	11 60						

¹ No "product limitation" or "lead time," whichever is applicable. Subject to direct negotiation by NPA if necessary.

² Of each item.

³ Applies to special rolled shapes including angles and channels.

⁴ In addition all hot-rolled sheet producers are to set aside for plates an amount equal to 5 percent of the average monthly shipments of hot-rolled carbon sheets in the base period Jan. 1, 1950, through Aug. 31, 1950.

⁵ Includes bars—rounds for piercing.

⁶ If annealed or heat-treated, add an additional 15 days.

⁷ For electrical sheets and strip, use this table:

Lead time	Percentage limitation	Definition
Low grade, 45.....	7	AISI M50, M43, M36.
Medium grade, 45.....	35	AISI M29, M22, M19.
High grade, 60.....	60	AISI M17, M15, M14, and oriented.

⁸ If cold finished, add an additional 15 days.

⁹ If cold drawn or cold finished, 60 days; for welded tubing, 75 days.

¹⁰ Wire drawn: low carbon, 11 percent; high carbon, 16 percent.

¹¹ Lead times apply to unmachined castings after approval of patterns for production.

¹² Such percentage being the total for any combination of these products.

¹³ An amount equal to 35 percent of the tonnage represented by hot-rolled carbon bar set aside. This is in addition to tonnage set aside for hot-rolled bars.

¹⁴ An amount equal to 35 percent of the tonnage represented by hot-rolled alloy bar set aside. This is in addition to tonnage set aside for hot-rolled bars.

¹⁵ An amount equal to 25 percent of the tonnage represented by the carbon blooms, slabs, billets set aside. This is in addition to tonnage set aside for blooms, slabs, billets.

TABLE 2.—*Minimum orders that may be placed on steel mills, steel and iron foundries, steel forge shops and merchant pig iron producers for the products specified*

(Special grades, shapes, specifications, and similar factors must be handled by negotiation)

Name of product	Minimum quantity for each size and grade of any item for shipment at any one time to any one destination	Name of product	Minimum quantity for each size and grade of any item for shipment at any one time to any one destination
STEEL MILL PRODUCTS		STEEL MILL PRODUCTS—continued	
Carbon and low-alloy steel:		Full alloy steel—Continued	
Ingots, blooms, billets, slabs, and tube rounds, sheet bars, skelp, etc., rerolling quality.	25 net tons.	Blooms, slabs, billets (except projectile and shell quality) tube rounds, sheet bars, etc.: 7" square (or equivalent cross sectional area) and under.	5 net tons.
Blooms, billets, and slabs, forging quality.	Product of 1 ingot.	Larger than 7" square (or equivalent cross sectional area).	10 net tons.
Wire rods, hot-rolled.	5 net tons.	Both of the above may be modified because of a mill's ingot size and/or rolling schedules.	
Structural shapes.	5 net tons.	Wire rods.	5 net tons.
Plates:		Structural shapes.	By negotiation. ¹
Rolled armor.	By negotiation. ¹	Plates:	
Continuous strip mill production.	10 net tons.	Rolled armor.	By negotiation. ¹
Sheared, universal, or bar mill production.	3 net tons.	Other, whether rolled on continuous strip, sheared, universal or bar mill.	10 net tons.
Rails.	5 net tons.	(A steel producer need not accept an order unless the total quantity ordered is sufficient to make a heat of steel or unless ingots or slabs are available in stock or unless similar material is regularly being produced.)	
Track accessories (joint bars, tie plates, track spikes).	5 net tons.	Rails.	By negotiation. ¹
Bars, hot-rolled:		Wheels.	By negotiation. ¹
Projectile and shell quality.	Product of 1 heat. ²	Axles.	By negotiation. ¹
Round bars up to and including 3" and squares, hexagons, half rounds, ovals, etc., of approximately equivalent sectional area.	5 net tons.	Bars, hot-rolled, projectile and shell quality.	By negotiation. ¹
Round and square bars over 3" to but not including 8".	15 net tons.	Bars, hot-rolled, other:	
Bar size shapes (angles, tees, channels and zeos under 3").	5 net tons.	Rounds and squares 3½" and smaller.	5 net tons.
Bars, cold finished.	3 net tons.	Rounds and squares larger than 3½".	By negotiation. ¹
Bars, tool steel.	500 pounds.	Hexagons and flats.	5 net tons.
Pipe, published carload minimum (mixed sizes and grades).		Bars, cold-finished.	3 net tons.
Tubing:		Bars, tool steel.	500 pounds.
Seamless cold-drawn (O. D. in inches):		Oil-country goods.	By negotiation. ¹
Up to ¾" inclusive.	1,000 feet.	Mechanical tubing.	5 net tons.
Over ¾" to 1½" inclusive.	800 feet.	Pressure tubing.	By negotiation. ¹
Over 1½" to 3" inclusive.	600 feet.	Sheet and strip.	By negotiation. ¹
Over 3" to 6" inclusive.	400 feet.		
Over 6" .	250 feet.		
Seamless hot-rolled.	By negotiation. ¹		
Welded.	By negotiation. ¹		
Wire rods. (See above.)			
Wire, drawn, for further fabrication and manufacturing:			
Low-carbon.	1 net ton.		
High-carbon (0.40 carbon and higher):			
0.0475" and heavier.	1 net ton.		
Under 0.0475" to 0.021" inclusive.	1,000 pounds.		
Under 0.021" .	500 pounds.		
Wire merchant trade products, assorted.	5 net tons.		
Tin mill products—any 1 gauge.	5,000 pounds.		
Sheet, hot- and cold-rolled.	5 net tons.		
Strip, hot- and cold-rolled.	3 net tons.		
Stainless steel: No minimum on standard grades and sizes. For unusual grades or sizes the minimum order is to be worked out by negotiation. ¹			
Full alloy steel:			
Ingots.	Product of 1 heat. ²		
Billet, projectile and shell quality.	By negotiation. ¹		

¹ "By negotiation" means negotiation between the mill and its customer. If no acceptable arrangements are worked out, the NPA should be notified.² "1 heat" means one batch of metal made in 1 furnace.

rial fact or furnishes false information in the course of operation under this order is guilty of a crime and upon conviction may be punished by fine or imprisonment or both. In addition, administrative action may be taken against any such person to suspend his privilege of making or receiving further deliveries of materials or using facilities under priority or allocation control and to deprive him of further priorities assistance.

³ 2,000 pounds or less from any 1 pattern or mold, or a minimum production run by the producing foundry even though the delivery from such minimum run may cause the consumers' inventory to exceed the 45-day minimum stated in section 13.

NOTE: All reporting and record-keeping requirements of this order have been approved by the Bureau of the Budget in accordance with said Federal Reports Act.

This order as amended shall take effect on April 6, 1951.

[SEAL]

NATIONAL PRODUCTION
AUTHORITY,
MANLY FLEISCHMANN,
Administrator.

DEPARTMENT OF COMMERCE

National Production Authority

[NPA Notice 1]

DESIGNATION OF SCARCE MATERIALS

Pursuant to section 102 of the Defense Production Act of 1950 (P.L. 774, 81st Cong.) and Executive Order 10161 (15 F.R. 6105) the materials on List A set forth below are hereby designated as scarce materials.

Section 102 of the Defense Production Act of 1950 provides in part that, in order to prevent hoarding, no person shall accumulate (1) in excess of the reasonable demands of business, personal, or home consumption, or (2) for the purpose of resale at prices in excess of prevailing market prices, materials which have been designated as scarce materials or materials the supply of which would be threatened by such accumulation.

This designation shall take effect December 27, 1950.

NATIONAL PRODUCTION
AUTHORITY,

W. H. HARRISON,

Administrator.

[SEAL]

LIST A—DESIGNATION OF MATERIALS UNDER NPA NOTICE 1

BUILDING MATERIALS

Cast iron pressure pipe and fittings.
Cast iron soil pipe and fittings.
Gypsum board, sheathing and lath.
Insulation and insulation material in which pulp is a component.
Insulation board, structural, in which paper is a component.
Portland cement.

CHEMICALS

Benzene.
Carbon tetrachloride.
Dichlorobenzene, ortho, meta and para.
Glycerin, crude and refined.
Methanol.
Methyl chloride.
Methylene chloride.
Phthalic anhydride.
Polyethylene.
Styrene and polystyrene.
Titanium pigments.
Trichloroethylene.

IRON AND STEEL

Iron:
Pig iron.
Gray iron castings (excluding soil and pressure pipe and fittings) rough and semi-finished; malleable iron castings, rough and semi-finished.
Steel (carbon including low alloy high strength alloy, and stainless):
Ingots and semifinished steel, including skelp; steel castings, rough and semi-finished; structural shapes and piling; plates; rails and track accessories; wheels and axles; bars, hot rolled including light shapes and reinforcing; cold-finished bars; pipe; tubing; wire, wire rods and drawn wire products; tin plate, terne plate and tin mill black plate; hot-rolled sheet and strip; cold-rolled sheet and strip; other mill shapes and forms.
Forgings, rough.
Iron and steel scrap.

LUMBER, PLYWOOD, AND WOOD PULP

Lumber:
Softwood and hardwood, rough-sawn, dressed, or worked to a pattern, including: box, crate and package shooks manufactured from sawed lumber; softwood cut stock, and hardwood small dimension stock; but not including railway cross ties, mine ties and hardwood flooring.
Softwood plywood:
Softwood plywood including: softwood plywood made in hardwood plywood mills; plywood which has a softwood face; and softwood plywood which has been overlaid with paper, plastic, metal, or other material, but not including hardwood veneer.
Wood pulp.

METALS AND MINERALS

Aluminum:
Primary and secondary in crude form.
Semifabricated shapes, castings (including die); forgings, plate, sheet and strip; foil; rolled structural shapes, rod, bar and wire; extruded shapes, tube blooms and tubing; powder, flake and paste.

All aluminum and aluminum base scrap containing commercially recoverable aluminum.

Antimony, all forms.

Asbestos:

Amosite; grades B-1, B-3, D-3 and D3/M-1.

Chrysotile, grades G and G1, C and C2, C and CP1 and CP2, Arizona crude 1, and Arizona crude 2.

Crocidolite.

Cadmium:

Cadmium metal.

Cadmium, oxide.

Cadmium salts.

All scrap and secondary material containing commercially recoverable cadmium of the above listed types.

Cerium:

Cerium metal, cerium alloys, such as ferrocerium, cerium compounds in which cerium is a recognizable component, and other rare earth metals.

All scrap and waste material containing commercially recoverable cerium of the above listed types.

Chromium:

Chromium metal.

Ferrochromium, including chromium briquettes.

Chromium alloys, other, in which chromium is a recognizable component.

All scrap and waste materials containing commercially recoverable chromium of the above listed types.

Cobalt:

Cobalt, the element in any form and combination with other elements in which cobalt is an essential constituent, except: cobalt concentrates; cemented carbide tipped tools, cast cobalt-chrome-tungsten-molybdenum tools, alloy hard-facing welding rods and materials, paints, varnishes, lacquers, inks and similar products containing cobalt driers.

All scrap or secondary materials containing commercially recoverable cobalt.

Columbium:

Ferro-columbium, ferro-columbium-tantalum, potassium columbium fluoride, columbium oxide, and columbium carbide.

All scrap or secondary material containing commercially recoverable columbium of the above listed types.

Copper:

Refined copper (fire refined and electrolytic) including finery shapes such as wire bars, slabs, cakes, billets and ingots.

Secondary copper and copper-base alloys.

Copper and copper base alloys: alloy plate, sheet, strip; alloy rod, bar and wire (including extruded shapes); alloy tube and pipe; unalloyed rod, bar, wire (including extruded shapes); unalloyed plate, sheet and strip; unalloyed tube and pipe; copper wire and copper wire mill products; copper and copper-base alloy castings.

All copper and copper base alloy scrap containing commercially recoverable copper.

Diamonds, industrial.

Lead, all forms.

Magnesium:

Magnesium, primary and secondary ingots and intermediate forms (slab, billets, and blooms).

Semifabricated shapes such as castings (die and all other forgings, rolled and extruded shapes (rod and bar, plate, sheet and strip; pipe and tubing; ribbon; foil); powder and stick.

All magnesium base alloy scrap containing commercially recoverable magnesium.

Manganese:

Manganese metal, ferro-manganese, spiegeleisen and other compounds and alloys in which manganese is essential and recognizable component.

All scrap and material containing sufficient manganese of commercial value.

Mica, block, film and splittings.

Molybdenum:

Calcium molybdate.

Ferromolybdenum.

Molybdenum metal, in any form.

Molybdenum oxide, bulk and briquettes.

Molybdenum alloys and compounds, other, in which molybdenum is a recognizable component.

All scrap and waste materials containing commercially recoverable molybdenum of the above listed types.

Nickel:

Nickel, alloyed or unalloyed.

Imported nickel matte.

Nickel and nickel alloy, metal (cathode nickel, pigs, and other primary forms).

Nickel and nickel alloy, secondary.

Nickel and nickel alloy, semifinished; bars, rods, tube sheet bar, ingot, blooms, billets, sheet strip and similar products not further manufactured.

All nickel and nickel base alloy scrap and nickel scrap containing commercially recoverable nickel.

Platinum:

Platinum and platinum-base alloy refinery shapes, including bar, ingot, grain, nugget and sponge.

Platinum and platinum-base-alloy basic shapes and for including wire.

All platinum and platinum-base alloy scrap containing commercially recoverable platinum of the above listed types.

Talc, block (steatite).

Tantalum:

Tantalum metal and alloys such as ferro-tantalum.

All scrap and waste material containing commercially recoverable tantalum of the above listed types.

Tin:

Tin, primary and secondary.

All alloys containing tin.

Tin, chemicals, including tin oxide.

Tin products such as tin pipe and sheet.

All tin and tin-base alloy scrap containing commercially recoverable tin content.

Tungsten:

Tungsten, in any form or shape into which it may be fabricated: except such finished forms as are fabricated for installation (without further processing) into electrical communication systems, incandescent lamps and electronic equipment such as radio, radar and similar products.

Tungsten, ferro, metal powder and any other ferrous combination of the element tungsten in semimanufactured or manufactured form, excluding alloy steel, high speed steel and tool steel.

Tungsten, all nonferrous mixtures or alloys containing tungsten, prepared for any purpose requiring further processing, whether the same or manufactured by means of melting, pressing, sintering, brazing, soldering or welding, including but not limited to mixtures or alloys to be used in the production of tools and tool blanks or as hard facing materials; but not including any finished tools.

Tungsten, all chemical compounds having tungsten as a recognizable and essential component.

Tungsten, all scrap or secondary material containing commercially recoverable tungsten.

Vanadium:

Metallic vanadium and vanadium alloys such as ferro-vanadium.

Fused vanadium oxide and all other vanadium compounds in which vanadium is a recognizable component.

All scrap and waste material containing commercially recoverable vanadium of the above listed types.

Zinc:

Zinc, slab (all grades).

Zinc, base alloy in crude form.

All zinc products, such as rolled and extruded shapes, wire and castings.

Zinc, and zinc-base alloy scrap containing commercially recoverable zinc.

Zircon.

Nonferrous scrap not covered above.

PAPER AND PAPERBOARD MATERIALS AND PRODUCTS

Converted paper and board products, all types and grades. Paper, paperboard, wet machine board and construction paper and board materials, all types and grades.

MISCELLANEOUS BASIC MATERIALS AND PRODUCTS

Hog bristles, all types.

[F.R. Doc. 60-12584; Filed, Dec. 28, 1950; 12:35 p.m.]

TITLE 32A—NATIONAL DEFENSE, APPENDIX

Chapter VI—National Production Authority, Department of Commerce

[NPA Notice 1, as amended November 7, 1951]

DESIGNATION OF SCARCE MATERIALS; AND WITHDRAWAL OF CERTAIN MATERIALS FROM PREVIOUS DESIGNATION AS SCARCE

NPA Notice 1, as amended January 10, 1951, is further amended to read as follows:

NPA Notice 1, as amended, is issued pursuant to section 102 of the Defense Production Act of 1950, as amended (64 Stat. 799, Pub. Law 96, 82d Cong.); Executive Order 10161 (15-F.R. 6105); Executive Order 10200 (16 F.R. 61); Executive Order 10281 (16 F.R. 8789); and Defense Production Administration Delegation 1, as amended (16 F.R. 738, 4594).

This amendment affects NPA Notice 1, as amended January 10, 1951, as follows: It designates additional scarce materials by adding them to List A of the notice,

amends the description of certain scarce materials included in the list, and withdraws from the list certain materials formerly designated as scarce. Such materials withdrawn are listed in section 7. It sets forth, in sections 4, 5, and 6, certain conditions under which a person may accumulate scarce materials in excess of the reasonable demands of business, personal, or home consumption; and makes other changes of a minor nature.

Sec.

1. Purpose of this notice.

2. Definition of person.

3. Designation of scarce materials.

4. Receipts of imported materials.

5. Receipts of minimum production or sales quantities.

6. Receipts of materials after adjustment of orders.

7. Withdrawal of designation of scarce materials.

AUTHORITY: Sections 1 to 7 issued under sec. 102, 64 Stat. 799, Pub. Law 96, 82d Cong.

SECTION 1. *Purpose of this notice.* Section 102 of the Defense Production Act of 1950, as amended, provides in part that, in order to prevent hoarding, no person shall accumulate (a) in excess of the reasonable demands of business, personal, or home consumption, or (b) for the purpose of resale at prices in excess of prevailing market prices, materials which have been designated as scarce materials or materials the supply of which would be threatened by such accumulation. This notice designates certain materials as scarce materials. It also prescribes in sections 4, 5, and 6, certain conditions under which a person may accumulate such materials in excess of the reasonable demands of business, personal, or home consumption.

SEC. 2. *Definition of person.* As used in this notice, the word "person" includes an individual, corporation, partnership, association, or any other organized group of persons, or legal successor or representative of the foregoing, and includes the United States or any agency thereof, or any other government, or any of its political subdivisions, or any agency of any of the foregoing.

SEC. 3. *Designation of scarce materials.* Each material included in List A appearing at the end of this notice, in the shapes and forms therein described, or in all shapes and forms if no particular shape or form is therein described, is hereby designated, pursuant to section 102 of the Defense Production Act, as amended, a scarce material. Whenever "material" or "materials" is hereinafter used, it means any such designated material or materials.

SEC. 4. *Receipts of imported materials.* (a) Notwithstanding any provision of this notice, a person may import by land, sea, or air, any material acquired by him prior to landing without regard to the reasonable demands of his business, personal, or home consumption. However, if his total quantity of a material accumulated thereby becomes in excess of the reasonable demands of his business, personal, or home consumption, he may not receive any additional amount of such material from any domestic source until his total quantity thereof has been reduced below an amount which is not in excess of the reasonable demands of his business, personal, or home consumption.

(b) Within the meaning of paragraph (a) of this section, importation by a person is not limited to the person who takes title to the material prior to landing or who pays the customs entry thereon, but includes a person who, prior to landing, purchases or contracts to purchase the material from or through an importing broker, wholesaler, or other importer, even though such broker, wholesaler, or other importer makes the customs entry in his own name, places the material on board the inland carrier for shipment to his customer, and retains title until such shipment is made. Within the meaning of paragraph (a) of this section, a material is not imported by a person who acquires such material from an importing broker, wholesaler, or other im-

porter who took such material into his own stock or inventory.

SEC. 5. *Receipts of minimum production or sales quantities.* Notwithstanding any provision of this notice, in the case of materials that are mass produced or are normally marketed only in minimum sales quantities, a person may order and receive from a producer a minimum production run of such material, or from any other supplier, a minimum sales quantity, provided it is not practicable for him to procure his needs from other suppliers in smaller quantities, even though his accumulation of such material thereby becomes in excess of the reasonable demands of his business, personal or home consumption. After such receipt, however, he may not receive any additional amount of such material until his accumulation thereof has been reduced below an amount which is not in excess of the reasonable demands of his business, personal, or home consumption.

SEC. 6. *Receipts of materials after adjustment of orders.* Notwithstanding any provision of this notice, a person who has promptly instructed the supplier to reduce or defer delivery of a material under an order for such material previously placed by him with the supplier, to the extent necessary so that his accumulation of such material will not be in excess of the reasonable demands of his business, personal, or home consumption, may accept delivery of the material involved in any of the following cases only:

(a) If the supplier has shipped the material or loaded it for shipment before receipt of the instruction to adjust the order.

(b) If the material is a special item which, before receipt of the instruction to adjust the order, the supplier has in stock or in production, or for the production of which he has acquired special components or special materials. For the purpose of this section a "special item" is one which the supplier does not usually make, stock, or sell, and cannot readily dispose of to others.

(c) If the material has already been produced or was in production before receipt of the instruction to adjust the order and cannot be used to fill other orders on the books of the producer.

SEC. 7. *Withdrawal of designation of scarce materials.* The following materials described as scarce materials in List A of NPA Notice 1, as amended January 10, 1951, are hereby withdrawn from such designation on November 7, 1951:

BUILDING MATERIALS

Cast iron soil pipe and fittings.
Gypsum board, sheathing, and lath.
Insulation and insulation material in which pulp is a component.
Insulation board, structural, in which paper is a component.
Portland cement.

CHEMICALS

Alcohol, industrial (ethyl alcohol).
Benzene.
Glycerine, crude and refined.
Polystyrene.
Titanium pigments.

METALS AND MINERALS

Rare earth metals, other than cerium.

NPA Notice 1, as so amended, shall take effect on November 7, 1951.

NATIONAL PRODUCTION AUTHORITY,

By JOHN B. OLVERSON,
Recording Secretary.

LIST A—DESIGNATION OF SCARCE MATERIALS

[*Items preceded by asterisk have been added since original issuance of NPA Notice 1 as amended (Jan. 10, 1951)]

BUILDING MATERIALS

Cast iron pressure pipe and fittings.

CHEMICALS

*Allethrin.
*Alkyl phenols.
*Alpha picoline.
*Carbon disulfide.
Carbon tetrachloride.
Chlorine, gaseous and liquid.
*Chloroform.
*Chlorophenol-para.
*Cobalt salts and driers.
*Copper-8-hydroxyquinolinolate.
*Copper chemicals.
*Cyclohexanol.
Dichlorobenzene, ortho, meta, and para.
*Dihydroxydichlorodiphenyl methane.
*Diphenylamine.
*Ethylene oxide.
*Freon.
*Hexylresorcinol.
*Hydrofluoric acid.
*Iron oxide yellow.
*Lithium salts.
Methanol.
Methyl chloride.
Methylene chloride.
*Naphthalene.
*Naphthenic acid.
*Nickel salts.
*Nicotinimide.
*Nicotinic acid.
*Nylon, plastic type.
*Orthophosphoric acid.
*Oxygen.
*Parachlorophenol.
*Paranitrophenol.
*Phenol.
*Phosphate plasticizers.
*Phosphorus.
Phthalic anhydride.
Polyethylene.
*Polyethylene resins.
Polytetrafluorethylene.
*Pyrethrum.
*Pyridine.
*Quinoline.
*Resorcinol.
*Resorcinol resins.
*Sebacic acid.
Styrene.
*Sulfur.
*Sulfuric acid.
*Thiokol-polymers.
Trichloroethylene.

FOREST PRODUCTS

*Lumber (except railway cross ties, mineties, and hardwood flooring).
*Plywood (softwood and hardwood).
*Wood poles and poles.
Wood pulp.
Paper, paperboard, wet machine board, and construction paper and board materials, all types and grades.
Converted paper and board products, all types and grades.

LEATHER AND TANNING MATERIALS

*Hides and skins (domestic).
*Vegetable tanning materials:
*Chestnut.
*Quebracho.
*Wattle.

IRON AND STEEL

Iron:
Pig iron.
Gray iron castings (excluding soil and pressure pipe and fittings) rough and semifinished; malleable iron castings, rough and semifinished.
Steel (carbon, including low alloy, high strength alloy, and stainless):
Ingots and semifinished steel, including skelp; steel castings rough and semifinished; structural shapes and piling; plates; rails and track accessories; wheels and axles; bars, hot-rolled, including light shapes and reinforcing; cold-finished bars; pipe; tubing; wire, wire rods and drawn wire products; tin plate, terneplate, and tin mill black plate; hot-rolled sheet and strip; cold-rolled sheet and strip; other mill shapes and forms.
Forgings, rough.
Iron and steel scrap.

METALS AND MINERALS

Aluminum:

Primary and secondary in crude form.

Semifabricated shapes, castings (including die); forgings; plate, sheet, and strip; foil; rolled structural shapes, rod, bar, and wire; extruded shapes, tube blooms, and tubing; powder, flake, and paste.

All aluminum and aluminum-base scrap containing commercially recoverable aluminum.

*Aluminum castings (before machining).

*Aluminum forgings, pressings, and impact extrusions (before machining).

*Antimony, all forms.

*Antimony scrap.

Asbestos:

Amosite; grades B-1, B-3, D-3, and D3/M-1.

Chrysotile; grades G and G1, C and C2, C and CP1, and CP2; Arizona crude 1, and Arizona crude 2.

Crocidolite.

*Beryllium; metals, oxides, alloys, and compounds.

*Bismuth.

*Boron:

Ferro-boron, boron metal, and all other alloys used as sources of boron.

Cadmium:

Cadmium metal.

Cadmium oxide.

Cadmium salts.

All scrap and secondary material containing commercially recoverable cadmium of the above listed types.

*Calcium:

Calcium-silicon, calcium-manganese-silicon, and metallic calcium.

Cerium:

Cerium metal, cerium alloys, such as ferro-cerium, and cerium compounds in which cerium is a recognizable component.

All scrap and waste material containing commercially recoverable cerium of the above listed types.

Chromium:

Chromium metal.

Ferro-chromium, including chromium briquets.

Chromium alloys, other, in which chromium is a recognizable component.

All scrap and waste materials containing commercially recoverable chromium of the above listed types.

Cobalt:

Cobalt, the element in any form and combination with other elements in which cobalt is an essential constituent (except cobalt concentrates, cemented carbide-tipped tools, cast cobalt-chrome-tungsten-molybdenum tools, alloy hard-facing welding rods and materials; and except paints, varnishes, lacquers, inks, and similar products, containing cobalt driers).

All scrap or secondary materials containing commercially recoverable cobalt.

Columbium:

Ferro-columbium, ferro-columbium-tantalum, potassium, columbium fluoride, columbium oxide, and columbium carbide.

All scrap or secondary material containing commercially recoverable columbium or the above listed types.

Copper:

Refined copper (fire-refined and electrolytic) including refinery shapes such as wire bars, slabs, cakes, billets, and ingots.

Secondary copper and copper-base alloys.

Copper and copper-base alloys: alloy plate, sheet, and strip; alloy rod, bar, and wire (including extruded shapes); alloy tube and pipe; unalloyed rod, bar, and wire (including extruded shapes); unalloyed plate, and copper wire mill products; copper and copper-base sheet, and strip; unalloyed tube and pipe; copper wire alloy castings.

All copper and copper-base alloy scrap containing commercially recoverable copper.

*Corundum; grain and superfines.

Diamonds, industrial.

*Electrodes, carbon.

*Fluorspar acid.

*Graphite, artificial; electrodes and anodes.

*Graphite, natural.

*Crucible flake.

*Madagascar flake.

*Ceylon lump, 95 percent and higher carbon.

*Iridium:

Lead, all forms.

Magnesium:

Magnesium, primary and secondary ingots and intermediate forms (slabs, billets, and blooms).

Semifabricated shapes such as castings (die and all other); forgings, rolled and extruded shapes (rod and bar; plate, sheet, and strip; pipe and tubing; ribbons; and foil); powder and stick.

All magnesium-base alloy scrap containing commercially recoverable magnesium.

Manganese:

Manganese metal, ferro-manganese, spiegeleisen, and all other compounds and alloys which are used as sources of manganese in the manufacture of any alloy products.

All scrap and material containing sufficient manganese to be of commercial value as an alloying agent.

Mica; muscovite block, film, and splittings.

Molybdenum:

Calcium molybdate; ferro-molybdenum; molybdenum metal, in any form; molybdenum oxide, bulk and briquet; molybdenum alloys and compounds, other, in which molybdenum is a recognizable component.

All scrap and waste materials containing molybdenum of the above listed types.

Nickel:

Nickel, alloyed or unalloyed.

Imported nickel matte.

Nickel and nickel alloy, metal (cathode nickel, pigs, shot, and other primary forms).

Nickel and nickel alloy, secondary.

Nickel and nickel alloy, semifinished; bars, rods, tubes, sheet bar, ingot, blooms, billets, sheet strip, and similar mill products not further manufactured.

All nickel and nickel-base alloy scrap and nickel silver scrap containing commercially recoverable nickel.

*Osmium.

Platinum:

Platinum and platinum-base alloy refinery shapes, including bar ingot, grain, nugget, and sponge.

Platinum and platinum-base alloy base shapes and forms, including wire.

All platinum and platinum-base alloy scrap containing commercially recoverable platinum of the above listed types.

Scrap, nonferrous, all types.

*Selenium.

*Silicon:

All grades of ferro-silicon, including silvery iron or silicon pig, all grades of silicon metal; and all other compositions containing more than 6 percent silicon, which are used as sources of silicon in the manufacture of any alloy products.

Talc block (steatite).

Tantalum:

Tantalum metal and alloys such as ferro-tantalum.

All scrap and waste material containing commercially recoverable tantalum of the above listed types.

Tin:

Tin, primary and secondary.

All alloys containing tin.

Tin, chemicals, including tin oxide.

Tin products such as tin pipe and sheet.

All tin and tin-base alloy scrap containing commercially recoverable tin content.

*Titanium:

*Ingot.

*Semifabricated shapes.

*Sheets, tubes, extrusions.

*All grades of ferro-titanium, titanium metal, and other alloys used to add titanium in the manufacture of any alloy product.

All titanium-base alloy scrap.

Tungsten:

Tungsten, in any form or shape into which it may be fabricated, except such finished forms as are fabricated for installation (without further processing) into electrical communication systems, incandescent lamps, and electronic equipment such as radio, radar, and similar products.

Tungsten, ferro, metal powder, and any other ferrous combination of the element tungsten in semimanufactured or manufactured form, excluding alloy steel, high speed steel and tool steel.

Tungsten, all nonferrous mixtures or alloys containing tungsten, prepared for any purpose requiring further processing, whether the same or manufactured by means of melting pressing, sintering, brazing, soldering or welding, including but not limited to mixtures or alloys to be used in the production of tools and tool blanks or as hard-facing materials, but not including any finished tools.

Tungsten, all chemical compounds having tungsten as a recognizable and essential component.

Tungsten, all scrap or secondary material containing commercially recoverable tungsten.

Vanadium:

Metallic vanadium and vanadium alloys such as ferro-vanadium.

Fused vanadium oxide and all other vanadium compounds in which vanadium is a recognizable component.

All scrap and waste material containing commercially recoverable vanadium of the above listed types.

Zinc:

Zinc, slab (all grades).

Zinc-base alloy in crude form.

Zinc, dust and oxide.

All zinc products such as rolled and extruded shapes, wire and castings.

Zinc and zinc-base alloy scrap containing commercially recoverable zinc.

Zircon:

*Zirconium:

Zirconium metal, ferro-aluminum-zirconium, zirconium-silicon alloys and all other metallic compositions used as sources of zirconium in the manufacture of any alloy products.

RUBBER MATERIALS

Natural rubber, dry and latex.
Synthetic rubbers, including latices, GR-S, butyl, neoprene, and N-types.

TEXTILE MATERIALS

- *Bristle, nylon tapered.
- *Burlap Hessian (in the piece)
- *Cotton duck, army (in the piece).
- *Cotton duck, numbered (in the piece).
- *Cotton pulp.
- *Feathers and down (waterfowl).
- *Nylon staple and nylon filament yarn.
- *Rayon yarn, high tenacity.
- *Silk, noils and waste.
- *Twine, binder and baler.
- *Webbing (heavy military types).

MISCELLANEOUS

- *Aluminum foil, converted.
- *Bristles.
- *Cans.
- *Collapsible tubes.
- *Components and parts for electric light bulbs and tubes.
- *Containers and fabricated products made wholly or partly from aluminum foil.
- *Containers, metal delivery and fluid milk shipping containers.
- *Containers, other shipping containers, packages and packaging materials.
- *Cylinders, gas.
- *Drums, steel, shipping.
- *Hog bristles, all types.
- *Packaging closures.
- *Reels and spools, shipping and package (wholly or in part of metal).
- *Strapping, metal.
- *Textile bags.
- *Unit package, wrappers, and shipping containers of all types made wholly or partly from any of the following films and plastics:
Cellophane, cellulose acetate, cellulose acetate butyrate, ethyl cellulose, melamine resins and molding powders, methyl cellulose, phenolic resins and molding powders, plicofilm, polyethylene, polystyrene and copolymers, polyvinyl alcohol, polyvinyl chloride and copolymers, polyvinylidene chloride and copolymers, urea resins and molding powders.

TITLE 32A—NATIONAL DEFENSE, APPENDIX

Chapter VI—National Production Authority, Department of Commerce

[NPA Order M-80]

M-80—IRON AND STEEL—ALLOYING MATERIALS AND ALLOY PRODUCTS

This order is found necessary and appropriate to promote the national defense and is issued pursuant to authority granted by section 101 of the Defense Production Act of 1950, as amended. In the formulation of this order, there has been consultation with industry representatives, including trade association representatives, and consideration has been given to their recommendations. However, consultation with representatives of all trades and industries affected in advance of the issuance of this order has been rendered impracticable due to the necessity for immediate action and because the order affects a large number of different trades and industries.

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2. Definitions.

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5. Changes in melting schedules.

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ALLOCATIONS OF ALLOYING MATERIALS

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AUTHORITY: Sections 1 to 23 issued under sec. 704, 64 Stat. 816, as amended; 50 U.S.C. App. Sup. 2154. Interpret or apply sec. 101, 64 Stat. 799, as amended; 50 U.S.C. App. Sup. 2071, sec. 101, E.O. 10161, Sept. 9, 1950, 15 F.R. 6105; 3 CFR 1950 Supp. sec. 2, E.O. 10200, Jan. 3, 1951, 16 F.R. 61.

INTRODUCTORY

SECTION 1. *What this order does.* (a) This order in general covers alloying materials and alloy products. It requires all melters and processors to file proposed melting or processing schedules and data concerning inventories. It requires authorization of melting or processing schedules by National Production Authority (hereinafter called "NPA"), and permits NPA to make changes therein. Certain schedules issued with this order require complete allocation of certain alloying materials and provide for the filing of applications with NPA for allocation authorizations; and these schedules also prohibit certain uses of specific alloying materials and alloy products. The order provides for the issuance of additional schedules when and if other alloying materials are to be made subject to allocation or to use limitations, or the use of any other alloy product is to be limited or prohibited. It contains provisions incidental to the effectuation of the foregoing in support of the Controlled Materials Plan and other programs requiring these alloying materials.

(b) Effective September 1, 1951, this order together with the schedules issued pursuant hereto and Order M-81 completely supersede present NPA Orders M-4, M-10, M-14, M-30, M-33, M-49, and M-52, and sections 14 and 18 (b) of NPA Order M-1. Order M-8 covers pure tungsten and pure molybdenum but other forms of tungsten and molybdenum, as defined in List I of this order, are covered by this order. However, this superseder does not relieve any person of an liability or obligation incurred under any of the order mentioned in the first sentence of this paragraph, nor does it take away any right received thereunder, being intended that any such liabilities, obligation and rights shall continue. Without limiting the generality of the preceding sentence, any requirements of any of the foregoing orders for filing forms or applications, or for granting any authorizations or approvals thereunder, shall continue until the date when the filing of any such forms or applications or the granting of any such authorizations or approvals is required or provided under this order and schedules; and all authorizations of melting schedules or allocations heretofore given or hereafter given pursuant to any of the foregoing orders, shall continue in full force and effect.

To a certain extent, this order is a rewriting of the said existing orders for the purpose of convenience in administration and for clarity. This order contains some new provisions not contained in said orders, including among others an additional list of prohibited nickel-bearing stainless steel products.

(c) Schedules 1 to 5, inclusive, and Schedules A and B are being issued on the effective date of this order. Those schedules are as follows: Schedule 1—Nickel; Schedule 2—Cobalt; Schedule 3—Tungsten (excluding pure tungsten); Schedule 4—Molybdenum (excluding pure molybdenum); Schedule 5—Columbium and Tantalum; Schedule A—Nickel-Bearing Stainless Steel, High Nickel Alloy, and Nickel Silver; Schedule B—High Speed and Tool Steel.

Sec. 2. *Definitions.* As used in this order:

(a) "Person" means any individual, corporation, partnership, association, or any other organized group of persons, and includes any agency of the United States or any other government. A person who keeps separate inventory records for any separate operating or producing unit shall treat each such separate operating or producing unit as a separate person for the purposes of this order, unless NPA otherwise directs or permits upon application of such person.

(b) "Alloying material" means any one of the forms or compounds of the elements as listed and defined in List I appearing at the end of this order. This term does not include pure tungsten or pure molybdenum, both of which are covered by NPA Order M-81.

(c) "Restricted alloying material" means any alloying material made subject to complete allocation under the provisions of this order.

(d) "Alloy product" means and includes those kinds of steel or iron hereafter defined as "alloy steel," "stainless steel," or "tool steel," and "nonferrous wrought or cast alloys," including high temperature heat- and corrosion-resisting alloys.

(1) "Alloy steel" means any steel (other than stainless and low alloy high strength steel, as defined in subparagraphs (2) and (3) of this paragraph) which contains any one or more of the following elements in the following amounts:

Manganese in excess of 1.65 percent.

Silicon in excess of 0.60 percent.

Copper in excess of 0.60 percent.

Aluminum, boron, chromium, cobalt, columbium, molybdenum, nickel, tantalum, titanium, tungsten, vanadium, zirconium, or any other alloying element in any amount specified or known to have been added to obtain a desired alloying effect.

(2) "Stainless steel" means any steel which is heat- and corrosion-resisting steel containing 10 percent or more of chromium, either with or without nickel, molybdenum, or other elements, and containing 50 percent or more of iron. This term also includes stainless-clad steel.

(3) "Low alloy high strength steel" means only the proprietary grades of alloy steel produced and sold for this purpose.

(4) "Nonferrous wrought or cast alloys" means nickel, cobalt, copper, aluminum, and other alloys containing one or more of the elements defined in List I of this order, and with less than 50 percent iron.

(5) "Tool steel" means any steel used in the manufacture of tools for use in mechanical fixtures, precision gauges, or for hand or power hacksaws. This term includes high speed steels as defined in Schedule B of this order.

(e) "Melter" means a person who produces alloy products by melting.

(f) "Alloying material supplier" means a person who produces alloying materials.

(g) "Processed product" means a product derived wholly or partially from an alloying material, by any means or process other than melting.

(h) "Processor" means a person who produces a processed product.

All definitions contained in this section 2 or List I of this order shall be applicable to the schedules at any time issued under the provisions of this order. The word "order" as used herein may include all schedules and lists issued as parts of this order.

PRODUCTION OF ALLOY PRODUCTS BY MELTING

SEC. 3. *Restrictions on melt.* No melter, who uses during any calendar month a greater quantity of any alloying material than shown on List II of this order, shall melt any such alloying material into an alloy product, except in accordance with a melting schedule which has been duly authorized by NPA under section 5 of this order: *Provided*, That, whenever an allocation authorization for the same period authorizes the use of a lesser amount of any such alloying material (which is a restricted alloying material) than permitted by the melting schedule, the use of any such restricted alloying material shall be governed by the allocation authorization rather than by the melting schedule.

SEC. 4. *Applications and reports from melters.* Each melter, who uses during any calendar month a greater quantity of any alloying material than shown in List II of this order, is hereby required to apply to NPA for approval of any proposed melting schedule on Form NPAF-60. Such application shall be filed with NPA not later than the first day of the month preceding the melt month, commencing September 1, 1951. Each melter, who uses during any calendar month a greater quantity of any alloying material than shown in List II, shall also file with NPA not later than September 7, 1951, a statement on Form NPAF-113 indicating the quantities of each alloying material in his inventory on certain dates, and shall furnish all other data required by that form. If any melter requires delivery or use of any restricted alloying material, he shall also file, simultaneously with Form NPAF-113, an application on Form NPAF-114. He shall file a separate application for each restricted alloying material required by him. Applications for allocation of restricted alloying materials are required whether or not a proposed melting schedule is approved. Authorization of a melting schedule does not carry with it authorization of an application for allocation. Whenever it is necessary in order to complete any of the above forms required to be filed under the provisions of this section, any person who orders alloy products from a melter shall state in his order the end use (by classification and specific part name) for which such alloy product will be used. A melter may file an additional melting schedule or schedules for authorization at any time.

SEC. 5. *Changes in melting schedules.* NPA may make such changes, modifications, postponements, or deletions in any proposed melting schedule filed by a melter as, in the discretion of NPA, may be deemed necessary or advisable in order to bring about the maximum possible conservation of alloying materials in the interest of national defense. Modifications or changes required by NPA in the alloy content of a product shall be binding upon a melter whether the alloy content of such product is procured from alloying materials, as defined in List I of this order, and/or from scrap containing usable quantities of such alloying material. Upon completion of the review of any proposed schedule or modification thereof as provided in this section, the approval of the melting schedule as originally filed or as modified will be mailed on Form GA-35, the Melting Schedule Metallurgical Authoriza-

tion, to each melter at least 10 days prior to the first day of the melt month.

PRODUCTION OF PROCESSED PRODUCTS BY MEANS OTHER THAN MELTING

SEC. 6. *Restrictions on processing.* No processor, who uses during any calendar month a greater quantity of any alloying material than shown on List II of this order, shall incorporate any such alloying material into any processed product, except in accordance with a processing schedule which has been duly authorized by NPA: *Provided*, That, whenever an allocation authorization for the same period authorizes the use of a lesser amount of any such alloying material (which is a restricted alloying material) than permitted by the processing schedule, then the use of any such restricted alloying material shall be governed by the allocation authorization rather than by the processing schedule.

SEC. 7. *Applications and reports from processors.* Each processor, who uses during any calendar month a greater quantity of any alloying material than shown in List II of this order, is required to apply to NPA for approval of any proposed processing schedule on Form NPAF-102. Such application shall be filed with NPA not later than the first day of the month preceding the processing month, commencing with September 1, 1951. Each processor who uses during any calendar month a greater quantity than shown on List II of any alloying material, shall also file with NPA on the seventh day of the month preceding the processing month, commencing September 7, 1951, a statement on Form NPAF-113 indicating the quantities of each alloying material in his inventory on certain dates, and shall furnish all other data required by that form. If any processor requires delivery or use of any restricted alloying material, he shall also file simultaneously with Form NPAF-113, an application for allocation on Form NPAF-114. He shall file a separate application for each restricted alloying material required by him. Applications for allocation of restricted alloying materials are required whether or not a proposed processing schedule is authorized. Authorization of a processing schedule does not carry with it authorization of an application for allocation. Whenever it is necessary in order to complete any of the above forms required to be filed under the provisions of this section, each person who orders processed products from a processor shall state in his purchase order the end use (by classification and specific part name) for which such processed product will be used. A processor may file an additional processing schedule or schedules for authorization at any time.

SEC. 8. *Changes in processing schedules.* NPA may make such changes, modifications, postponements, or deletions in any proposed processing schedule filed by a processor, as in the discretion of NPA, may be deemed necessary or advisable in order to bring about the maximum possible conservation of alloying materials in the interests of national defense. Modifications or changes required by NPA in the alloy content of a product shall be binding upon a processor whether the alloy content of such product is procured from alloying materials, as defined in List I of this order, and/or from scrap containing usable quantities of such alloying materials. Upon completion of the review of any proposed processing schedule or modification thereof as provided in this section, the approval of the processing schedule, as originally filed or as modified, will be mailed on Form GA-41, Processing Schedule Authorization, to each processor prior to the first day of the processing month.

ALLOCATION OF ALLOYING MATERIALS

SEC. 9. *Alloying materials subject to complete allocation.* Schedules 1 through 5, inclusive, of this order, are being issued to continue complete allocation of nickel, cobalt, tungsten, molybdenum, and columbium and tantalum. These alloying materials are termed "restricted alloying materials." Separate schedules numbered consecutively from 6 upwards will be issued under this order for each alloying material to be made subject to complete allocation after the effective date of this order. Each numbered schedule makes a particular alloying material subject to complete allocation and contains any special requirements, exemptions, prohibited uses, or provisions pertaining to the particular alloying material that are not contained in this order.

SEC. 10. *Restrictions on deliveries and exceptions thereto.* (a) No alloying material supplier shall deliver to any person any restricted alloying material, except in accordance with the terms of an NPA directive, an allocation authorization issued to such alloying material supplier by NPA, or except upon receipt of the certification for users of limited quantities as required by the schedules of this order.

(b) No person shall accept delivery of a restricted alloying material from an alloying material supplier except in accordance with the terms of an allocation authorization or except upon delivery of the certificate for users of limited quantities as required by the schedules of this order.

(c) No alloying material supplier shall deliver any alloying material if he knows or has reason to believe that the person receiving the alloying material may not accept delivery thereof under this order or that he will use the alloying material in violation of this order.

(d) No person shall use in any calendar month a greater quantity of a restricted alloying material than he is authorized to use for that month by this order or by Form NPAF-114 issued by NPA. When the amount of a restricted alloying material contained in the melting schedule authorization or processing schedule authorization is not the same as the amount allocated for use on Form NPAF-114, the lesser of the authorized amounts must not be exceeded.

(e) The foregoing restrictions of this section with respect to deliveries shall not apply to deliveries of restricted alloying materials made to General Services Administration or to any other duly authorized Government agency of the United States for the purpose of stockpiling.

SEC. 11. *Allocation authorizations.* As set forth in sections 4 and 7 of this order, each melter and processor desiring to receive an allocation authorization for any restricted alloying material is required, commencing September 7, 1951, to file with NPA an application on Form NPAF-114. This form is required to be filed simultaneously with Form NPAF-113 on or before the seventh day of the month preceding the month in which delivery of the restricted alloying material is required. NPA may grant the application in whole or in part or may reject the application. Whenever an application is granted, in whole or in part, an authorization will be issued at least 10 days prior to the first day of the delivery month to the appropriate alloying material supplier and a copy furnished to the applicant. The copy returned to the applicant will show the amount of restricted alloying material he is authorized to use and the amount he is allowed for inventory purposes to permit continuous operation from month to month. The alloying material supplier to whom the allocation authorization is issued shall fill orders of the applicant within the limits of the allocation authorization. No person receiving any restricted alloying material may use such restricted alloying material except in ac-

cordance with an allocation authorization. An allocation authorization issued by NPA to any person shall terminate at the close of the calendar month for which such allocation authorization was granted.

PROHIBITED PRODUCTS AND USES

SEC. 12. *Prohibited uses of alloying materials.* If the use of any alloying material for any particular purpose or product is to be prohibited, the provisions concerning such prohibition are, or will be, set forth in a schedule issued with or pursuant to this order concerning that alloying material. No person shall use any alloying material in violation of the provisions of any schedule issued with this order or which may be issued by NPA from time to time under this order.

SEC. 13. *Prohibited uses of alloy products or processed products.* On the effective date of this order, Schedule A is being issued to continue certain prohibitions with respect to the use of stainless steel, high nickel alloy steel, and nickel silver products and to add certain additional restrictions; and Schedule B is being issued to continue certain provisions and add others with respect to high speed steel and tool steel. Separate schedules lettered alphabetically may be issued under this order from time to time covering additional classes of alloy or processed products. Each schedule contains or will contain specific prohibitions or restrictions as to specific classes of alloy products or processed products and additional requirements that are not covered in this order. No person shall use or manufacture any alloy product or processed product in violation of the provisions of any schedule issued with this order or which may be issued by NPA from time to time under this order.

GENERAL PROVISIONS

SEC. 14. *Schedules.* Schedules issued under this order shall be numbered consecutively beginning with "1" or lettered alphabetically beginning with "A", and shall be designated according to number or letters as "Schedule _____ of NPA Order M-80." A schedule may be issued or amended without any change in the text of this order, and without any republication of this order or of any provision of this order. All provisions of any schedule shall be deemed to be incorporated into and made a part of this order as of the effective date of the schedule or amendment thereto, as the case may be. In the event of an inconsistency or conflict between the provisions of any schedule issued with this order or which may be issued by NPA from time to time under this order and the provisions of this order, the provisions of the schedule shall govern. Schedules may be issued or amended at any time and from time to time and shall remain in full force and effect until individually amended, superseded, or revoked. This order may be amended without any change in the text of any schedule issued herewith or from time to time.

SEC. 15. *Conservation required.* No person shall use a restricted alloying material in the production, processing, or manufacture of an alloy or processed product when it is commercially feasible to substitute some material therefor other than a restricted alloying material. No person shall use a greater quantity or higher quality of an alloying material in the production, processing, or manufacture of any alloy or processed product than is necessary to produce, process, or manufacture any such alloy or processed product on a commercially feasible basis, unless required to meet military material specifications.

SEC. 16. *Imports.* Nothing contained in this order shall prohibit the importation of any restricted alloying material: *Provided*, That any such restricted alloying material after importation and delivery to or for

the account of the importer shall not be further delivered, used, or consumed except in accordance with the provisions of this order.

SEC. 17. *Relation to other NPA orders and regulations.* All provisions of any NPA regulation or order are superseded to the extent that they are inconsistent with this order or with the schedules issued herewith or from time to time, but in all other respects the provisions of such regulations and orders shall remain in full force and effect. Except as otherwise directed in writing by NPA, restricted alloying material shall be delivered only under an allocation authorization pursuant to the provisions of this order and, accordingly, DO rated orders or other preference orders shall have no effect, except to the extent that NPA takes such DO or preference rating into account in granting an allocation authorization.

SEC. 18. *Limitation on inventories of alloying materials.* No melter or processor, notwithstanding any allocation authorization received by him, shall place an order for any alloying material (except ferro-manganese and ferro-silicon) calling for delivery of, and no such person shall accept delivery of, any such alloying material at a time when his inventory thereof exceeds, or by acceptance of such delivery would be made to exceed, 45 calendar days' requirements at his then scheduled rate and method of operation. Any melter or processor who at any time has outstanding orders for any alloying material calling for delivery earlier than, or in quantities greater than, he would be permitted to receive under this section, shall forthwith notify his supplier of the extent to which delivery cannot be accepted as scheduled, and such orders shall be adjusted accordingly. Imported as well as domestic alloying materials are subject to this order and are to be included in computing inventory: *Provided*, That any alloying material acquired prior to landing may be imported even though a person's inventory thereby becomes in excess of the amount herein permitted, but, that in such event, such person may not receive further deliveries from domestic sources until his inventory is reduced to permitted levels. Any alloying material which has been processed to any degree, but has not yet been actually incorporated into a finished or partially finished product is likewise to be included in computing inventory. The provisions of NPA Reg. 1 shall continue to apply to ferro-manganese, and, for the purposes of this order, shall also be deemed applicable to ferro-silicon.

SEC. 19. *Export of alloying materials.* Alloying materials exported from the United States, its territories or possessions, pursuant to a validated export license issued by the Office of International Trade, Department of Commerce, are exempt from all provisions of this order and of the schedules issued with this order or which may be issued by NPA from time to time under this order, except for the provisions of section 9, and paragraphs (a) and (b) of section 10 of this order, and the provisions of this order requiring the keeping of records and the making of reports.

SEC. 20. *Applications for adjustment or exception.* Any person affected by any provision of this order may file a request for adjustment or exception upon the ground that such provision works an undue or exceptional hardship upon him not suffered generally by others in the same trade or industry, or that its enforcement against him would not be in the interest of the national defense or in the public interest. In examining requests for adjustment claiming that the public interest is prejudiced by the application of any provision of this order, consideration will be given to the requirements of the public health and safety, civilian defense, and dislocation of labor and resulting unemployment that would impair the defense program.

Each request shall be in writing, by letter in duplicate, shall set forth all pertinent facts and the nature of the relief sought, and shall state the justification therefor.

Sec. 21. *Records and reports.* (a) Commencing September 1, 1951, every person who, at any time in a calendar month, had in his possession or under his control or who, during a calendar month, consumed any restricted alloying material in greater quantities than the minimum permitted by List II of this order shall report to NPA on Form NPAF-113 on or before the seventh day of the following months. However, if he applies on such form for an allocation of restricted alloying material for delivery during the succeeding month, his application serves also as the required report.

(b) Each person participating in any transaction covered by this order shall retain in his files for at least 2 years records of receipts, deliveries, inventories, and use, in sufficient detail to permit an audit that determines for each transaction that the provisions of this order have been met. This does not specify any particular accounting method, nor does it require alteration of the system of records customarily maintained, provided the system assures an adequate basis for audit. Records may be retained in the form of microfilm or other photographic copies instead of the originals by those persons who have maintained or may maintain such microfilm or other photographic records in the regular and usual course of business.

(c) All records required by this order shall be made available at the usual place of business where maintained for inspection and audit by duly authorized representatives of NPA.

(d) Persons subject to this order shall make such records and submit such additional reports to NPA as it shall require, subject to the terms of the Federal Reports Act of 1942 (5 U.S.C. 139-139F).

Sec. 22. *Communications.* All communications concerning this order shall be addressed to the Iron and Steel Division, National Production Authority, Washington 25, D.C., Ref: M-80.

Sec. 23. *Violations.* Any person who wilfully violates any provision of this order or any other order or regulation of NPA or who wilfully conceals a material fact or furnishes false information in the course of operation under this order is guilty of a crime and, upon conviction, may be punished by fine or imprisonment or both. In addition, administrative action may be taken against any such person to suspend his privilege of making or receiving further deliveries of materials or using facilities under priority or allocation control and to deprive him of further priorities assistance.

NOTE: All reporting and record-keeping requirements of this order have been approved by the Bureau of the Budget in accordance with the Federal Reports Act of 1942.

Schedules 1 to 5, inclusive; Schedules A and B; and List I and List II are issued simultaneously with and made a part of this order.

This order shall take effect, except as otherwise provided herein, on August 15, 1951.

NATIONAL PRODUCTION
AUTHORITY,
MANLY FLEISCHMANN,
Administrator.

LIST I—DEFINITIONS OF ALLOYING MATERIALS

1. *Boron* means ferro-boron, boron metal, and all other alloys used as sources of boron.
2. *Calcium* means calcium-silicon, calcium-manganese-silicon and metallic calcium.
3. *Chromium* means all forms of ferro-chromium including those alloys known as ferro-silicon chromium and ferro-chromium silicon, chromium nickel, chromium metal, and all other compositions containing more than 25 percent chro-

mium, which are used as sources of chromium in commercial manufacture or processing.

4. *Cobalt* means and includes cobalt metal, cobalt oxide, cobalt fines, cobalt powder, and all other primary compounds, as well as scrap containing more than 5 percent cobalt, which are used as sources of cobalt in commercial manufacture and processing.

5. *Columbium and tantalum* mean ferro-columbium and ferro-columbium tantalum.

6. *Manganese* means ferro manganese, manganese metal, silicomanganese, silicospiegel, spiegelisen, and all other compositions used as sources of manganese in the manufacture of any alloy products.

7. *Molybdenum* means ferro-molybdenum, all grades of molybdenum oxide, and all primary molybdates and other molybdenum compounds used as a source of molybdenum in commercial manufacture and processing. It does not include the molybdenum present in steel scraps or pure molybdenum metal or scrap molybdenum metal.

8. *Nickel* means only the following forms of primary nickel: electrolytic nickel, ingots, pigs, rondelles, cubes, pellets and powder, rolled and cast anodes, shot, oxides, salts, and chemicals and residues derived directly from new nickel, including residues containing nickel derived as a byproduct from copper refinery operation.

9. *Silicon* means all grades of ferro-silicon including silvery iron or silicon pig, all grades of silicon metal, and all other compositions containing more than 6 percent metallic silicon, which are used as sources of silicon in the manufacture of any alloy products.

10. *Titanium* means all grades of ferro-titanium, titanium metal, and other alloys used to add titanium in the manufacture of any alloy products.

11. *Tungsten* means ferro-tungsten, tungsten scrap, and tungsten ores and concentrates. It does not include pure tungsten metal.

(a) Tungsten scrap means steel or alloy scrap containing 1 percent or more tungsten.

(b) Tungsten ores and concentrates means any ore or concentrate, either natural or synthetic, when used as a source of tungsten in the manufacture of any alloy products.

12. *Vanadium* means all forms of ferro-vanadium, vanadium pentoxide, and all other alloys and compositions used as sources of vanadium in commercial manufacture and processing.

13. *Zirconium* means zirconium metal, ferro-aluminum-zirconium, zirconium-silicon alloys, and all other metallic compositions used as sources of zirconium in the manufacture of any alloy products.

LIST II—QUANTITIES OF CONTAINED METALS IN ALLOYING MATERIALS EXEMPTED PER MONTH

1. Boron—100 pounds.
2. Calcium—1,000 pounds.
3. Chromium—2,000 pounds; except chromium metal—50 pounds.
4. Cobalt—25 pounds.
5. Columbium and tantalum—10 pounds.
6. Manganese—15 tons; except manganese metal—100 pounds.
7. Molybdenum—200 pounds.
8. Nickel—100 pounds.
9. Silicon—15 tons; except silicon metal—100 pounds.
10. Titanium—200 pounds.
11. Tungsten—25 pounds.
12. Vanadium—500 pounds.
13. Zirconium—200 pounds.

[F.R. Doc. 51-9912; Filed, Aug. 15, 1951; 5:08 p.m.]

[NPA Order M-80, Schedule 2]

M-80—IRON AND STEEL—ALLOYING MATERIALS AND ALLOY PRODUCTS

SCHEDULE 2—COBALT

This schedule is found necessary and appropriate to promote the national defense and is issued pursuant to the authority of section 101 of the Defense Production Act of 1950, as amended. In the formulation of NPA Order M-80, on which this schedule is based, there has been consultation with industry representatives, including trade association representatives, and consideration has been given to their recommendations. This schedule is issued under NPA Order M-80, and is made a part of that order.

Sec.

1. Definitions.
2. Cobalt subject to allocation.
3. Applications for allocations.
4. Exceptions to allocation requirements.
5. Uses prohibited.
6. Communications.

AUTHORITY: Sections 1 to 6 issued under sec. 704, 64 Stat. 816, as amended; 50 U.S.C. App. Sup. 2154. Interpret or apply sec. 101, 64 Stat. 799, as amended; 50 U.S.C. App. Sup. 2071, sec. 101, E.O. 10161, Sept. 9, 1950, 15 F.R. 6105, 3 CFR 1950 Sup., sec. 2, E.O. 10200, Jan. 3, 1951, 16 F.R. 61.

SECTION 1. Definitions. All definitions contained in NPA Order M-80, including definition of cobalt contained in List I of that order are applicable to this schedule. Cobalt means and includes cobalt metal, cobalt fines, cobalt oxide, cobalt powder, and all other primary compounds, as well as scrap containing more than 5 percent cobalt, which are used as sources of cobalt in commercial manufacture and processing.

SEC. 2. Cobalt subject to allocations. Cobalt is subject to complete allocation.

SEC. 3. Applications for allocations. Section 10 of NPA Order M-80 forbids deliveries or use of any alloying material made subject to complete allocation, except in accordance with an allocation authorization. Applications for an allocation authorization for delivery during the month of October 1951 may be made on or before September 7, 1951, on Form NPAF-114. Thereafter, such applications may be made on or before the seventh day of any month for delivery in the succeeding month.

SEC. 4. Exceptions to allocation requirements. The provisions of sections 2 and 3 of this schedule shall not apply to:

(a) Delivery to any person whose total receipts from all sources during any calendar month are not thereby made to exceed 25 pounds of cobalt, and who delivers a signed certificate to his supplier as follows:

The undersigned, subject to statutory penalties, certifies that acceptance of delivery and use by the undersigned of the cobalt herein ordered will not be in violation of NPA Order M-80 or of Schedule 2 of that order.

This certification constitutes a representation by the purchaser to the seller and to NPA that delivery of such cobalt ordered may be accepted by the purchaser under NPA Order M-80 and this schedule, and that such cobalt will not be used by the purchaser in violation of that order or this schedule.

(b) Deliveries of cobalt bearing scrap or cobalt ores and concentrates; *Provided*, That the use of such cobalt ores and concentrates shall be subject to sections 2 and 3 when used as a source of cobalt in commercial melting, manufacture, or processing.

SEC. 5. Uses prohibited. Commencing September 1, 1951, no person shall use cobalt for:

(a) Coloring glazes, glass, or porcelain enamels, or for the manufacture of ceramic body stains, porcelain enamel color oxides including blacks, glaze stains, glass batch colors, or paint or plastic pigments (except where used for optical or signal glass, decolorizers for glass and white ware, artists' colors, and color stabilizers in white pigment manufacture).

(b) Manufacturing or coloring of enameled metal signs.

(c) Fertilizers of any type.

(d) Manufactured feeds for poultry, dogs, and cats.

(e) Magnets used in the following:

(1) Appliances, toys, games, musical instruments, model electric trains, and novelties.

(2) Coin rejectors for juke boxes, pinball games, or gambling devices.

(f) Magnet steels containing more than 20 percent cobalt (except where required by rated orders).

(g) Cast magnets containing more than 30 percent cobalt (except where required by rated orders).

(h) Paint driers for use in exterior house paints.

SEC. 6. Communications. All communications concerning this schedule shall be addressed to the National Production Authority, Washington 25, D.C., Ref: M-80, Schedule 2.

This schedule is issued simultaneously with NPA Order M-80. It shall take effect on the same date as that order, namely, August 15, 1951.

NATIONAL PRODUCTION
AUTHORITY,
MANLY FLEISCHMANN,
Administrator.

[F.R. Doc. 51-9915; Filed, Aug. 15, 1951; 5:09 p.m.]

TITLE 32A—NATIONAL DEFENSE, APPENDIX

Chapter III—Office of Price Stabiliza- tion, Economic Stabilization Agency

[General Overriding Regulation 9, Amendment 4]

GOR 9—EXEMPTIONS OF CERTAIN INDUSTRIAL MATERIALS AND MANUFACTURED GOODS

SALES OF CERTAIN STRATEGIC AND CRITICAL METALS AND MINERALS

Pursuant to the Defense Production Act of 1950 (Public Law 774, 81st Cong.) as amended, Executive Order 10161 (15 F.R. 6105), and Economic Stabilization Agency General Order No. 2 (16 F.R. 738), this Amendment 4 to General Overriding Regulation 9 is hereby issued.

STATEMENT OF CONSIDERATIONS

This amendment to General Overriding Regulation 9 exempts from price control all sales of raw asbestos, beryl ores, chrome ores, cobalt ores and metal, columbite-tantalite ores, natural graphite, kyanite and related ores, manganese ores, and acid grade fluorspar.

All of the foregoing commodities affected are critical and strategic industrial raw materials and a substantial portion of our requirements of each comes from foreign sources. There is a shortage of all of these commodities and the exemption granted herein was considered necessary to avoid any interference with the flow of needed supplies to the United States. Although there may be some increase in costs to domestic consumers as a result of this action, any such increase will have far less an effect upon the stabilization program than the reduction in supply which might result if the exemption were not granted. In view of the relatively small proportion of our supply of these commodities which comes from domestic sources, it appears that the administrative burden of retaining ceiling prices on domestic production would outweigh any benefits to be derived therefrom. Since ceiling prices are imposed upon the products in which the exempted commodities are used, it is anticipated that this action will have little, if any, effect upon the cost of the defense program or the cost of living.

This amendment also exempts sales of domestic mercury from price control. Although there does not appear to be a shortage of this metal at the present time, at least one producer has supplies which are being withheld from sale because of the relatively low ceiling price applicable to his transactions. It is likely that these supplies will be released if sales can be made at the current market price and since this price is well below the general level of ceiling prices under the GPCR, the exemption granted will have no inflationary effect. Sales of imported mercury will remain subject to price control and are being included in Ceiling Price Regulation 31—Imports.

The special nature of the provisions of this amendment made it impracticable to consult with industry representatives or trade associations, but consideration has been given to the advice of various members of the metals industries with regard to the exemption of these ores and materials.

AMENDATORY PROVISIONS

General Overriding Regulation 9 is amended in the following respects:

1. Section 2(a) (9) is added to read as follows:

(9) *Sales of raw asbestos*. "Raw asbestos" includes crude fibres and fibrous masses derived from chrysotile or amphibole.

2. Section 2(a) (10) is added to read as follows:

(10) *Sales of beryl ores*. "Beryl ores" includes any beryl ore in a crude state and any berillium concentrate derived from the crude ore by concentration or beneficiation.

3. Section 2(a) (11) is added to read as follows:

(11) *Sales of chrome ores*. "Chrome ores" includes any metallurgical, chemical and refractory chrome ore in a crude state or in concentrated, beneficiated or sized form.

4. Section 2(a) (12) is added to read as follows:

(12) *Sales of cobalt ores and metal*. "Cobalt ores and metal" includes any cobalt ore in a crude state or in concentrated or beneficiated form, any "crude cobalt" (impure cobalt alloy), and any refined cobalt metal.

5. Section 2(a) (13) is added to read as follows:

(13) *Sales of columbite-tantalite ores*. "Columbite-tantalite ores" includes any columbium (niobium) and tantalum ore in a crude state or in concentrated or beneficiated form.

6. Section 2(a) (14) is added to read as follows:

(14) *Sales of natural graphite*. "Natural graphite" includes any soft native carbon of metallic lustre (often called plumbago or black lead), either in the state of a crude ore or in concentrated or beneficiated form.

7. Section 2(a) (15) is added to read as follows:

(15) *Sales of kyanite and related ores*. "Kyanite and related ores" includes any kyanite, andalusite, sillimanite or dumortierite ore in a crude state or in concentrated or beneficiated form.

8. Section 2(a) (16) is added to read as follows:

(16) *Sales of manganese ores*. "Manganese ores" includes any metallurgical, battery, and chemical manganese ore in a crude state or in concentrated, beneficiated, or sized form.

9. Section 2(a) (17) is added to read as follows:

(17) *Sales of domestic mercury*. "Domestic mercury" includes any mercury produced in the United States, its Territories or Possessions.

10. Section 2(a) (18) is added to read as follows:

(18) *Sales of acid grade fluorspar*. "Acid grade fluorspar" includes any fluorspar which, on a dry basis, conforms to the following chemical analysis:

	Percent
Calcium fluoride (minimum)-----	97
Silica (maximum)-----	1.10
Sulphur (as sulphide or free sulphur) (maximum)-----	.03
Calcium carbonate (maximum)-----	1.25
Iron oxide (maximum)-----	.25
Lead (maximum)-----	.20
Zinc (maximum)-----	.20

It also includes any fluorspar ore which conforms to such specification after concentration or beneficiation. (Sec. 704, Pub. Law 774, 81st Cong.; Pub. Law 96, 82d Cong.)

Effective date: This amendment shall become effective August 10, 1951.

HAROLD LEVENTHAL,

Acting Director of Price Stabilization.

AUGUST 10, 1951.

TITLE 32A—NATIONAL DEFENSE, APPENDIX

Chapter III—Office of Price Stabilization, Economic Stabilization Agency

MATERIALS AND MANUFACTURED GOODS

[General Overriding Regulation 9, Amendment 8]

GOR 9—EXEMPTION OF CERTAIN INDUSTRIAL

SALES OF COBALT OXIDE

Pursuant to the Defense Production Act of 1950, as amended, Executive Order 10161 (15 F.R. 6105), and Economic Stabilization Agency General Order No. 2 (16 F.R. 738), this Amendment 8 to General Overriding Regulation 9 is hereby issued.

STATEMENT OF CONSIDERATIONS

This amendment to General Overriding Regulation 9 exempts from price control all sales of Cobalt Oxide. Amendment 4 to General Overriding Regulation 9 exempted from price control Cobalt Ore and Cobalt Metal. These materials are predominantly all imported into the United States and are of extreme importance to the defense program. Cobalt oxide, which was not included in that amendment, appears in two grades, the metallurgical grade and ceramic grade, and is also very vital to the defense program. 100 percent of the crude cobalt alloy from which the metallurgical grade is made is imported into the United States, and about 75 percent of the ceramic grade is imported. There is an extreme shortage of this material and this exemption is considered necessary to avoid any interference with the flow of this commodity to the United States.

Prior to the promulgation of this amendment, the Director consulted with industry representatives to the extent practicable under the circumstances and has given consideration to their recommendations.

AMENDATORY PROVISIONS

General Overriding Regulation 9 is amended by amending section 2(a) (12) to read as follows:

(12) *Sales of cobalt ores, oxide and metal*. "Cobalt ores, oxide and metal" includes any cobalt ore in a crude state or in concentrated or beneficiated form, any "crude cobalt" (impure cobalt alloy), any cobalt oxide in a crude or refined form, and any refined cobalt metal.

(Sec. 704, 64 Stat. 816, as amended; 50 U.S.C. App. Sup. 2154)

This amendment shall become effective October 12, 1951.

MICHAEL V. DiSALLE,
Director of Price Stabilization.

OCTOBER 12, 1951.

[F.R. Doc. 51-12408; Filed, Oct. 12, 1951; 11:29 a.m.]

TITLE 32A—NATIONAL DEFENSE, APPENDIX

Chapter VI—Defense Minerals Administration, Department of the Interior

[MO 1]

PART 1009—DESIGNATION OF SCARCE MATERIALS

Pursuant to the provisions of section 102 of the Defense Production Act of 1950 (Public Law 774, 81st Congress), Executive Order 10161 (15 F.R. 6105), and the delegation of December 18, 1950, by the Secretary of Commerce to the Secretary of the Interior (NPA Delegation 5, 15 F.R. 9195), the materials specified on the attached list are hereby designated as scarce materials. These materials are therefore subject to said section 102 which provides in part that in order to prevent hoarding, no person shall accumulate such materials (1) in excess of the reasonable demands of business, personal, or home consumption, or (2) for the purpose of resale at prices in excess of prevailing market prices.

Special circumstances have rendered consultation with industry representatives, including trade associations, prior to the formulation of this order, impracticable and contrary to the interest of the national defense.

§ 1009.1 *Designation of scarce materials.*

Iron ore, concentrates, sinter, Pyrites cinder.
Manganese ores, concentrates.
Chromium ores, concentrates.
Cobalt ores, concentrates.
Nickel ores, concentrates.
Tungsten ores, concentrates.
Molybdenum ores, concentrates.
Vanadium ores, concentrates, flue dust.
Fluorspar ores.
Miscellaneous ferro-alloy ores, concentrates (including Boron, Columbium, Ferro-Titanium, Ferro-Zirconium, Ferro-Tantalum, etc.).
Beryllium ores.
Cerium and other rare-earth metal ores.
Columbium ores.
Germanium concentrates, residues.
Lithium ores.
Platinum-group unrefined materials, including grain, nuggets, ores, concentrates.
Selenium anode slimes.
Tantalum ores.
Tellurium bearing anode slimes and lead residues.
Thallium: Cottrell dusts, residues from zinc, cadmium and lithopone works. Ores (Mercur, Utah).
Aluminum (crude), dried and calcined bauxite, aluminum pig, pig, alumina.
Magnesium: Dolomite, magnesium chloride, magnesium pig, crystals.
Titaniferous ores, titanium metal sponge, chips, powder.
Zirconium-bearing ores, zirconium metal sponge.
Antimony ores, concentrates, residues.
Bismuth concentrates, base bullion, residues.
Cadmium concentrates, flue dusts, residues.
Copper ores, concentrates, matte, blister, anodes.
Lead ores, concentrates, base bullion, matte, speiss, residues.
Mercury ores, concentrates.
Tin ores, concentrates.
Zinc ores, concentrates, fumes, residues.
Corundum ores, concentrates crystals.
Emery ores.
Grinding pebbles, mill liners (crude).
Asbestos, unmilled.
Barite, witherite (crude).
Borates ores, brines (crude).
Bromine.
Fuller's earth, crude.
Cryolite ores.
Graphite, crude.
Quartz, crystals, raw.
Strontium ores.
Sulphur, pyrites.
Talc, pyrophyllite, crude.
Topaz, crude.
Wollastonite.
Kyanite and other mullite-forming minerals, synthetic mullite.
Mica, crude, trimmed, scrap.

Monazite, bastnasite.
Nitrogen Compounds (natural).
Potash, crude.

(Sec. 704, Pub. Law 774, 81st Cong. Interprets or applies sec. 102, Pub. Law 774, 81st Cong.)

Dated: December 29, 1950.

JAMES BOYD,
*Administrator,
Defense Minerals Administration.*

Approved: December 29, 1950.

OSCAR L. CHAPMAN,
Secretary of the Interior.

Chapter XII—Defense Minerals Administration, Department of the Interior

[MO-5]

MO-5—REGULATIONS GOVERNING GOVERNMENT AID IN DEFENSE EXPLORATION PROJECTS

This regulation is found to be necessary and appropriate to carry out the provisions of the Defense Production Act of 1950 with reference to the encouragement of exploration, development, and mining of critical and strategic minerals and metals pursuant to section 303(a)(2) of the act. In the formulation of this regulation there has been consultation with industry representatives, including trade association representatives, and consideration has been given to their recommendations.

EXPLANATORY PROVISIONS

Sec.

1. What this regulation does.
2. Government aid.

APPLICATIONS AND CONTRACTS

3. Forms and filing.
4. Scope of application.
5. Action on applications.
6. Form and term of contracts.
7. Criteria.
8. Definitions.

GOVERNMENT PARTICIPATION

9. Ratio of contributions.
10. Fixtures and improvements.
11. Operating equipment.
12. Title to and disposition of property.
13. Allowable costs of the project.
14. Repayment by Operator.

AUTHORITY: Sections 1 to 14 issued under sec. 704, Pub. Law 774, 81st Cong. Interpret or apply sec. 303, Pub. Law 774, 81st Cong. E.O. 10161, Sept. 9, 1950, 15 F.R. 6105, 3 CFR, 1950 Supp.; E.O. 10200, Jan. 3, 1951, 16 F.R. 61.

EXPLANATORY PROVISIONS

SECTION 1. *What this regulation does.* This regulation sets forth procedures under which Government aid may be obtained in financing the cost of projects for exploration for unknown or undeveloped sources of strategic or critical metals and minerals.

SEC. 2. *Government aid.* The Government, in suitable cases, will aid in an exploration project for strategic or critical metals and minerals by providing some part of the costs of the project, the Government's contribution to be repayable from the net returns from any ore, concentrates, or metal produced as a result of the exploration project.

APPLICATIONS AND CONTRACTS

SEC. 3. *Forms and filing.* Application for Government aid in any specified exploration project shall be submitted in quadruplicate on Form No. MF-103, either to

The Defense Minerals Administration,
Department of the Interior,
Washington 25, D.C.

or to the nearest Defense Minerals Administration field executive officer as indicated by the following addresses:

Region	Area served	Address
I.....	Alaska.....	Federal Bldg., P.O. Box 2990, Juneau, Alaska.
II.....	Washington, Oregon, Idaho, and Montana.	South 157 Howard St., Spokane, Wash.
III.....	California and Nevada.....	1415 Appraisers Bldg., San Francisco, Calif.
IV.....	Arizona, New Mexico, Colorado, Utah, and Wyoming.	224 New Customhouse Bldg., Denver 2, Colo.
V.....	North Dakota, South Dakota, Nebraska, Minnesota, Iowa, Wisconsin, and Michigan.	426 Plymouth Bldg., Minneapolis, Minn.
VI.....	Kansas, Louisiana, Oklahoma, Texas, Arkansas, and Missouri.	P.O. Box 431, Joplin, Mo.
VII.....	Tennessee, North Carolina, South Carolina, Georgia, Florida, Alabama, and Mississippi.	Room 13, Post Office Bldg., Knoxville, Tenn.
VIII.....	Illinois, Indiana, Ohio, Kentucky, Virginia, West Virginia, Maryland, New York, Vermont, Maine, New Hampshire, Connecticut, Rhode Island, New Jersey, Delaware, and Pennsylvania.	Eastern Experiment Station, College Park, Md.

Applications filed prior to the effective date of this regulation, if sufficient, will be treated as though filed on the prescribed form. Applications must be filed at least 30 days prior to the expiration of the authority granted by the Defense Production Act of 1950, which at the time of issuing these regulations, is June 30, 1951.

Sec. 4. Scope of application. Each application shall relate to a single exploration project which shall be fully described and justified by detailed substantiating data as called for by the application form. The Administrator may require the filing of additional information, reports, and exhibits, in connection with the application, and may, at his discretion, require such physical examination of the project as he deems necessary.

Sec. 5. Action on applications. The Administrator, after considering the application and all matters relating thereto, shall either approve or disapprove the application. If the Administrator approves the application, he shall certify it as presenting a suitable project for an exploration project contract.

Sec. 6. Form and term of contracts. If the application is approved and certified for a contract, the Government, acting through the Administrator, will enter into an exploration project contract with the applicant on Form MF-200. No exploration project that will take more than two years to perform shall be approved for an exploration project contract.

Sec. 7. Criteria. The following factors will be considered and weighed in passing upon applications:

- Strategic importance of the mineral involved.
- The geologic probability of making a significant discovery.
- The availability of manpower.
- The availability of equipment and supplies.
- The accessibility of the project.
- The availability of water and power.
- The operating experience and background of the applicant.

Sec. 8. Definitions. As used in these regulations:

(a) "Exploration project" means the search for unknown or underdeveloped sources of strategic or critical metals or minerals within a specified area or parcel of ground in the United States, its territories or possessions, whether conducted from the surface or

underground, including recognized and sound procedures for obtaining pertinent geological, geophysical, and geochemical information. The work shall not go beyond a reasonable delineation and sampling of the ore, and shall not include work prosecuted primarily for mining or preparation for mining.

(b) "Operator" means a person, firm, partnership, corporation, association, or other legal entity by whom or for whose account and interest an exploration project is to be carried out.

(c) "Administrator" means the Administrator of Defense Minerals Administration or his representative authorized in writing.

(d) "Government" means The United States of America.

GOVERNMENT PARTICIPATION

SEC. 9. Ratio of contributions. The Government will contribute to the exploration project, upon the terms specified in the contract, a certain percentage of the total cost of the project, depending upon the mineral which is the subject of exploration, as follows:

(a) In the case of chromium, copper, fluor spar, graphite (crucible flake), iron ore, lead, molybdenum, sulfur, and zinc (and cadmium)—50 percent.

(b) In the case of antimony, manganese, mercury, tungsten—75 percent.

(c) In the case of asbestos (spinning grade), beryl, cobalt, columbium-tantalum, corundum, cryolite, industrial diamonds, kyanite (strategic), mica (strategic), monazite, uranium, and rare earth ores, nickel, platinum group metals, quartz crystals (piezo-electric, talc (steatite), and tin—90 percent.

Sec. 10. Fixtures and improvements. The Operator shall devote the land and all existing improvements, facilities, buildings, installations, and appurtenances to the purpose of the exploration project without any allowance for the use, rental value, depreciation, depletion, or other cost of acquiring, owning, or holding possession thereof. With the written approval in advance by the Administrator, necessary additional facilities, buildings, and fixtures may be purchased, installed and erected by the Operator, and the Government will contribute its agreed pro-rata share of the cost thereof. The difference between the cost of such additional facilities, buildings, or fixtures, and the salvage value thereof at the conclusion of the work, shall be charged as a cost of the project to which the Government has contributed its pro-rata share.

Sec. 11. Operating equipment. With the written approval in advance by the Administrator, necessary operating equipment may be rented, purchased, or otherwise furnished by the Operator. Rentals paid for equipment rented and the rental value of equipment owned and furnished by the Operator shall be allowed as costs of the project. As to equipment purchased for the project, the Government will contribute its agreed pro-rata share of the cost thereof, and the difference between the cost and the salvage value at the conclusion of the work shall be charged as a cost of the project to which the Government has contributed its pro-rata share.

Sec. 12. Title to and disposition of property. All facilities, buildings, fixtures, equipment, or other items costing more than \$50 each, paid for or purchased with funds contributed jointly by the Operator and the Government, shall belong to the Operator and the Government jointly, in proportion to their respective contributions, and upon the termination of the contract, if they have any salvage value, shall be disposed of for their joint account unless the Government, in writing, waives its interest in any such items. The Government may require the dismantling, severance from land, and removal of any such items in order to realize its

interest in the salvage value thereof, and the cost of any such removal and of the disposal of the items shall be for the joint account of the parties in proportion to their respective interests.

SEC. 13. *Allowable costs of the project.* The allowable costs of the project in which the Government will participate shall include the following:

(a) The necessary, reasonable, direct costs of performing the exploration work, including the costs of materials, supplies, labor, direct supervision, engineering, power, water, and utilities.

(b) The reasonable, necessary cost of rehabilitating and putting into useful and operable condition existing facilities, buildings, installations, and fixtures, and of maintaining them in that condition.

(c) If the purchase, installation, or erection was approved in advance by the Administrator, as provided in section 10 of this regulation, the depreciation on fixtures and improvements computed as provided in section 10 of this regulation.

(d) If the rental or purchase of operating equipment was approved in advance by the Administrator, as provided in section 11, of this regulation, the rental, rental value, or depreciation, on operating equipment, computed as provided in section 11 of this regulation.

No items of general overhead, corporate management, interest, or any other indirect costs not expressly allowed by these regulations, or work performed or costs incurred before the date of the contract, shall be allowed as costs of the project in which the Government will participate.

SEC. 14. *Repayment by Operator.* If, upon the completion of the exploration project or termination of the contract, the Administrator considers that a discovery or development has resulted from the work from which commercial production of ore may be made, the Administrator, within six months thereafter shall so certify to the Operator, particularly describing and delimiting his estimate of the discovery of the development. Thereafter, if and when ore is produced as a result of such discovery or development, the Operator and his successor in interest shall be and become obligated to pay to the Government a percentage royalty on the net smelter returns or other net proceeds realized from such ore, concentrates, or metal produced within ten (10) years from the date of this contract, until the total amount contributed by the Government, without interest, is fully repaid or said ten years have elapsed, whichever occurs first, as follows:

Of net smelter returns or other net proceeds not in excess of eight dollars (\$8.00) per ton of ore: one and one-half (1½) percent.

Of net smelter returns or other net proceeds in excess of eight dollars (\$8.00) per ton of ore: one and one-half (1½) percent, plus one-half (½) percent additional for each full fifty cents (\$.50) in excess of eight dollars (\$8.00) per ton of ore, but not in excess of a maximum of five (5) percent.

This obligation to repay from net returns or proceeds shall be and remain a claim and lien upon the property which is the subject of the exploration project and upon any production resulting from such discovery or development, in favor of the Government, until fully paid, or until said ten-year period has elapsed; and this claim and lien and the Government's right to repayment shall survive any termination of the contract, whether by completion of the exploration project or otherwise. This section is not to be construed as imposing any obligation on the Operator or his successor in interest to produce ore from any such discovery or development.

This regulation shall become effective upon publication in the FEDERAL REGISTER.

JAMES BOYD,
Administrator,

Defense Minerals Administration.

[F.R. Doc. 51-4364; Filed, Apr. 10, 1951; 11:44 a.m.]

TITLE 32A—NATIONAL DEFENSE, APPENDIX

Chapter XII—Defense Minerals Exploration Administration, Department of the Interior

[DMEA Order-1]

GOVERNMENT AID IN DEFENSE EXPLORATION PROJECTS

This order is found to be necessary and appropriate to carry out the provisions of the Defense Production Act of 1950, as amended, with reference to the encouragement of exploration, development, and mining of critical and strategic minerals and metals pursuant to section 303(a) of the act. It supersedes Mineral Order 5 of the former Defense Minerals Administration. In the formulation of this order there has been consultation with industry representatives, including trade association representatives, and consideration has been given to their recommendations.

EXPLANATORY PROVISIONS

Sec.

1. What this order does.
2. Definitions.

APPLICATIONS

3. Form and filing.
4. Scope of application.
5. Action on applications.
6. Criteria.

EXPLORATION PROJECT CONTRACTS

7. Ratio of contributions.
8. Operator's property rights.
9. Allowable costs.
10. Repayment by operator.
11. Title to and disposition of property.

AUTHORITY: Sections 1 to 11 issued under sec. 704, 64 Stat. 816, Pub. Law 96, 82d Cong.; 50 U.S.C. App. Sup. 2154. Interpret or apply sec. 303, 64 Stat. 801, Pub. Law 96, 82d Cong.; 50 U.S.C. App. Sup. 2093, E.O. 10161, Sept. 9, 1950, 15 F.R. 6105; 3 CFR 1950 Supp., E.O. 10281, Aug. 28, 1951, 16 F.R. 8789.

EXPLANATORY PROVISIONS

SECTION 1. *What this order does.* This order sets forth procedures and regulations for obtaining Government aid in financing the cost of projects for exploration for unknown or undeveloped sources of strategic or critical metals and minerals.

SEC. 2. *Definitions.* As used in this order:

(a) "Exploration project" means the search for unknown or undeveloped sources of strategic or critical metals or minerals within a specified area or parcel of ground in the United States, its territories or possessions, whether conducted from the surface or underground, including recognized and sound procedures for obtaining pertinent geological, geophysical, and geochemical information. The work shall not go beyond a reasonable delineation and sampling of the ore, and shall not include work prosecuted primarily for mining or preparation for mining.

(b) "Operator" means a person, firm, partnership, corporation, association, or other legal entity by whom or for whose account and interest an exploration project is to be carried out.

(c) "Administrator" means the Administrator of Defense Minerals Exploration Administration, or his representative authorized in writing.

(d) "Government" means the United States of America.

APPLICATIONS

SEC. 3. Form and filing. An application for aid in any specified exploration project must be in quadruplicate on forms which may be obtained from and filed with either:

The Defense Minerals Exploration Administration,
Department of the Interior,
Washington 25, D.C.

or the nearest Defense Minerals Exploration Administration field executive officer as indicated by the following addresses:

Area served and address

Region I: Alaska—Bureau of Mines, P.O. Box 2990, Juneau, Alaska.

Region II: Washington, Oregon, Idaho, and Montana—South 157 Howard Street, Spokane 8, Wash.

Region III: California and Nevada—1012 Flood Building, 870 Market Street, San Francisco 2, Calif.

Region IV: Arizona, New Mexico, Colorado, Utah, and Wyoming—Bureau of Mines, 224 New Customhouse Building, Denver 2, Colo.

Region V: North Dakota, South Dakota, Nebraska, Minnesota, Iowa, Wisconsin, and Michigan—2908 Colfax Avenue South, Minneapolis 8, Minn.

Region VI: Kansas, Louisiana, Oklahoma, Texas, Arkansas, and Missouri—221 West Third Street, Joplin, Mo.

Region VII: Tennessee, North Carolina, South Carolina, Georgia, Florida, Alabama, and Mississippi—Room 13, Post Office Building, Knoxville 01, Tenn.

Region VIII: Illinois, Indiana, Ohio, Kentucky, Virginia, West Virginia, Maryland, Massachusetts, New York, Vermont, Maine, New Hampshire, Connecticut, Rhode Island, New Jersey, Delaware, and Pennsylvania—Bureau of Mines, Eastern Experiment Station, College Park, Md.

SEC. 4. Scope of application. Each application shall relate to and fully describe a single exploration project, which shall be justified by detailed substantiating data as called for by the application form. The Administrator may require the filing of additional information, reports, maps or charts, and exhibits, in connection with the application, and may make such physical examination of the project as he deems necessary.

SEC. 5. Action on application. If the application is approved, the Government, acting through the Administrator, will enter into an exploration project contract with the applicant upon such terms and conditions as are set forth in the contract form which the Administrator will supply. Exploration projects the estimated time for the performance of which is more than two years will be approved only if justified, in the opinion of the Administrator, by special circumstances.

SEC. 6. Criteria. The following factors will be considered and weighed in passing upon applications:

- (a) The strategic importance of the mineral involved.
- (b) The geologic probability of making a significant discovery.
- (c) The availability of manpower, materials, supplies, equipment, water, and power.
- (d) The accessibility of the project.
- (e) The operating experience and background of the applicant.

EXPLORATION PROJECT CONTRACTS

SEC. 7. Ratio of contributions. The Government, upon the terms specified in the contract, will contribute a percentage of the total cost of a project, depending upon the mineral or minerals which are the subject of exploration, as follows:

(a) In the case of chromium, copper, fluor spar, crucible flake graphite, iron ore, lead, molybdenum, sulfur, catalytic grade halloysite, bauxite, zinc and cadmium—50 percent.

(b) In the case of antimony, manganese, mercury, tungsten, rutile and brookite—75 percent.

(c) In the case of chrysotile and amosite asbestos, beryl, cobalt, columbium tantalum, corundum, cryolite,

industrial diamonds, strategic kyanite, strategic mica; monazite, uranium, and rare-earth ores; nickel, platinum-group metals, piezo-electric quartz, crystals, black steatite talc, and tin—90 percent.

(d) In the event that two or more of the minerals named in this section are the subject of the proposed exploration, the allowable percentage shall be apportioned between them.

SEC. 8. Operator's property rights. The Operator must have, preserve, and maintain a sufficient interest in the land, as owner, lessee, or otherwise, for the purposes of the exploration project contract. The Operator shall devote the land and all existing improvements, facilities, buildings, installations, and appurtenances to the purposes of the exploration project without any allowance for the use, rental value, depreciation, depletion, or other cost of acquiring, owning, or holding possession thereof.

SEC. 9. Allowable costs. (a) The Government, to the extent provided in the exploration project contract, will contribute to the necessary, reasonable, direct costs of performing the exploration work, including the costs of labor, supervision, and consultants; workmen's compensation and employers' liability insurance and payroll and sales taxes; operating materials and supplies; operating equipment to be rented or purchased, or which is owned and will be furnished by the Operator; necessary rehabilitation or repairs of existing buildings, installations, fixtures, and movable operating equipment owned by the Operator and devoted to the purposes of the exploration project contract; necessary buildings, fixed improvements, or installations to be purchased, installed, or constructed for the purposes of the exploration work; repairs to and maintenance of operating equipment in the course of operations; analytical work; accounting; amounts paid by the Operator to independent contractors; costs estimated and agreed upon by the Operator and the Government in terms of units of work performed (per foot of drifting, per foot of drilling, etc.); and such other necessary, reasonable, direct costs as may be approved by the Government in the course of the work.

(b) No items of general overhead, corporate management, interest, taxes (other than payroll and sales taxes), or any other indirect costs, or work performed or costs incurred before the date of the contract, shall be allowed as costs of the project in which the Government will participate.

SEC. 10. Repayment by operator. (a) If, at any time, the Government considers that a discovery or a development from which production may be made has resulted from the exploration work, the Government, at any time not later than six months after the Operator has rendered any final report and final account, may so certify in writing to the Operator. The certification shall describe broadly or indicate the nature of the discovery or development. In the event of such certification, any minerals mined or produced from the land which is the subject of the exploration project contract within ten years from the date of the contract, including any mined or produced before the certification, shall be subject to a percentage royalty which the Operator or his successor in interest shall pay to the Government, upon the net smelter returns, the net concentrator returns, or other net amounts realized from the sale or other disposition of any such production, in whatever form disposed of, including ore, concentrates, or metal, until the total amount contributed by the Government, without interest, is fully repaid, or said ten years have elapsed, whichever occurs first, as follows:

(1) One and one-half (1½) percent of any such net amounts not in excess of eight dollars (\$8.00) per ton.

(2) One and one-half (1½) percent of any such net amounts, plus one-half (½) percent of such net

amounts for each additional full fifty cents (\$0.50) by which such net amounts exceed eight dollars (\$8.00) per ton, but not in excess of five (5) percent of such net amounts.

(For instance: The percentage royalty on a net amount of five dollars (\$5.00) per ton, would be one and one-half (1½) percent; on a net amount of ten dollars (\$10.00) per ton, three and one-half (3½) percent.)

(b) As here used, "net smelter returns," "net concentrator returns," and "other net amounts realized from the sale or other disposition," mean gross revenue from sales; or if not sold, the market value of the material after it is mined in the form in which and the place where it is held. In the case of integrated operations in which the material is not disposed of as such, these terms mean what is or would be gross income from mining operations for percentage depletion purposes in income tax determination.

(c) To secure the payment of its percentage royalty, the exploration project contract shall provide for a lien upon the land or the Operator's interest in the land which is the subject of the contract and upon any production of minerals therefrom, and personal liability of the Operator if he fails to preserve the lien, until the royalty claim is extinguished by lapse of time or is fully paid, or is otherwise satisfied or extinguished as provided in the contract.

(d) This section is not to be construed as imposing any obligation on the Operator or the Operator's successor in interest to engage in any mining or production operations.

SEC. 11. *Title to and disposition of property.* All facilities, buildings, fixtures, equipment, or other items costing more than \$50.00 each, paid for or purchased with funds contributed jointly by the Operator and the Government, although title may be taken in the name of the Operator, shall belong to the Operator and the Government jointly, in proportion to their respective contributions, and the exploration project contract shall make suitable provisions for their disposal for the joint account of the Operator and the Government.

Dated: March 7, 1952.

C. O. MITTENDORF,
*Acting Administrator, Defense Minerals
Exploration Administration.*

[F.R. Doc. 52-2912; Filed, Mar. 10, 1952; 11:27 a.m.]

TITLE 32A—NATIONAL DEFENSE, APPENDIX

Chapter XII—Defense Minerals Exploration Administration, Department of the Interior

[DMEA Order 1, Amendment 3]

DMEA 1—GOVERNMENT AID IN DEFENSE EXPLORATION PROJECTS

RATIO OF CONTRIBUTION

In the formulation of this amendment there has been no consultation with industry representatives or trade association representatives because special circumstances have rendered such consultation impracticable and contrary to the interests of the national defense.

1. Section 7, after the colon in the first sentence, is amended to read as follows:

(a) In the case of chromium, copper, and molybdenum—50 percent.

(b) In the case of asbestos (chrysotile only), beryl, cobalt, columbium, manganese, mica (muscovite block and film only), nickel, platinum, tantalum, tungsten, and uranium—75 percent.

(c) In the event that two or more of the minerals named in this section are the subject of the proposed exploration, the allowable percentage shall be apportioned between them.

2. This amendment shall not apply to applications for exploration project contracts received by or placed in the United States mail for Defense Minerals Exploration Administration before 12 o'clock midnight of the day of its publication in the FEDERAL REGISTER.

(Sec. 704, 64 Stat. 816, as amended; 50 U.S.C. App. Sup. 2154)

[SEAL]

C. O. MITTENDORF,
*Administrator, Defense Minerals
Exploration Administration.*

OCTOBER 30, 1953.

[F.R. Doc. 53-9338; Filed, Nov. 2, 1953; 9:59 a.m.]

TITLE 32A—NATIONAL DEFENSE, APPENDIX

Chapter XII—Defense Minerals Exploration Administration, Department of the Interior

[DMEA Order 1, Amended]

DMEA 1—GOVERNMENT AID IN DEFENSE EXPLORATION PROJECTS

This amended order is found to be necessary and appropriate to carry out the provisions of the Defense Production Act of 1950, as amended, with reference to the encouragement of exploration, development, and mining of critical and strategic minerals and metals pursuant to section 303(a) of the Act. It is a complete restatement and revision of the order as heretofore amended. In the formulation of this amended order there has been no consultation with industry representatives or trade association representatives because special circumstances have rendered such consultation impracticable.

EXPLANATORY PROVISIONS

Sec.

1. What this order does.
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EXPLORATION PROJECT CONTRACTS

7. Ratio of contributions.
8. Operator's property rights.
9. Allowable costs.
10. Repayment by operator.
11. Government not obligated to buy.
12. Title to and disposition of property.

AUTHORITY: Sections 1 to 12 issued under sec. 704, 64 Stat. 816, 65 Stat. 139, 50 U.S.C. App. Sup. 2154. Interpret or apply sec. 303, 64 Stat. 801, 65 Stat. 133; secs. 5-6, Pub. Law 95, 83d Cong.; 50 U.S.C. App. Sup. 2093; E.O. 10480, Aug. 20, 1953, 18 F.R. 4939.

EXPLANATORY PROVISIONS

SECTION 1. *What this order does.* This order sets forth procedures and regulations for obtaining Government aid in financing the cost of projects for exploration for indicated or undeveloped sources of strategic or critical metals and minerals.

SEC. 2. *Definitions.* As used in this order:

(a) "Exploration project" means the search for indicated or undeveloped sources of strategic or critical metals or minerals within a specific area or parcel of ground in the United States, its territories or possessions, whether conducted from the surface or underground, including recognized and sound procedures for obtaining pertinent geological, geophysical, and geochemical information. The work shall not go beyond a reasonable delineation and sampling of the ore, and shall not include work prosecuted primarily for mining or preparation for mining.

(b) "Operator" means a person, firm, partnership, corporation, association, or other legal entity by whom or for whose account and interest an exploration project is to be carried out.

(c) "Administrator" means the Administrator of Defense Minerals Exploration Administration, or his representative authorized in writing.

(d) "Government" means the United States of America.

APPLICATIONS

SEC. 3. *Form and filing.* An application for aid in any specified exploration project must be in quadruplicate on forms which may be obtained from and filed with either:

The Defense Minerals Exploration Administration,
Department of the Interior,
Washington 25, D.C.

or the nearest Defense Minerals Exploration Administration field executive officer as indicated by the following addresses:

Region	Area served	Address
I.....	Alaska.....	Bureau of Mines P. O. Box 560, Juneau, Alaska.
II.....	Washington, Oregon, Idaho and Montana.....	South 157 Howdsr Street, Spokane 4, Wah.
III.....	California and Nevada.....	1012 Flood Building, 870 Market Street, San Francisco 2, Calif.
IV.....	Arizona, New Mexico, Colorado, Utah, and Wyoming.....	Bureau of Mines, 224 New Customhouse Building, Denver 2, Colo.
V.....	North Dakota, South Dakota, Nebraska, Minnesota, Iowa, Wisconsin, and Michigan.....	2908 Colfax Avenue, South Minneapolis 8, Minn.
VI.....	Kansas, Louisiana, Oklahoma, Texas, Arkansas, and Missouri.....	P. O. Box 431, Joplin Mo.
VII.....	Tennessee, North Carolina, South Carolina, Georgia, Florida, Alabama, and Mississippi.....	Room 13, Post Office Building, Knoxville 2, Tenn.
VIII.....	Illinois, Indiana, Ohio, Kentucky, Virginia, West Virginia, Maryland, Massachusetts, New York, Vermont, Maine, New Hampshire, Connecticut, Rhode Island, New Jersey, Delaware, and Pennsylvania.....	Bureau of Mines, Eastern Experiment Station, College Park, Md.

SEC. 4. *Scope of application.* Each application shall relate to and fully describe the exploration project, which shall be justified by detailed substantiating data as called for by the application form. The Administrator may require the filing of additional information, reports, maps or charts, and exhibits, in connection with the application, and may require such physical examination of the project as he deems necessary.

SEC. 5. *Action on applications.* If the application is approved, the Government, acting through the Administrator, will enter into an exploration project contract with the applicant upon such terms and conditions as are set forth in the contract form which the Administrator will supply. Exploration projects esti-

mated to require more than two years to complete will be approved only if justified in the opinion of the Administrator by special circumstances.

SEC. 6. *Criteria.* The following factors will be considered and weighed in passing upon applications:

(a) The strategic importance of the mineral involved.

(b) The geologic probability of making a significant discovery.

(c) The availability of manpower, materials, supplies, equipment, water, and power.

(d) The accessibility of the project.

(e) The operating experience and background of the applicant.

EXPLORATION PROJECT CONTRACTS

SEC. 7. *Ratio of contributions.* The Government, upon the terms specified in the contract, will contribute a percentage of the total allowable costs of a project, depending upon the mineral or minerals which are the subject of exploration, as follows:

(a) In the case of bauxite, chromium, copper, fluorspar, graphite (crucible flake), lead, molybdenum, zinc, and cadmium—50 percent.

(b) In the case of antimony, asbestos (chrysotile only), beryl, cobalt, columbium, corundum diamonds (industrial), kyanite (strategic), manganese, mercury, mica (strategic), monazite and rare earths, nickel, platinum-group metals, quartz crystals (piezo-electric), rutile-brookite, talc (bloc-steatite), tantalum, thorium, tin, tungsten, and uranium—75 percent.

(c) In the event that two or more of the minerals named in this section are the subject of the proposed exploration, the allowable percentage shall be apportioned between them.

SEC. 8. *Operator's property rights.* The operator must have, preserve, and maintain a sufficient interest in the land, as owner, lessee, or otherwise, for the purposes of the exploration project contract: *Provided*, That the Administrator may waive any deficiencies in the operator's interest in the land when he finds such action to be in the best interest of the Government. The operator shall devote the land and all existing improvements, facilities, buildings, installations, and appurtenances to the purposes of the exploration project without any allowance for the use, rental value, depreciation, depletion, or other cost of acquiring, owning, or holding possession thereof.

SEC. 9. *Allowable costs.* (a) The Government, to the extent provided in the exploration project contract, will contribute to the necessary, reasonable, direct costs of performing the exploration work, including: The costs of labor, supervision, and consultants; operating materials and supplies; operating equipment; any necessary initial rehabilitation or repairs of existing buildings, installations, fixtures, and operating equipment; any necessary buildings, fixed improvements, or installations; repairs and maintenance, analytical work, accounting, payroll deductions for the account of the operator, and liability insurance covering employment; payments by the operator to independent contractors; costs estimated and agreed upon by the operator and the Government in terms of units of work performed (per foot of drifting, per foot of drilling, etc.); and such other necessary, reasonable, direct costs as may be approved by the Government in the course of the work.

(b) No costs of acquiring, owning, or holding possession of the land, and no items of general overhead, corporate management, interest, taxes (other than payroll and sales taxes), or work performed or costs incurred before the date of the contract, shall be allowed as costs of the contract in which the Government will participate.

SEC. 10. *Repayment by operator.* (a) If the Government considers that a discovery or development from which production may be made has resulted from the work, the Government, within the time limited by the contract, may so certify in writing to the operator. Such certification shall describe broadly or indicate the nature of the discovery or development.

(b) The operator shall pay to the Government a royalty on all minerals mined or produced from the land described in the contract: (1) Regardless of any certification of discovery or development, from the date of the contract until the lapse of time within which the Government may make such certification, or until the total net amount contributed by the Government without interest is fully repaid, whichever occurs first; or (2) if the Government makes a certification of discovery or development, within ten years (or other period fixed by the contract) from the date of the contract, or until the total net amount contributed by the Government is fully repaid, whichever occurs first.

(c) The Government's royalty shall be a percentage of the gross proceeds (including any bonuses, premiums, allowances, or other benefits) from the production sold, in the form sold (ore, concentrates, metal, or equivalent), at the point of delivery (the f.o.b. point); except, that charges of the buyer arising in the regular course of business, and shown as deductions on the buyer's settlement sheets, on account of the cost of treatment processes performed by the buyer, sampling and assaying to determine the value of the production sold, and freight paid by the buyer to a carrier (not the operator), shall be allowed as deductions in arriving at the "gross proceeds" as that term is used herein. Any costs of treatment processes, sampling or assaying, or transportation, performed or paid by the operator or by anyone other than the buyer, are not deductible in arriving at the "gross proceeds" as that term is here used. The term "treatment processes," as here used, means those processes (such as milling, concentrating, smelting, refining, or equivalent) applied to the raw ore or other production after it is extracted from the ground, to put it into a commercially marketable form; excluding fabricating or manufacturing.

(d) If any production (ore, concentrates, metal, or equivalent), after the lapse of six months from the date the ore was extracted from the ground, remains neither sold nor used by the operator in integrated manufacturing or fabricating operations (for instance, if it is stockpiled), the Government, at its option, as long as it so remains, may require the computation and payment of its royalty on the value of such production in the form (ore, concentrates, metal, or equivalent) it is in when the Government elects to require computation and payment. If any production is used by the operator in integrated manufacturing or fabricating operations before the Government makes its election, the Government's royalty on such production shall be computed on the value thereof in the form in which and at the time when it is so used. "Value" is here used means what is or would be gross income from mining operations for percentage depletion purposes in Federal income tax determination, or the market value, whichever is greater.

(e) The percentages of the Government's royalty shall be as follows:

One and one-half (1½) percent of amounts ("gross proceeds" or "value") not in excess of eight dollars (\$8.00) per ton of production in the form in which sold, held, or used, plus one-half (½) percent for each additional full fifty cents (\$0.50) by which such amounts exceed eight dollars (\$8.00) per ton, but not in excess of five (5) percent of such amounts.

(For instance: The royalty on an amount of five dollars (\$5.00) per ton, would be one and one-half (1½) percent; on an amount of ten dollars (\$10.00) per ton, three and one-half (3½) percent.)

(f) To secure the payment of the Government's percentage royalty, the contract shall provide for a lien upon the land or the operator's interest in the land which is the subject of the contract, and upon any production of minerals therefrom. To the extent provided in the contract, if the operator is not the producer or if the operator transfers his interest in production, the operator shall remain liable as surety for the payment of the Government's royalty, unless such liability is waived by the Administrator.

(g) If, in any particular case, the administrator finds that it would be more economical or practicable to compute the Government's royalty upon some basis other than "gross proceeds" or "value," as those terms are used in this order, or upon the production in some form other than that in which it is sold, held, or used in integrated operations, he may agree with the operator, either in the original exploration project contract or by an amendment thereof, upon some other basis of computation. The Administrator may, in special cases, fix the term of the Government's percentage royalty and lien at more or less than ten years, when he finds such action to be in the best interest of the Government.

(h) This section is not to be construed as imposing any obligation on the operator or the operator's successor in interest to engage in any mining or production operations.

SEC. 11. *Government not obligated to buy.* Nothing in this order or in any contract entered into pursuant thereto shall be construed as imposing any obligation on the Government to purchase any materials mined or produced from the property which is the subject of such contract.

SEC. 12. *Title to and disposition of property.* All facilities, buildings, fixtures, equipment, or other items costing more than \$50.00 each, paid for or purchased with funds contributed jointly by the operator and the Government, although title may be taken in the name of the operator, shall belong to the operator and the Government jointly, in proportion to their respective contribution, and the exploration project contract shall make suitable provisions for their disposal for the joint account of the operator and the Government.

Dated: March 19, 1954.

C. O. MITTENDORF,
Administrator, Defense Minerals Exploration
Administration.

[F.R. Doc. 54-2056; Filed, Mar. 22, 1954; 8:50 a.m.]

TITLE 32A—NATIONAL DEFENSE, APPENDIX

Chapter XII—Defense Minerals Exploration Administration, Department of the Interior

[DMEA Order 1, Revised]

DMEA 1—GOVERNMENT AID IN DEFENSE EXPLORATION PROJECTS

This revised order, which is necessary and appropriate to carry out the provisions of the Defense Production Act of 1950, as amended, supersedes DMEA Order 1, Amended (19 F.R. 1563) and Amendments 1 to 4 inclusive (20 F.R. 337, 1698; 21 F.R. 3838; 22 F.R. 5685), with reference to the encouragement of explora-

tion, development, and mining of critical and strategic minerals and metals pursuant to section 303(a) of the act. It revises and completely restates the order as heretofore amended. In its formulation there has been no consultation with industry representatives or trade association representatives because special circumstances have rendered such consultation impracticable.

EXPLANATORY PROVISIONS

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11. Government not obligated to buy.
12. Title to and disposition of property.

AUTHORITY: Sections 1 to 12 issued under sec. 704, 64 Stat. 816, as amended; 50 U.S.C. App. 2154. Interpret or apply sec. 303, 64 Stat. 801, as amended; 50 U.S.C. App. 2093. E.O. 10480, 18 F.R. 4939, 3 CFR 1953 Supp. E.O. 10662, 21 F.R. 1673, 3 CFR, 1956 Supp.

EXPLANATORY PROVISIONS

SECTION 1. What this order does. This order sets forth procedures and regulations for obtaining Government aid in financing the cost of projects for exploration of new or undeveloped sources of strategic or critical metals and minerals.

Sec. 2. Definitions. As used in this order:

(a) "Exploration project" means the search for new or undeveloped sources of strategic or critical metals or minerals within a specified area or parcel of ground in the United States, its territories or possessions. Exploration may be conducted from the surface or underground, using recognized and sound procedures including standard geophysical and geochemical methods, to obtain pertinent geological and mineralogical information in those areas where favorable targets appear to exist. The work shall not go beyond a reasonable delineation and sampling of a mineral deposit, and shall not include work prosecuted primarily for mining or preparation for mining.

(b) "Operator" means a person, firm, partnership, corporation, association, or other legal entity by whom or for whose account and interest an exploration project is to be carried out.

(c) "Administrator" means the Administrator of Defense Minerals Exploration Administration, or his representative authorized in writing.

(d) "Government" means the United States of America.

APPLICATIONS

SEC. 3. Form and filing. An application for aid in any specified exploration project must be submitted in quadruplicate on forms which may be obtained from and filed with either:

The Defense Minerals Exploration Administration, Department of the Interior, Washington 25, D.C.

or the nearest Defense Minerals Exploration Administration field executive officer as indicated by the following addresses:

Area served and address

Region I: Idaho, Montana, Oregon, Washington, and Alaska—DMEA, South 157 Howard Street, Spokane 4, Washington. Applicants for Alaskan projects may file applications with the Bureau of Mines Office at Juneau, Alaska, for forwarding to the DMEA Executive Officer, Region I.

Region II: California and Nevada—DMEA, 1605 Evans Avenue, Reno, Nevada.

Region III: Arizona, Colorado, Nebraska, New Mexico, North Dakota, South Dakota, Utah, and Wyoming—DMEA, 224 New Customhouse Building, Denver 2, Colorado.

Region IV: Arkansas, Kansas, Louisiana, Mississippi, Missouri, Oklahoma, and Texas—DMEA, Room 303, Post Office Building, P.O. Box 431, Joplin, Missouri.

Region V: Alabama, Connecticut, Delaware, Florida, Georgia, Illinois, Indiana, Iowa, Kentucky, Maine, Maryland, Massachusetts, Michigan, Minnesota, New Hampshire, New Jersey, New York, North Carolina, Ohio, Pennsylvania, Rhode Island, South Carolina, Tennessee, Vermont, Virginia, West Virginia, Wisconsin—DMEA, Room 13, Post Office Building, Knoxville 2, Tennessee.

SEC. 4. Scope of application. Each application shall relate to and fully describe the exploration project, which shall be justified by detailed substantiating data as called for by the application form. The Administrator may require the filing of additional information, reports, maps or charts, and exhibits, in connection with the application, and may require such physical examination of the project as he deems necessary.

SEC. 5. Action on applications. If the application is approved, the Government, acting through the Administrator, will enter into an exploration project contract with the applicant upon such terms and conditions as are set forth in the contract form which the Administrator will supply. Exploration projects estimated to require more than two years to complete will be approved only if justified in the opinion of the Administrator by special circumstances.

SEC. 6. Criteria. The following factors will be considered and weighed in passing upon applications:

- (a) The strategic importance of the mineral involved.
- (b) The geologic probability of making a significant discovery.
- (c) The availability of manpower, materials, supplies, equipment, water and power.
- (d) The accessibility of the project.
- (e) The operating experience and background of the applicant.

EXPLORATION PROJECT CONTRACTS

SEC. 7. Ratio of contributions. The Government, upon the terms specified in the contract, will contribute a percentage of the total allowable costs of a project, depending upon the mineral or minerals which are the subject of exploration, as follows:

(a) In the case of asbestos (strategic chrysotile), bauxite, cadmium, chromium, columbium, copper, corundum, diamonds (industrial), fluor spar, graphite (crucible flake), kyanite (strategic), lead, mercury, molybdenum, monazite and rare earths, platinum group metals, quartz crystals (piezo-electric), tantalum, thorium, tin, tungsten, uranium, and zinc—50 percent.

(b) In the case of antimony, beryl, cobalt, manganese, mica (strategic), nickel, rutile-brookite, selenium, and talc (block steatite)—75 percent.

(c) In the case of a combination of the minerals named in paragraphs (a) and (b) of this section—62.5 percent.

SEC. 8. Operator's property rights. The operator must have, preserve, and maintain a sufficient interest in the land, as owner, lessee, or otherwise, for the purposes of the exploration project contract: *Provided*, That the Administrator may waive any deficiencies in the operator's interest in the land when he finds such action to be in the best interest of the Government. The operator shall devote the land and all existing improvements, facilities, buildings, installations, and appurtenances to the purposes of the exploration project without any allowance for the use, rental value, depreciation, depletion, or other cost of acquiring, owning, or holding possession thereof.

SEC. 9. Allowable costs. (a) The Government, to the extent provided in the exploration project contract, will

contribute to: (1) The necessary, reasonable, and direct actual costs of performing the exploration work, including: the costs of labor, supervision, and consultants; operating materials and supplies; operating equipment; any necessary initial rehabilitation or repairs of existing buildings, installations, fixtures, and operating equipment; any necessary buildings, fixed improvements, or installations; repairs and maintenance, analytical work, accounting, payroll deductions for the account of the operator, and liability insurance covering employment; payments by the operator to independent contractors; and such other necessary, reasonable, and direct actual costs as may be approved by the Government in the course of the work; and (2) the fixed unit costs agreed upon by the operator and the Government in terms of units of work performed (per foot of drifting, per foot of drilling, etc.).

(b) No costs of acquiring, owning, or possessing the land; no costs of general overhead, corporate management, interest and taxes (other than payroll and sales taxes); and no costs incurred before the date of the contract shall be allowed as costs of the contract in which the Government will participate.

Sec. 10. *Repayment by operator.* (a) If the Government considers that a discovery or development from which production may be made has resulted from the work, the Government, within the time limited by the contract, may so certify in writing to the operator. Such certification shall describe broadly or indicate the nature of the discovery or development.

(b) The operator shall pay to the Government a royalty on all minerals mined or produced from the land described in the contract: (1) Regardless of any certification of discovery or development, from the date of the contract until the lapse of time within which the Government may make such certification, or until the total net amount contributed by the Government without interest is fully repaid, whichever occurs first; or (2) if the Government makes a certification of discovery or development, within ten years (or other period fixed by the contract) from the date of the contract, or until the total net amount contributed by the Government is fully repaid, whichever occurs first.

(c) The Government's royalty shall be a percentage of the gross proceeds (including any bonuses, premiums, allowances, or other benefits) from the production sold, in the form sold (ore, concentrate, metal, or equivalent) at the point of delivery (the f.o.b. point); except, that charges of the buyer arising in the regular course of business, and shown at deductions on the buyer's settlement sheets, on account of the cost of treatment processes performed by the buyer, sampling and assaying to determine the value of the production sold, and freight paid by the buyer (not the operator) to a carrier, shall be allowed as deductions in arriving at the "gross proceeds" as that term is used herein. Any costs of treatment processes, sampling or assaying, or transportation performed or paid by the operator or by anyone other than the buyer are not deductible in arriving at the "gross proceeds" as that term is here used. The term "treatment processes", as here used, means those processes (such as milling, concentrating, smelting, refining, or equivalent) applied to the crude ore or other production after it is extracted from the ground to put it into a commercially marketable form, excluding fabricating or manufacturing.

(d) If any production (ore, concentrate, metal, or equivalent) remains unsold or is not used by the operator in integrated manufacturing or fabricating operations (for instance, if it is stockpiled) after the lapse of six months from the date the ore is extracted from the ground, the Government, at its option, may require the computation and payment of its royalty

on the value of such production in the form (ore, concentrate, metal, or equivalent) it is in at the time the Government elects to exercise its option. If any production is used by the operator in integrated manufacturing or fabricating operations, the Government's royalty on such production shall be computed on the value thereof in the form in which and at the time when it is so used. "Value" as here used means what is or would be gross income from mining operations for percentage depletion purposes in Federal income tax determination, or the market value, whichever is greater.

(e) The percentages of the Government's royalty shall be as follows: One and one-half ($1\frac{1}{2}$) percent of amounts ("gross proceeds" or "value") not in excess of eight dollars (\$8.00) per ton of production in the form in which sold, held, or used, plus one-half ($\frac{1}{2}$) percent for each additional full fifty cents (\$0.50) by which such amounts exceed eight dollars (\$8.00) per ton, but not in excess of five (5) percent of such amounts. (For instance: The royalty on an amount of five dollars (\$5.00) per ton, would be one and one-half ($1\frac{1}{2}$) percent; on an amount of ten dollars (\$10.00) per ton, three and one-half ($3\frac{1}{2}$) percent.)

(f) To secure the payment of the Government's percentage royalty, the contract shall provide for a lien upon the land or the operator's interest in the land which is the subject of the of the contract, and upon any production of minerals therefrom. To the extent provided in the contract, if the operator is not the producer or if the operator transfer his interest in production, the operator shall remain liable as surety for the payment of the Government's royalty, unless such liability is waived by the Administrator.

(g) If, in any particular case, the Administrator finds that it would be more economical or practicable to compute the Government's royalty upon some basis other than "gross proceeds" or "value", as those terms are used in this order, or upon the production in some form other than that in which it is sold, held, or used in integrated operations, he may agree with the operator, either in the original exploration project contract or by an amendment thereof, upon some other basis of computation. The Administrator may, in special cases, fix the term of the Government's percentage royalty and lien at more or less than ten years, when he finds such action to be in the best interest of the Government.

(h) This section is not to be construed as imposing any obligation on the operator or the operator's successor in interest to engage in any mining or production operations.

Sec. 11. *Government not obligated to buy.* Nothing in this order or in any contract entered into pursuant thereto shall be construed as imposing any obligation on the Government to purchase any materials mined or produced from the property which is the subject of such contract.

Sec. 12. *Title to and disposition of property.* All facilities, buildings, fixtures, equipment, or other items costing more than \$50.00 each, paid for or purchased with funds contributed jointly by the operator and the Government, although title may be taken in the name of the operator, shall belong to the operator and the Government jointly, in proportion to their respective contribution and the exploration project contract shall make suitable provisions for their disposal for the joint account of the operator and the Government.

Dated: October 18, 1957.

C. O. MITTENDORF,
Administrator,
Defense Minerals
Exploration Administration.

TITLE 30—MINERAL RESOURCES

Chapter III—Office of Minerals Exploration, Department of the Interior

PART 301—REGULATIONS FOR OBTAINING FEDERAL ASSISTANCE IN FINANCING EXPLORATIONS FOR MINERAL RESERVES, EXCLUDING ORGANIC FUELS, IN UNITED STATES, ITS TERRITORIES AND POSSESSIONS

There was published in the *FEDERAL REGISTER* of September 17, 1958 (23 F.R. 7181), a notice and text of proposed regulations to be codified in Chapter III of Title 30, Code of Federal Regulations, prescribing the manner for obtaining and conditions governing Federal assistance in financing explorations for mineral reserves.

Interested persons were allowed 30 days after publication of the notice to submit written comments, suggestions, or objections with respect to the proposed regulations.

Some objections were received to the requirement in section (4) (b) for furnishing evidence with an application that funds were not available from private sources at reasonable terms. However, as the requirement is a statutory one, it has not been deleted from the regulations.

Several objections were received to the proposal in section 12 to compound interest. The proposal was reconsidered and provision has been made for computing interest as simple interest.

All other comments were fully considered preliminary to adopting the regulations in the present form, as set forth below.

FRED A. SEATON,
Secretary of the Interior

DECEMBER 17, 1958.

GENERAL PROVISIONS

- SEC.
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301.2 Definitions.
301.3 Eligible minerals or mineral products.
301.4 Operator's property rights.

APPLICATIONS

- SEC.
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- 301.9 Government participation.
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301.11 Repayment by operator.
301.12 Interest on amount of Government participation.
301.13 Limitation on amount of Government participation.
301.14 Government not obligated to buy.
301.15 Title to and disposition of property.

AUTHORITY: §§ 301.1 to 301.15, issued under sec. 2, 72 Stat. 700; 30 U.S.C. 642.

GENERAL PROVISIONS

§ 301.1 *Purpose.* The regulations in this part govern the obtaining of Federal financial assistance in conducting exploration for mineral reserves, excluding organic fuels, in the United States, its territories or possessions.

§ 301.2 *Definitions.* As used in this part:

(a) "Exploration" means the search, including related development work, for new or unexplored mineral deposits within a specified area or parcel of ground where geologic conditions favor their occurrence. Exploration using recognized and sound procedures, including standard geophysical and geochemical methods, may be conducted from the surface or underground to

obtain pertinent geological and mineralogical information. The work shall not go beyond a reasonable delineation and sampling of a mineral deposit, and shall not be conducted primarily for mining or preparation for mining.

(b) "Operator" means an individual, partnership, corporation, or other legal entity that is party to an exploration contract with the Government.

(c) "Secretary" means the Secretary of the Interior, or his authorized representative.

(d) "Government" and "Federal" mean the United States of America.

(e) "Commercial sources" means banking institutions.

§ 301.3 *Eligible minerals or mineral products.* The following are eligible for financial assistance:

Antimony.
Asbestos (strategic).
Bauxite.
Beryl.
Cadmium.
Chromite.
Cobalt.
Columbium.
Copper.
Corundum.
Diamond (industrial).
Fluorspar.
Graphite (crucible flake).
Kyanite (strategic).
Lead.
Manganese.
Mercury.
Mica (strategic).
Molybdenum.
Monazite.
Nickel.
Platinum group metals.
Quartz Crystal (piezoelectric).
Rare Earths.
Rutile—Bookite.
Selenium.
Talc (block steatite).
Tantalum.
Thorium.
Tin.
Uranium.
Zinc.

§ 301.4 *Operator's property rights.* The operator must have and preserve the right to possession of the land (as owner, lessee, or otherwise) for a term at least sufficient to complete the exploration work. (See § 301.11(f), regarding repayment.) The operator shall devote the land and all existing improvements, facilities, buildings, installations, and appurtenances necessary to the purposes of the exploration.

APPLICATIONS

§ 301.5 *Form and filing.* An application for Federal financial assistance must be submitted in quadruplicate on forms which may be obtained from and filed with either:

The Office of Minerals Exploration, Department of the Interior, Washington 25, D.C.

or, the Office of Minerals Exploration Executive Officers. The regions which they serve and their Post Office addresses are as follows:

Region I: Idaho, Montana, Oregon, Washington, and Alaska—OME, South 157 Howard Street, Spokane 4, Washington. Applicants for Alaskan projects may file applications with the United States Bureau of Mines, P.O. Box 2688, Juneau, Alaska, for forwarding to the Executive Officer, Region I.

Region II: California and Nevada—OME, 1605 Evans Avenue, Reno, Nevada.

Region III: Arizona, Colorado, Nebraska, New Mexico, North Dakota, South Dakota, Utah, and Wyoming—OME, 224 New Customhouse Building, Denver 2, Colorado.

Region IV: Arkansas, Kansas, Louisiana, Mississippi, Missouri, Oklahoma, and Texas—OME, Room 303, Post Office Building, P. O. Box 431, Joplin, Missouri.

Region V: Alabama, Connecticut, Delaware, Florida, Georgia, Illinois, Indiana, Iowa, Kentucky, Maine, Maryland, Massachusetts, Michigan, Minnesota, New Hampshire, New Jersey, New York, North Carolina, Ohio, Pennsylvania, Rhode

Island, South Carolina, Tennessee, Vermont, Virginia, West Virginia, and Wisconsin—OMD, Room 2B, Post Office Building, Knoxville 2, Tennessee.

§ 301.6 *Information required.* (a) Each application shall fully describe the proposed exploration, and shall include all detailed data called for by the application form. The Secretary may require the filing of additional information, including financial statements, reports, maps or charts, and exhibits, and such physical onsite examination as he deems necessary.

(b) The application must contain evidence that funds for the exploration are unavailable on reasonable terms from commercial sources. The evidence shall include information as to the names of banks (including applicant's bank of account) to which applications were made for a loan, the amount and terms requested, and the reasons why the loan was not obtained.

§ 301.7 *Criteria.* The following factors will be considered and weighed in passing upon applications:

(a) The strategic importance of the mineral involved and the criticalness thereof.

(b) The geologic probability of a significant discovery being made.

(c) The estimated cost of the exploration in relation to the size and grade of the potential deposit.

(d) The plan and method of conducting the exploration.

(e) The accessibility of the project area.

(f) The background and operating experience of the applicant.

§ 301.8 *Approval.* If the application is approved, the Government may enter into an exploration contract with the applicant upon terms and conditions which the Secretary deems necessary and appropriate as set forth in the contract form furnished by the Government.

EXPLORATION CONTRACTS

§ 301.9 *Government participation.* The Government will contribute fifty (50) percent of the total allowable costs of the exploration specified by the terms of the contract.

§ 301.10 *Allowable costs.* (a) The Government, to the extent provided in the exploration contract, will contribute to:

(1) The necessary, reasonable and direct actual costs of performing the exploration, including the costs of: labor, supervision, and consultants; operating materials, supplies and equipment; initial rehabilitation or repair of existing buildings, installations, fixtures, and operating equipment; construction of buildings, fixed improvements, and installations; repairs and maintenance of operating equipment; analytical work, accounting, payroll and sales taxes, and employees' liability insurance; payments by the operator to independent contractors; and such other necessary, reasonable, and direct actual costs as may be approved by the Government in the course of work; and

(2) The fixed unit costs agreed upon by the operator and the Government in terms of units of work to be performed (per foot of drifting, per foot of drilling, etc.) in lieu of actual costs.

(b) The Government will not contribute to costs incurred before the date of the contract, or to costs of or incident to:

(1) Acquiring, using, or possessing land and any existing improvements, facilities, buildings, installations, and appurtenances, or the depreciation and depletion thereof;

(2) General overhead, corporate management, interest and taxes (other than payroll and sales taxes);

(3) Insurance (other than employees' liability insurance); and

(4) Damages to persons or property (other than authorized repair to or replacement of equipment or other property used in the work).

§ 301.11 *Repayment by the operator.* (a) If the Secretary considers that, as a result of the exploration, mineral or metal production from the area covered by the contract may be possible, he shall so certify in writing to the operator within the time specified in the contract.

(b) When the Secretary determines not to certify, he shall promptly so notify the operator provided the operator has completed all obligations under the contract.

(c) The operator shall pay the Government a royalty on all minerals or metals produced from the land described in the contract:

(1) Irrespective of any certification of possible production—from the date of the contract to the date of notice that certification will not be made, or until the total amount contributed by the Government with interest is fully repaid, whichever occurs first; or

(2) Irrespective of any certification of possible production—if the Secretary, deeming it necessary and in the public interest, enters into an agreement to provide for royalty payments.

(3) If a certification of possible production is issued—for a period of ten years (or other period fixed by the contract not exceeding 25 years) from the date of the contract, or until the total amount contributed by the Government, with interest, is fully repaid, whichever occurs first.

(d) The Government's royalty shall be 5 percent of the operator's "gross proceeds" (including any bonuses, premiums, allowances, or other benefits) from the production sold, in the form sold (ore, concentrate, metal, or equivalent) at the point of delivery (the f.o.b. point); except, that charges of the buyer (not the operator) arising in the regular course of his business, and shown on the buyer's settlement sheets as deductions (such as treatment processes performed by the buyer, sampling and assaying to determine the value of the production sold, and freight payable by the buyer to a carrier (not the operator)) shall be allowed as deductions in arriving at the "gross proceeds" as that term is used in this section. No costs of the operator are deductible in arriving at the "gross proceeds" as that term is used in this section. The term "treatment processes", as used in this paragraph means those processes (such as milling, concentrating, smelting, refining, or equivalent) applied to the crude ore or other production after it is extracted from the ground to put it into a commercially marketable form, excluding fabricating or manufacturing.

(e) If any production (ore, concentrate, metal or equivalent) remains unsold or is not used by the operator in integrated manufacturing or fabricating operations (for instance, if it is stockpiled) after the lapse of six months from the date it is extracted from the ground, the Government, at its option, may require the computation and payment of its royalty on the value of such production in the form (ore, concentrate, metal, or equivalent) it is in at the time the Government elects to exercise its option. If any production is used by the operator in integrated manufacturing or fabricating operations, the Government's royalty on such production shall be computed on the "value" thereof in the form in which and at the time when it is used. "Value" as used in this section means what is or would be gross income from mining operations for percentage depletion purposes in Federal income tax determination, or the market value, whichever is greater.

(f) (1) To secure the payment of the Government's royalty, the contract shall provide for a lien upon the

operator's interest in the land, upon any production from the land and upon any interests in the land other than the operator's interest. However, the Secretary may accept the undertaking of a surety company or third person in lieu of a lien upon interests in the land other than the operator's interest. In circumstances where the Secretary deems it to be in the public interest, the requirement for a lien or other undertaking concerning interests in land, other than the lien upon the operator's interest, may be omitted from the contract.

(2) If the operator is not the producer (for example, if the operator transfers or does not retain his interest in production or in the land), the operator shall remain liable for the payment of the Government's royalty.

(g) If, in any particular case, the Secretary finds that it would be more economical or practicable to compute the Government's royalty upon some basis other than "gross proceeds" or "value", as those terms are used in this section, or upon the production in some form other than that in which it is sold, held, or used in integrated operations, he may agree with the operator, either in the original exploration contract or by an amendment thereof, upon some other basis of computation.

(h) Nothing in this part shall be construed as imposing any obligation on the operator to engage in any mining or production operations.

(i) The Secretary may modify and adjust the terms and conditions of any contract to reduce the amount and terms of any royalty payment when he shall determine that such action is necessary and in the public interest.

§ 301.12 Interest on amount of Government participation. (a) Simple interest, computed annually, shall accrue from the date Federal funds are made available until the period specified for royalty payment expires or until the amount of Federal funds contributed, including interest, is fully repaid by royalty on production.

(b) The rate of interest shall be fixed by the Secretary at not less than the rate the Department of the Interior would be required to pay if it borrowed from the Treasury, plus a two percent interest charge in lieu of the actual cost to the Government of administering the contract.

(c) Paragraphs (a) and (b) of this section shall not be construed to increase the rate of royalty or to extend the period for which the royalty is payable as set forth in § 301.11.

§ 301.13 Limitation on the amount of Government participation. No single contract shall authorize Government participation in excess of \$250,000.

§ 301.14 Government not obligated to buy. Nothing in this part or in any contract entered into pursuant to this part shall be construed as imposing any obligation on the Government to purchase any materials mined or produced from the land which is the subject of such contract.

§ 301.15 Title to and disposition of property. All facilities, buildings, fixtures, equipment, or other items, or groups of items (such as pipe, rail, steel, etc.), costing more than \$50.00 each, paid for or purchased with funds contributed jointly by the operator and the Government, although title may be taken in the name of the operator, shall belong to the operator and the Government jointly, in proportion to their respective contribution and the exploration contract shall make suitable provisions for their disposal for the joint account of the operator and the Government.

[F.R. Doc. 58-10535; Filed, Dec. 22, 1958; 8:48 a.m.]

Chapter III—Office of Minerals Exploration, Department of the Interior [Revised]

PART 301—REGULATIONS FOR OBTAINING FEDERAL ASSISTANCE IN FINANCING EXPLORATIONS FOR MINERAL RESERVES, EXCLUDING ORGANIC FUELS, IN THE UNITED STATES, ITS TERRITORIES AND POSSESSIONS

GENERAL PROVISIONS

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301.13	Limitation on the amount of Government participation.
301.14	Government not obligated to buy.
301.15	Title to and disposition of property.

AUTHORITY: §§ 301.1 to 301.15, issued under sec. 2(e), 72 Stat. 700; 30 U.S.C. 642(e).

SOURCE: §§ 301.1 to 301.15 appear at 24 F.R. 6757, Aug. 22, 1959.

GENERAL PROVISIONS

§ 301.1 Purpose.

These regulations govern the obtaining of Federal financial assistance in conducting exploration for mineral reserves, excluding organic fuels, in the United States, its territories or possessions.

§ 301.2 Definitions.

As used in this part:

(a) "Exploration" means the search, including related development work, for new or unexplored mineral deposits within a specified area or parcel of ground where geologic conditions favor their occurrence. Exploration using recognized and sound procedures, including standard geophysical and geochemical methods, may be conducted from the surface or underground to obtain pertinent geological and mineralogical information. The work shall not go beyond a reasonable delineation and sampling of a mineral deposit, and shall not be conducted primarily for mining or preparation for mining.

(b) "Operator" means an individual, partnership, corporation, or other legal entity that is party to an exploration contract with the Government.

(c) "Secretary" means the Secretary of the Interior, or his authorized representative.

(d) "Government" and "Federal" mean the United States of America.

(e) "Commercial Sources" means banking institutions or other private sources of credit.

§ 301.3 Eligible minerals or mineral products.

The following are eligible for financial assistance:

Antimony.
Asbestos (strategic).
Bauxite.
Beryl.
Cadmium.
Chromite.

Cobalt.
Columbium.
Copper.
Corundum.
Diamond (industrial).
Fluorspar.
Graphite (crucible flake).
Kyanite (strategic).
Lead.
Manganese.
Mercury.
Mica (strategic).
Molybdenum.
Monazite.
Nickel.
Platinum group metals.
Quartz Crystal (piezoelectric).
Rare Earths.
Rutile—Brookite.
Selenium.
Talc (block steatite).
Tantalum.
Thorium.
Tin.
Uranium.
Zinc.

§ 301.4 Operator's property rights.

The operator must have and preserve the right to possession of the land (as owner, lessee, or otherwise) for a term at least sufficient to complete the exploration work. (See § 301.11(f) regarding repayment.) The operator shall devote the land and all existing improvements, facilities, buildings, installations, and appurtenances necessary to the purposes of the exploration.

APPLICATIONS

§ 301.5 Form and filing.

An application for Federal financial assistance must be submitted to quadruplicate on forms which may be obtained from and filed with either:

The Office of Minerals Exploration,
Department of the Interior,
Washington 25, D.C.

or the Office of Minerals Exploration Executive Officers. The regions which they serve and their Post Office addresses are as follows:

Region I: Alaska, Idaho, Montana, Oregon, and Washington—OME, South 157 Howard Street, Spokane 4, Washington. Applicants for Alaska projects may file applications with the United States Bureau of Mines, P.O. Box 2688, Juneau, Alaska, for forwarding to the OME Executive Officer, Region I.

Region II: California and Nevada—OME, Room 420 Customhouse, 555 Battery Street, San Francisco 11, California.

Region III: Arizona, Colorado, Kansas, Nebraska, New Mexico, North Dakota, Oklahoma, South Dakota, Texas, Utah, and Wyoming—OME, Federal Center, Denver 25, Colorado.

Region V: Alabama, Arkansas, Connecticut, Delaware, Florida, Georgia, Illinois, Indiana, Iowa, Kentucky, Louisiana, Maine, Maryland, Massachusetts, Michigan, Minnesota, Mississippi, Missouri, New Hampshire, New Jersey, New York, North Carolina, Ohio, Pennsylvania, Rhode Island, South Carolina, Tennessee, Vermont, Virginia, West Virginia, and Wisconsin—OME, Room 2B, Post Office Building, Knoxville 2, Tennessee.

§ 301.6 Information required.

(a) Each application shall fully describe the proposed exploration, and shall include all detailed data called for by the application form. The Secretary may require the filing of additional information, including financial statements, reports, maps or charts, and exhibits and such physical on-site examination as he deems necessary.

(b) The application must include evidence that funds for the exploration work are unavailable on reasonable terms from commercial sources. The evidence shall include information as to the names of banks (including applicant's bank of account) or other private sources of credit to which applications were made for loans, the amounts and terms requested, and the reasons why loans were not obtained.

§ 301.7 Criteria.

The following factors will be considered and weighed in passing upon applications:

- (a) The geologic probability of a significant discovery being made.
- (b) The estimated cost of the exploration in relation to the size and grade of the potential deposit.
- (c) The plan and method of conducting the exploration.
- (d) The accessibility of the project area.
- (e) The background and operating experience of the applicant.
- (f) The applicant's title or right to possession of the property.
- (g) The unavailability of funds from commercial sources on reasonable terms.
- (h) Whether the applicant would normally undertake the exploration at his sole expense under current conditions or circumstances.

§ 301.8 Approval.

If the application is approved, the Government may enter into an exploration contract with the applicant upon terms and conditions which the Secretary deems necessary and appropriate as set forth in the contract form furnished by the Government.

EXPLORATION CONTRACTS

§ 301.9 Government participation.

The Government will contribute not more than fifty (50) percent of the total allowable costs of the exploration specified by the terms of the contract.

§ 301.10 Allowable costs.

(a) The Government, to the extent provided in the exploration contract, will contribute to:

(1) The necessary, reasonable, and direct actual costs of performing the exploration, including the costs of: Labor, supervision, and consultants; operating materials, supplies, and equipment; initial rehabilitation or repair of existing buildings, installations, fixtures, and operating equipment; construction of buildings, fixed improvements, and installations; repairs and maintenance of operating equipment; analytical work, accounting, payroll and sales taxes, and employers' liability or employees' compensation insurance; payments by the operator to independent contractors; and such other necessary, reasonable, and direct actual costs as may be approved by the Government in the course of work; and

(2) The fixed unit costs agreed upon by the operator and the Government in terms of units of work to be performed (per foot of drifting, per foot of drilling, etc.) in lieu of actual costs.

(b) The Government will not contribute to costs incurred before the date of the contract, or to costs of or incident to:

(1) Acquiring, owning or possessing land with any existing improvements, facilities, buildings, installations, and appurtenances, or the depreciation and depletion thereof;

(2) General overhead, corporate management, interest and taxes (other than payroll and sales taxes);

(3) Insurance (other than employers' liability or employees' compensation insurance); and

(4) Damages to persons or property (other than authorized repair to or replacement of equipment or other property used in the work).

§ 301.11 Repayment by the operator.

(a) If the Secretary considers that as a result of the exploration, mineral or metal production from the area covered by the contract may be possible, he shall

so certify in writing to the operator within the time specified in the contract.

(b) When the Secretary determines not to certify, he shall promptly so notify the operator provided the operator has completed all obligations under the contract.

(c) The operator shall pay the Government a royalty on all minerals or metals produced from the land described in the contract:

(1) Irrespective of any certification of possible production—from the date of the contract to the date of notice that certification will not be made, or until the total amount contributed by the Government with interest in fully repaid, whichever occurs first; or

(2) Irrespective of any certification of possible production—if the Secretary, deeming it necessary and in the public interest, enters into an agreement to provide for royalty payments.

(3) If a certification of possible production is issued—for a period of ten years (or other period fixed by the contract not exceeding 25 years) from the date of the contract, or until the total amount contributed by the Government, with interest, is fully repaid, whichever occurs first.

(d) The Government's royalty shall be 5 percent of the "gross proceeds" (including any bonuses, premiums, allowances, or other benefits) from the production sold, in the form sold (ore, concentrate, metal, or equivalent) at the point of delivery (the f.o.b. point) except, that charges of the buyer (not the operator or producer) arising in the regular course of his business, and shown on the buyer's settlement sheets as deductions (such as treatment processes performed by the buyer, sampling and assaying to determine the value of the production sold, and freight payable by the buyer to a carrier (not the operator or producer) shall be allowed as deductions in arriving at the "gross proceeds" as that term is used in this section. No costs of the operator or producer are deductible in arriving at the "gross proceeds" as that term is used in this section. The term "treatment processes", as used in this paragraph means those processes (such as milling, concentrating, smelting, refining, or equivalent) applied to the crude ore or other production after it is extracted from the ground to put it into a commercially marketable form, excluding fabricating or manufacturing.

(e) If any production (ore, concentrate, metal, or equivalent) remains unsold or is not used by the operator or producer in integrated manufacturing or fabricating operations (for instance, if it is stockpiled) after the lapse of six months from the date it is extracted from the ground, the Government, at its option, may require the computation and payment of its royalty on the value of such production in the form (ore, concentrate, metal, or equivalent) it is in at the time the Government elects to exercise its option. If any production is used by the operator or producer in integrated manufacturing or fabricating operations, the Government's royalty on such production shall be computed on the "value" thereof in the form in which and at the time when it is used. "Value" as used in this section means what is or would be gross income from mining operations for percentage depletion purposes in Federal income tax determination, or the market value, whichever is greater.

(f) (1) To secure the payment of the Government's royalty, the contract shall provide for a lien upon the operator's interest in the land, upon any production from the land, and upon any interests in the land other than the operator's interest. However, the Secretary may accept the undertaking of a surety company or third person in lieu of a lien upon interests

in the land other than the operator's interest. In circumstances where the Secretary deems it to be in the public interest, the requirement for a lien or other undertaking concerning interests in land, other than the lien upon the operator's interest, may be omitted from the Contract.

(2) If the operator is not the producer (for example, if the operator transfers or does not retain his interest in production or in the land), the operator shall remain liable for the payment of the Government's royalty.

(g) If, in any particular case, the Secretary finds that it would be more economical or practicable to compute the Government's royalty upon some basis other than "gross proceeds" or "value", as these terms are used in this section, or upon the production in some form other than that in which it is sold, held, or used in integrated operations, he may agree with the operator, either in the original exploration contract or by an amendment thereof, upon some other basis of computation.

(h) Nothing in this part shall be construed as imposing any obligation on the operator to engage in any mining or production operations.

(i) The Secretary may modify and adjust the terms and conditions of any contract to reduce the amount and terms of any royalty payment when he shall determine that such action is necessary and in the public interest.

§ 301.12 Interest on amount of Government participation.

(a) Simple interest is calculated from the date Federal funds are made available until the period specified for royalty payments expires or until the amount of Federal funds contributed, including interest, is fully repaid by royalty on production, whichever occurs first.

(b) The rate of interest shall be fixed by the Secretary at not less than the rate the Department of the Interior would be required to pay if it borrowed from the Treasury, plus a two percent interest charge in lieu of the actual cost to the Government of administering the contract.

(c) Paragraphs (a) and (b) of this section shall not be construed to increase the rate of royalty or to extend the period for which the royalty is payable as set forth in § 301.11.

§ 301.13 Limitation on the amount of Government participation.

No single contract shall authorize Government participation in excess of \$250,000.

§ 301.14 Government not obligated to buy.

Nothing in this part or in any contract entered into pursuant to this part shall be construed as imposing any obligation on the Government to purchase any materials mined or produced from the land which is the subject of such contract.

§ 301.15 Title to and disposition of property.

All facilities, buildings, fixtures, equipment, or other items or groups of items (such as pipe, rail, steel, etc.), costing more than \$50.00 each, paid for or purchased with funds contributed jointly by the operator and the Government, although title may be taken in the name of the operator, shall belong to the operator and the Government jointly, in proportion to their respective contributions, and the exploration contract shall make suitable provisions for their disposal for the joint account of the operator and the Government.

DMO V-7—GENERAL POLICIES FOR THE STOCKPILE OF STRATEGIC AND CRITICAL MATERIALS [ADDED]

By virtue of the authority vested in me by the Strategic and Critical Materials Stock Piling Act, it is hereby ordered:

1. *General role of the strategic stockpile.* The strategic stockpile shall take account of the potentiality of limited war and general war and shall assume rapid mobilization in the event of an emergency.

2. *Period covered by stockpiling.* All strategic stockpile objectives shall be limited to meeting estimated shortages of materials for a 3-year emergency period.

3. *Stockpile objectives.* Strategic stockpile objectives shall be adequate for limited or general war whichever shows the larger supply-requirements deficit to be met by stockpiling. The objectives shall consist of (1) a "basic objective" which assumes reliance on sources of supply factored to reflect estimated supply risks and (2) a "maximum objective" which includes an additional allowance to take into account the complete discounting of sources of supply beyond North America and comparably accessible areas.

4. *Emergency requirements.* The requirements estimates for both limited and general war shall reflect specific requirements so far as they are applicable and available. Otherwise it shall be assumed that the total requirements would about equal the consumption by industrial capacity, considering necessary wartime limitation, conservation, and substitution measures. Requirements shall be discounted for wartime losses of consuming capacity to the extent that such losses can be reliably estimated.

5. *Emergency supplies.* Estimates of supply for the mobilization period shall be based on readily available capacity and known resources. The share available to the United States shall be discounted to reflect (1) the strategic vulnerability and possible economic and political instability of foreign sources, (2) overseas shipping losses and (3) vulnerability of domestic sources that are heavily concentrated geographically, including vulnerability to sabotage. Domestic supplies shall be discounted in cases of excessive concentration to the extent of the estimated time required to restore capacity that may be damaged.

6. *Provision for special-property materials.* Prospective needs for high-temperature and other special-property materials shall be considered on the basis of a three-year period beginning not more than two years in the future. Estimates of requirements therefor shall be included in the computation of objectives when there are indications of reasonably firm minimum requirements. In this connection arrangements shall be made for the regular availability of objective scientific advice to assist in such evaluation.

7. *Frequency of supply-requirements reviews.* The supply-requirements balance for any material that is now or may become important to defense shall be kept under continuing surveillance and shall be given a full-scale review at any time that a change is believed to be taking place that would have a significant bearing on the wartime readiness position. Supply-requirements balances shall be examined at least once a year to ascertain the need for a full-scale review. The interim recalculation of basic and maximum stockpile objectives now underway shall be completed immediately. Priority of review shall be given to materials under procurement.

8. *Procurement policy.* The basic objectives shall be attained expeditiously. If necessary, sources of

supply shall be expanded. Procurement, however, shall be tapered as the basic objectives are approached. The maximum objective shall be reached on a lower priority basis by such means as (1) deliveries under existing contracts, (2) transfers from other Government programs, (3) purchases with available foreign currencies, (4) barter of U.S. agricultural surpluses, and (5) programs to maintain the mobilization base under paragraph 9. Future long-term contracts should contain termination clauses whenever possible.

9. *Maintenance of the mobilization base.* The mobilization base shall relate to the projected supply capacity including standby capacity that would be readily available for an emergency commencing on any assumed date rather than to the output of a given period. Stockpile procurement to maintain this capacity shall be undertaken only within the maximum objective. Although various measures that are feasible shall be considered for meeting a mobilization deficit of materials, measures other than stockpiling shall be undertaken only after it is clear that stockpiling is not the best solution. All inventories of Government-owned materials held for long-term storage are a part of the mobilization base. If they are sufficiently large they may eliminate the need for a producing mobilization base segment.

10. *Upgrading to ready usability.* Where the general basis for estimating supplies of a material, including allowance for plant vulnerability, does not call for a sufficient quantity in a form suitable for immediate use to meet the initial surge of demand and abnormal conditions of intensive mobilization, a minimum readiness inventory—approximately a six months' requirement—shall be provided near centers of consumption. An interagency review should be undertaken to determine whether a need for a larger or lesser allowance may exist. Materials in Government inventories may be upgraded only when the net cost is less than the cost of new material. Materials will not be upgraded to such a degree, however, as to impair flexibility of use. Payment in kind may be used within the objectives to finance the upgrading, provided that the release of materials to pay for the upgrading will meet disposal criteria.

11. *Beneficiation of subspecification materials.* Subspecification-grade material in Government inventory may be beneficiated within the limits of the maximum objectives when this can be accomplished at less net cost than buying new material.

12. *Cancellation of contracts.* Commitments for deliveries to strategic stockpile and Defense Production Act accounts beyond the maximum objectives shall be cancelled when settlements can be arranged that would be mutually satisfactory to the supplier and the Government, that would not be disruptive to the economy or to projects essential to the national security and that would protect the financial interests of the Government.

13. *Disposal.* Strategic and critical materials shall be retained in Government inventories so long as they are needed to meet maximum stockpile objectives or any foreseeable increases in such objectives.

Disposals of excesses shall be undertaken only if they do not cause serious economic disruption or adversely affect the international interests of the United States.

14. *Declassification of stockpile data.* The Office of Defense Mobilization shall declassify stockpile data to the maximum extent feasible when it determines with the concurrence of agencies concerned that the national security would not thereby be jeopardized. [DMO V-7, 23 F.R. 4333, June 14, 1958]

TITLE 32A—NATIONAL DEFENSE, APPENDIX

Chapter I—Office of Civil and Defense Mobilization

[D.M.O. V-3 Cancelled]

DMO V-3—POLICY REGARDING SURPLUS MATERIALS ACQUIRED UNDER THE DEFENSE PRODUCTION ACT

[D.M.O. V-7, Revised]

DMO V-7—GENERAL POLICIES FOR STRATEGIC AND CRITICAL MATERIALS STOCKPILING

By virtue of the authority vested in me by Reorganization Plan No. 1 of 1958 and Executive Order 10773, it is hereby ordered:

1. *General role of the strategic stockpile.* The strategic stockpile shall take account of the potentiality of limited war and general war and shall assume rapid mobilization in the event of an emergency.

2. *Period covered by stockpiling.* All strategic stockpile objectives shall be limited to meeting estimated shortages of materials for a three-year emergency.

3. *Stockpile objectives.* Strategic stockpile objectives shall be adequate for limited or general war, whichever shows the larger supply-requirements deficit to be met by stockpiling. Stockpile objectives shall be determined on the basis of time required for supplies of materials in a national emergency to match essential needs of the emergency. The objectives shall consist of (1) a "basic objective," which assumes reliance on sources of supply factored to reflect estimated supply risks, and (2) a "maximum objective," which includes an additional allowance to take into account the complete discounting of sources of supply beyond North America and comparably accessible areas.

Until such time as the essential needs of the nation in the event of a nuclear attack (including reconstruction) can be determined, the maximum objective shall not be less than six months' usage by industry in the United States in periods of active demand.

4. *Emergency requirements.* The requirements estimates for both limited and general war shall reflect specific requirements so far as they are applicable and available. Otherwise it shall be assumed that the total requirements would about equal the consumption by industrial capacity, considering necessary wartime limitation, conservation, and substitution measures. Requirements shall be discounted for wartime losses of consuming capacity to the extent that such losses can be reliably estimated.

5. *Emergency supplies.* Estimates of supply for the mobilization period shall be based on readily available capacity and known resources. The share available to the United States shall be discounted to reflect the risks involved internally in supply countries, the risks of concentration of the source, the risks of overseas shipping and the vulnerability of domestic sources to destruction. Domestic supplies shall be discounted in cases of excessive concentration to the extent of the estimated time required to restore capacity that may be damaged.

6. *Provision for special-property materials.* Prospective needs for high-temperature and other special-property materials shall be considered on the basis of a three-year period beginning not more than two years in the future. Estimates of requirements therefor shall be included in the computation of objectives when there are indications of reasonably firm minimum requirements. In this connection arrangements shall be made for the regular availability of objective scientific advice to assist in such evaluation.

7. *Frequency of supply-requirements reviews.* The supply-requirements balance for any material that is now or may become important to defense shall be kept under continuing surveillance and shall be given a full-scale review at any time that a change is believed to be taking place that would have a significant bearing on the wartime readiness position. Supply-requirements balances shall be examined at least once a year to ascertain the need for a full-scale review. Priority of review shall be given to materials under procurement.

8. *Procurement policy.* The basic objectives shall be attained expeditiously. If necessary, sources of supply shall be expanded. Procurement, however, shall be tapered as the basic objectives are approached. The maximum objective shall be reached on a lower priority basis by such means as (1) deliveries under existing contracts, (2) transfers from other Government programs, (3) purchases with available foreign currencies, (4) barter of U.S. agricultural surpluses, and (5) programs to maintain the mobilization base under paragraph 9. Future long-term contracts shall contain termination clauses whenever possible.

9. *Maintenance of the mobilization base.* The mobilization base shall relate to the projected supply capacity, including standby capacity, that would be readily available for an emergency commencing on any assumed date rather than to the output of a given period. Stockpile procurement to maintain this capacity shall be undertaken only within the maximum objective. Although various measures that are feasible shall be considered for meeting a mobilization deficit of materials, measures other than stockpiling shall be undertaken only after it is clear that stockpiling is not the best solution. All inventories of Government-owned materials held for long-term storage are a part of the mobilization base. If they are sufficiently large they may eliminate the need for a producing mobilization base segment.

10. *Upgrading to ready usability.* Where the general basis for estimating supplies of a material, including allowance for plant vulnerability, does not call for a sufficient quantity in a form suitable for immediate use to meet the initial surge of demand and abnormal conditions of intensive mobilization, a minimum readiness inventory—approximately a six months' requirement—shall be provided near centers of consumption. An interagency review should be undertaken to determine whether a need for a larger or lesser allowance may exist. Materials in Government inventories may be upgraded only when the net cost is less than the cost of new material. Materials will not be upgraded to such a degree, however, as to impair flexibility of use. Payment in kind may be used within the objectives to finance the upgrading, provided that the release of materials to pay for the upgrading will meet disposal criteria.

11. *Beneficiation of subspecification materials.* Subspecification-grade material in Government inventory may be beneficiated within the limits of the maximum objectives when this can be accomplished at less net cost than buying new material.

12. *Cancellation of commitments.* Commitments for deliveries to national stockpile and Defense Production Act inventories beyond the maximum objectives shall be canceled or reduced when settlements can be arranged which would be mutually satisfactory to the supplier and the Government and which would not be disruptive to the economy or to projects essential to the national security. Such settlements may take into account anticipated profits and cover adjustments for above-market premiums. The settlement of commitments may be made through the payment of cash or through the application of surplus property or resale of materials. Responsibility with respect to the settle-

ment of commitments in the light of over-all interests of the Government rests with the Administrator of General Services, who shall keep other agencies advised and consult with them to the extent appropriate.

13. *Retention of Defense Production Act inventories.* Within the limits of unfilled maximum stockpile objectives, stockpile-grade materials acquired under the Defense Production Act shall be retained for national stockpile purposes.

14. *Disposals.* The Director of the Office of Civil and Defense Mobilization will authorize the disposal of excess materials whenever possible under the following conditions: (a) avoidance of serious disruption of the usual markets of producers, processors, and consumers, (b) avoidance of adverse effects on international interests of the United States, (c) due regard to the protection of the United States against avoidable loss, and (d) except when the materials are channeled to other agencies for their direct use, approval of the Departments of the Interior, Commerce, State, Agriculture, and Defense, and other governmental agencies concerned, and consultation as appropriate with the industries concerned.

In making such disposals preference shall be given to materials in the DPA inventories.

Disposals of materials that deteriorate, that are likely to become obsolete, that do not meet quality standards, or that do not have stockpile objectives, are to be expedited.

The Administrator of General Services shall be responsible for conducting negotiations for the sale of materials and will consult with and advise the agencies concerned.

15. *Public notice on disposals.* Generally, the sale of excess materials acquired under the Defense Production Act will be made only after appropriate public announcement of the quantity or quantities to be offered in a specified period of time.

16. *Direct Government use.* Government agencies which directly use strategic and critical materials shall fulfill their requirements through the use of materials in Government inventories that are excess to the needs thereof whenever such action is found to be consistent with overall disposal policies and with the best interests of the Government. Except where appropriate in the judgment of the Administrator, General Services Administration, the requirements of section 14, above, with respect to approval by Government departments or agencies and consultation with industries, shall not be applicable to transfers of strategic and critical materials for direct Government use.

17. *Declassification of stockpile data.* The Office of Civil and Defense Mobilization shall declassify stockpile data to the maximum extent feasible when it determines with the concurrence of agencies concerned that the national security would not thereby be jeopardized.

Defense Mobilization Order V-3 (19 F.R. 1511, Mar. 19, 1954) is hereby canceled.

Defense Mobilization Order V-7 (23 F.R. 4333, June 14, 1958) is hereby superseded.

These policies are effective immediately.

Dated: December 10, 1959.

LEO A. HOEGH,
Director, Office of Civil
and Defense Mobilization.

[F.R. Doc. 59-10745; Filed, Dec. 16, 1959; 8:45 a.m.]

DMO VII-6—EXPANSION GOALS

By virtue of the authority vested in me by Executive Order 10480 of August 14, 1953 (3 CFR, 1953 Supp.); It is hereby ordered:

1. In view of the amount of expansion which has

been undertaken, and on the recommendation of the agency to which authority has been delegated for this purpose in each instance, it is hereby ordered that no accelerated tax amortization certificates under section 124A¹ of the Internal Revenue Code will be issued on applications filed after this date for further expansions in the areas of production appearing on List I set forth below. The expansion goals in these areas will be reviewed from time to time by the appropriate agencies under the direction of the Office of Defense Mobilization in order to determine (1) that certified expansion is in fact being accomplished and (2) that changes in defense requirements are adequately reflected in the goals. If after such review new goals are established for any of the areas of production on List I, a public announcement to that effect will be made so that all members of the affected industries may have equal opportunity to apply for accelerated tax amortization to the extent of the additional capacity required and within the limitations of the statute.

2. The need for further expansion in the areas of production appearing on List II set forth below, is currently under active consideration by the Office of Defense Mobilization with appropriate agencies and no accelerated tax amortization certificates in an area on List II will be issued on applications filed after this date until a decision has been reached. Public announcement of each decision will be made.

3. Since the amount of expansion which has been undertaken in the areas of production appearing on List III set forth below, is not adequate for defense purposes, the Office of Defense Mobilization will continue to issue accelerated tax amortization certificates for further expansions within such areas of production, up to the amount of the defense requirement.

LIST I
CLOSED

No.	Goal	Delegate agency
125	Abrasive products.....	Commerce.
183	Acetic acid.....	Commerce.
188	Acetone.....	Commerce.
159A	Adipic acid.....	Commerce.
159B	Adiponitrile.....	Commerce.
79	Air preheaters, regenerative.....	Commerce.
23	Aniline.....	Commerce.
31	Anthraquinone vat dyes (single strength basis).....	Commerce.
58	Antifriction bearing industry.....	Commerce.
210	Argon.....	Commerce.
182	Batteries, "AA" type dry cell.....	Commerce.
157	Benzene.....	Commerce.
53	Benzene hexachloride (lindane) 99 percent or more gamma isomer content.....	Commerce.
44	Benzene hexachloride (technical grade).....	Commerce.
195	Beryllium copper alloy mill products facilities.....	Commerce.
196	Beryllium copper master alloy producing facilities.....	Commerce.
5	Blast furnaces.....	Commerce.
188	Brass mill facilities.....	Commerce.
61	Butadiene.....	Commerce.
60	Calcium carbide.....	Commerce.
102	Carbon, activated (water purification and decolorizing grade).....	Commerce.
72	Carbon black.....	Commerce.
57	Carbon electrodes.....	Commerce.
35	Carbon tetrachloride.....	Commerce.
167	Chemical manufacturing machinery.....	Commerce.
24	Chlorine.....	Commerce.
77	Condensers.....	Commerce.
131	Continuous galvanized sheet and strip.....	Commerce.
189	Copper foundry facilities.....	Commerce.
150	Copper wire mill facilities.....	Commerce.
164	Cotton compresses.....	Agriculture.
95	Cotton gins.....	Agriculture.
48	Crawler-type tractor industry.....	Commerce.
159C	Cyclohexane.....	Commerce.
37	D.D.T.....	Commerce.
128	Dies, rigs and fixtures.....	Commerce.
137	Electrical connectors.....	Commerce.

¹ Section 168, Internal Revenue Code, 1954.

LIST I—Continued
CLOSED—continued

No.	Goal	Delegate agency
166A	Electronic class envelopes (ribbon machine).	Commerce.
166B	Electronic class envelopes (other than ribbon machine).	Commerce.
199	Elephant tools—Manufacturing facilities.	Commerce.
194A	Ethylchloride.	Commerce.
71	Ethylene glycol.	Commerce.
70	Ethylene oxide.	Commerce.
194B	Ethylene dibromide.	Commerce.
179	Ferroalloys, blast furnace (ferromanganese, silicomanganese, spiegeleisen and silvery pig iron).	Commerce.
180	Ferroalloys, electric furnace.	Commerce.
116A	Fibrous glass, continuous filament.	Commerce.
116B	Fibrous glass, superfine.	Commerce.
201	Filter aids—Calcined diatomite.	GSA.
36	Formaldehyde.	Commerce.
97	Friction hearings.	Commerce.
94	Gears and gear drives.	Commerce.
75	Generators, water wheel driven.	Commerce.
202A	Glass tubing (lead and soda lime).	Commerce.
202B	Glass tubing (porosilicate).	Commerce.
115	Graphite, artificial.	Commerce.
117	Heat exchangers, tubular.	Commerce.
107	Heavy metal tanks (special process and storage vessels).	Commerce.
159D	Hexamethylenediamine.	Commerce.
172	Hexamethylenetetramine.	Commerce.
32	Hose, horizontal wire braided.	Commerce.
30	Hydrogen peroxide.	Commerce.
25	Hydrofluoric acid.	Commerce.
103	Industrial ethyl alcohol.	Commerce.
42	Iron oxide, yellow (synthetic).	Commerce.
160	Kenaf fiber processing facilities.	Commerce.
160	Ketone, methyl ethyl.	Commerce.
161	Ketone, methyl isobutyl.	Commerce.
170	Limestone and dolomite.	GSA.
100	Lithium compounds.	Commerce.
1	Lubricating oil.	Interior.
96A	Lumber and wood products (except debarking and chipping facilities).	Commerce.
123	Machine tools.	Commerce.
13	Magnesium.	Commerce.
43	Maleic anhydride.	Commerce.
None	Marginally punched continuous forms.	Commerce.
139	Materials handling equipment.	Commerce.
106	Mechanical power transmission equipment (except gears).	Commerce.
184	Metal cans.	Commerce.
127	Metal cutting tools.	Commerce.
140	Metalworking equipment, miscellaneous.	Commerce.
38	Methyl chloride.	Commerce.
89	Methylene chloride.	Commerce.
209	Military canvas reclamation facilities.	Commerce.
86	Mining machinery.	Commerce.
146	Motors, miniature electric.	Commerce.
26	Naphthalene.	Commerce.
3	Newsprint.	Commerce.
9	Nitrogen.	Commerce.
173	Octyl alcohols.	Commerce.
66B	Oil (crude) refining capacity (foreign).	Interior.
66C	Oil pipelines (foreign).	Interior.
66D	Oil storage facilities (foreign).	Interior.
65A	Oil wells drilled (domestic).	Interior.
66A	Oil wells drilled (foreign).	Interior.
136	Optical glass.	Commerce.
155	Optics—Facilities for producing precision type.	Commerce.
28	Oxygen, high-purity.	Commerce.
49A	Paper.	Commerce.
49B	Paperboard.	Commerce.
129	Penicillin.	Commerce.
174	Pentaerythritol.	Commerce.
52	Perchloroethylene.	Commerce.
7	Phenol.	Commerce.
138	Phosphate rock.	GSA.
149A	Phosphatic fertilizers.	Commerce.
149B	Phosphatic feed supplements.	Commerce.
108	Phosphatizing of steel drums.	Commerce.
29	Phosphorus, elemental.	Commerce.
80	Photographic film and paper.	Commerce.
8	Phthalic anhydride.	Commerce.
93	Plastics materials.	Commerce.
46	Plywood, exterior type, softwood.	Commerce.
141	Potash.	GSA.
67	Power crane and shovel industry.	Commerce.
105	Precision and large size fasteners.	Commerce.
124	Presses and forging equipment.	Commerce.
142	Pumping machinery.	Commerce.
39	Quinoline.	Commerce.
120	Railroad equipment (production facilities).	Commerce.
203	Reels and spools.	Commerce.
153	Refractories, basic.	Commerce.
190	Refractories, fire clay, super duty and high alumina bricks.	Commerce.

LIST I—Continued
CLOSED—continued

No.	Goal	Delegate agency
154	Refractories, insulating fire brick.	Commerce.
191	Refractories, ladle bricks.	Commerce.
192	Refractories, pouring.	Commerce.
193	Refractories, silica.	Commerce.
40	Resoreinol.	Commerce.
62	Rubber and rubber products.	Commerce.
69	Scrap, ferrous and nonferrous.	Commerce.
101	Screw machine products, precision.	Commerce.
87	Sebacic acid.	Commerce.
208	Sensitive electrical switches.	Commerce.
110	Soda ash.	Commerce.
162	Sodium bichromate.	Commerce.
88	Sodium chlorate.	Commerce.
50	Sodium cyanide.	Commerce.
111	Special components.	Commerce.
104	Special industrial services.	Commerce.
6	Steel ingots.	Commerce.
54	Storage batteries, electric.	Commerce.
147	Strapping, steel.	Commerce.
109	Styrene, monomer (including methyl styrenes).	Commerce.
200	Sulfuric acid.	Commerce.
17	Sulphur.	GSA.
126	Synthetic fibers, noncellulose.	Commerce.
144	Tape, acetate.	Commerce.
145	Tape, filament.	Commerce.
143	Telegraph, domestic system.	Commerce.
175	Tetraethyl lead.	Interior.
51	Titanium Dioxide pigment.	Commerce.
156	Toluene.	Commerce.
41	Triethlorethylene.	Commerce.
73	Turbines, hydraulic.	Commerce.
168	Valves and fittings, industrial.	Commerce.
45	Vulcanized fiber.	Commerce.
49C	Wood pulp.	Commerce.

LIST III
OPEN

148	Aircraft, commercial.	Commerce.
220	Airport facilities.	Defense Air Transportation Administration.
207	Alkylate.	Interior.
63A	Alumina.	GSA.
222	Aluminum forging facilities.	Commerce.
63	Aluminum, primary.	GSA.
177B	Aluminum sheet and plate heat treating facilities.	Commerce.
177A	Aluminum sheet and plate, producing facilities.	Commerce.
112	Antimony.	GSA.
151	Asbestos, chrysotile, strategic grades.	GSA.
119	Barite.	GSA.
92	Bauxite.	GSA.
118	Beryl.	GSA.
76	Bollers, steam.	Commerce.
181	Casting, steel.	Commerce.
20	Chromite (chemical grade).	GSA.
19	Chromite (metallurgical grade).	GSA.
21	Chromite (refractory grade).	GSA.
133	Coal, Territory of Alaska.	Interior.
4A	Coal, metallurgical for byproduct coke.	Interior.
10	Cobalt.	GSA.
4	Coke—Byproduct.	Interior.
11	Columbite and tantalite ores.	GSA.
56	Copper.	GSA.
83	Cryolite (synthetic).	GSA.
197	Cylinders, compressed gas.	Commerce.
55	Electric power.	Interior.
130	Electrolytic tin plate.	Commerce.
165	Fluorspar, acid grade.	GSA.
68	Freight cars.	Defense Transport Administration.
171A	Gas pipe (large) lines laid.	Interior.
171B	Gas pipe (small) lines laid.	Interior.
82	Glycerine.	Commerce.
204	Gray iron castings (over 3,000 pounds).	Commerce.
99	Heavy aluminum aircraft forgings.	Commerce.
212	Heavy steel plate (over 20,000 pounds).	Commerce.
122	High voltage switchgear.	Commerce.
218	Inland waterway terminal facilities.	Defense Transport Administration.
98	Inland waterway vessels (specified types).	Defense Transport Administration.
132	Iron ore.	GSA.
3	Iron ore (taconite).	GSA.
206	Laboratories research and development.	Commerce.
12	Lead.	GSA.
152	Locomotives, diesel.	Defense Transport Administration.
96B	Lumber and wood products—Debarking and chipping facilities.	Commerce.

LIST III—Continued
OPEN—continued

No.	Goal	Delegate agency
187	Manganese ore, battery and chemical grades.	GSA.
14	Manganese ore, metallurgical grade.	GSA.
198	Medical supplies and equipment.	Commerce
64	Mercury.	GSA.
114	Metal can manufacturers—Tin conservation.	Commerce.
59	Methanol synthetic.	Commerce.
15	Molybdenum.	GSA.
216	Motor truck terminal and repair facilities.	Defense Transport Administration.
65C	Natural gas liquids capacity.	Interior.
16	Nickel.	GSA.
65B	Oil (crude) refining capacity (domestic).	Interior.
65D	Oil pipelines (domestic).	Interior.
65E	Oil storage facilities (domestic).	Interior.
90	Ore carriers, Great Lakes.	Defense Transport Administration.
113	Ore carriers, ocean-going.	Commerce.
219	Port facilities.	Defense Transport Administration.
34	Portland cement.	Commerce.
225	Power facilities for military, atomic energy, and defense related needs.	Department of the Interior.
224	Production facilities for military and atomic energy procurement.	Commerce.
21	Railroad passenger cars.	Defense Transport Administration.
135	Railroad terminal and road facilities.	Defense Transport Administration.
185	Rare earths.	GSA.
163	Rutile.	GSA.
176	Scientific instruments.	Commerce.
178	Selenium.	GSA.
214	Steel sheets, grain oriented.	Commerce.
211	Structural shapes, wide flange.	Commerce.
27	Tankers, ocean-going.	Commerce.
134	Tapered aluminum sheet.	Commerce.
33	Tires (specific types).	Commerce.
215	Titanium melting facilities.	Commerce.
121	Titanium metal.	GSA.
223	Titanium processing facilities.	Commerce.
78	Transformers, distribution.	Commerce.
18	Tungsten ore.	GSA.
74	Turbines, steam.	Commerce.
217	Warehouse and storage facilities.	Defense Transport Administration.
91	Welded aluminum tubing.	Commerce.
22	Zinc.	GSA.

[DMO VII-6, 18 F.R. 7876, Dec. 5, 1953, as amended by Amdt. 1, 19 F.R. 856, Feb. 13, 1954; Amdt. 2, 19 F.R. 1542, Mar. 20, 1954; Amdt. 3, 19 F.R. 1929, Apr. 6, 1954; Amdt. 4, 19 F.R. 2589, May 5, 1954; Amdt. 5, 19 F.R. 5042, Aug. 11, 1954; Amdt. 6, 19 F.R. 5221, Aug. 18, 1954; Amdt. 7, 19 F.R. 5265, Aug. 19, 1954; Amdt. 8, 19 F.R. 5395, Aug. 25, 1954; 19 F.R. 5490, Aug. 27, 1954; Amdt. 9, 20 F.R. 1647, Mar. 18, 1955; Amdt. 10, 20 F.R. 2024, Mar. 31, 1955; Amdt. 11, 20 F.R. 2582, Apr. 19, 1955; Amdt. 12, 20 F.R. 2724, Apr. 23, 1955]

DMO VII-6, SUPP. 1—EXPANSION GOALS

By virtue of the authority vested in me by Executive Order 10480 of August 14, 1953, the following is hereby ordered in connection with expansion goals and certificates of necessity issued pursuant to Sections 124A and 168 of the Internal Code:

1. *Closed goals.* The issuance of certificates of necessity shall be discontinued immediately in connection with the expansion goals included in List I attached and all other goals previously closed.

Applications for certificates of necessity currently pending in these closed goal areas shall be denied immediately. Such applications received hereafter shall be rejected immediately.

2. *Suspended goals.* The issuance of certificates of necessity shall be suspended immediately in connection with the expansion goals included in List II attached. Applications for certificates of necessity currently pending in these suspended goal areas together with any such new applications received hereafter shall be held in suspension until a decision is announced either to open or to close the goals involved.

3. *Open goals.* The issuance of certificates of necessity shall continue in accordance with the present or appropriately revised terms of the individual expansion goals included in List III attached and in accordance with regulations and policies heretofore or hereafter established by competent authority.

4. *General provisions.* Applications for tax amortization which do not fall within the scope of an open or suspended goal shall be denied. Future decisions to open, suspend, close, or otherwise modify expansion goals shall be accomplished by further supplements to this order.

LIST I—CLOSED

Goal No.	Title	Delegate A
151	Asbestos, Chrysotile.	Interior.
118	Barite.	Interior.
118	Beryl.	Interior.
118	Chromite, Metallurgical.	Interior.
21	Chromite, Refractory.	Interior.
133	Coal, Territory of Alaska.	Interior.
11	Columbite and Tantalite Ore.	Interior.
197	Compressed Gas Cylinders.	Commerce.
105	Fluorspar, Acid Grade.	Interior.
12	Lead.	Interior.
14	Manganese Ore, Metallurgical.	Interior.
59	Methanol (Synthetic).	Commerce.
15	Molybdenum.	Interior.
34	Portland Cement.	Commerce.
185	Rare Earths.	Interior.
33	Tires (Specific Types).	Commerce.
18	Tungsten.	Interior.
211	Wide Flange Structural Shapes.	Commerce.
22	Zinc.	Interior.

LIST II—SUSPENDED

148	Aircraft, Commercial.	Commerce.
220	Airport Facilities.	Commerce.
222	Aluminum Forging Facilities.	Commerce.
63	Aluminum, Primary.	Interior.
112	Antimony.	Interior.
92	Bauxite.	Interior.
20	Chromite, Chemical Grade.	Interior.
10	Cobalt.	Interior.
4	Coke By-Product.	Commerce.
83	Cryolite, Synthetic.	Interior.
55	Electric Power.	Commerce.
130	Electrolytic Tin Plate.	ICC.
68	Freight Cars.	Interior.
171	Gas Utility Industry, Pipe Lines.	Commerce.
82	Glycerin.	Commerce.
214	Grain-Oriented Steel Sheets.	Commerce.
204	Gray Iron Castings (3,000 pounds and over).	Commerce.
122	High Voltage Switchgear.	Commerce.
218	Inland Waterway Terminal Facilities.	ICC.
98	Inland Waterway Vessels (Specific Types).	ICC.
132	Iron Ore.	Interior.
3	Iron Ore, Taconite.	Interior.
152	Locomotives, Diesel.	ICC.
96	Lumber and Wood Products (Debarking and Chipping Facilities).	Commerce.
187	Manganese Ore, Battery and Chemical Grade.	Interior.
216	Motor Truck Terminal and Repair Facilities.	ICC.
90	Ore Carriers, Great Lakes.	ICC.
113	Ore Carriers, Ocean-Going.	Commerce.
65	Petroleum.	Interior.
219	Port Facilities.	ICC.
221	Railroad Passenger Cars.	Interior.
163	Rutile.	ICC.
155	Railroad Terminal and Road Facilities.	ICC.
114	Special Manufacturing Facilities—Metal Cans.	Commerce.
27	Tankers, Ocean-Going.	Commerce.
121	Titanium Metal.	Interior.
78	Transformers, Distribution.	Commerce.
217	Warehousing and Storage Facilities.	ICC.

LIST III—OPEN

207	Alkylate.	Interior.
177	Aluminum Sheet Producing and Heat Treating Facilities.	Commerce.
56	Copper.	Interior.
99	Heavy Aluminum Aircraft Forgings.	Commerce.
212	Heavy Steel Plates.	Commerce.
206	Laboratories, Research and Development (Defense).	Commerce.

List III—Open—Continued

Goal No.	Title	Delegate A
198	Medical Supplies and Equipment.....	Commerce.
64	Mercury.....	Interior.
16	Nickel.....	Interior.
225	Power Facilities for Military, Atomic Energy and Defense Related Needs.	Interior.
224	Production Facilities for Military and Atomic Energy Procurement.	Commerce.
176	Scientific Instruments.....	Commerce.
178	Selenium.....	Interior.
76	Steam Boilers.....	Commerce.
74	Steam Turbines.....	Commerce.
181	Steel Castings.....	Commerce.
134	Tapered Aluminum Sheet.....	Commerce.
215	Titanium Melting Facilities.....	Commerce.
223	Titanium Processing Facilities.....	Commerce.
91	Welded Aluminum Tubing.....	Commerce.

[DMO VII-6, Supp. 1, 20 F.R. 5898, Aug. 13, 1955]

DMO VII-6, SUPP. 2—EXPANSION GOALS

1. Defense Mobilization Order-VII-6, dated December 3, 1953 (18 F.R. 7876) is supplemented as follows: Expansion Goal No. 63 Aluminum, Primary is hereby transferred from List II, Suspended to List I, Closed. [DMO VII-6, Supp. 2, 20 F.R. 7167, Sept. 23, 1955]

DMO VII-6, SUPP. 3—EXPANSION GOALS FOR TAX AMORTIZATION

By virtue of the authority vested in me by Executive Order 10480 of August 14, 1953, as amended, the following is hereby ordered in connection with expansion goals and the issuance of necessity certificates pursuant to Section 168 of the Internal Revenue Code of 1954:

1. *Closed and suspended goals.* The issuance of necessity certificates shall be discontinued immediately in connection with the expansion goals included in List I attached and all other goals previously closed on August 11, 1955, by Supplement 1 to DMO VII-6, except as follows:

a. Any application filed with the government more than 60 calendar days prior to the date of suspension or closing of the applicable goal, whichever is earlier, shall be considered for certification under the terms and conditions of the expansion goal involved.

This means that applications will be eligible for certification on the basis of priority of filing and other factors to the extent of the unfilled portion of the goal at the time of suspension.

b. Any application filed with the government within 60 calendar days prior to the date of suspension or closing of the applicable expansion goal, whichever is earlier, shall be considered for certification only when it is determined by the government that an application covering similar facilities, filed on the same or a later date, was certified.

2. *Closed goals.* Applications for necessity certificates currently pending in closed goal areas shall be denied unless they qualify under the rules stated above. Such applications received hereafter shall be rejected.

3. *Suspended goals.* All expansion goals previously suspended by Supplement 1 to DMO-VII-6, dated August 11, 1955, are hereby transferred to the open or closed list in accordance with List I and List III set forth below with the exception of Goal No. 3, Iron Ore, Taconite.

4. *Open goals.* Necessity certificates shall be issued in accordance with the present or appropriately revised terms of the individual expansion goals in List III attached and in accordance with regulations and policies heretofore or hereafter established by com-

petent authority. In addition, there is added to List III the following new expansion goal:

Goal No.	Title	Delegate agency
226	Oil and Gas Pipelines and Petroleum Storage Facilities (Specific Defense Programs).	Interior.

5. *General provisions.* Applications for tax amortization which do not fall within the scope of an open or suspended goal shall be denied. Future decisions to open, suspend, or close expansion goals shall be accomplished by further supplements to this order. Future decisions to modify expansion goals, upon approval of the Director of the Office of Defense Mobilization, shall be published as notices in the FEDERAL REGISTER.

List I—Closed

Goal No.	Title	Delegate agency
220	Airport Facilities.....	Commerce.
112	Antimony.....	Interior.
92	Beauxite.....	Interior.
10	Cobalt.....	Interior.
4	Coke, By-Product.....	Interior.
83	Cryolite, Synthetic.....	Commerce.
130	Electrolytic Tin Plate.....	Commerce.
171	Gas Utility Industry, Pipe Lines.....	Interior.
214	Grain-Oriented Steel Sheets.....	Commerce.
204	Gray Iron Castings (3,000 pounds and over).....	Commerce.
218	Inland Waterway Terminal Facilities.....	ICC.
98	Inland Waterway Vessels (Specific Types).....	ICC.
132	Iron Ore.....	Interior.
152	Locomotives, Diesel.....	ICC.
96	Lumber and Wood Products (Debarking and Chipping Facilities).....	Commerce.
216	Motor Truck Terminal and Repair Facilities).....	ICC.
65C	Natural Gas Liquids Capacity.....	Interior.
65D	Oil Pipe Line (Domestic).....	Interior.
65E	Oil Storage Facilities (Domestic).....	Interior.
90	Ore Carriers, Great Lakes.....	ICC.
113	Ore Carriers, Ocean-Going.....	Commerce.
219	Port Facilities.....	ICC.
221	Railroad Passenger Cars.....	ICC.
135	Railroad Terminal and Road Facilities.....	ICC.
114	Special Manufacturing Facilities—Metal Cans.....	Commerce.
121	Titanium Metal.....	Interior.
217	Warehousing and Storage Facilities.....	ICC.

List III—Open

148	Aircraft, Commercial.....	Commerce.
207	Alkylate.....	Interior.
222	Aluminum Forging Facilities.....	Commerce.
177	Aluminum Sheet Producing and Heat Treating Facilities.....	Commerce.
20	Chromite, Chemical Grade.....	Interior.
56	Copper.....	Interior.
55	Electric Power.....	Interior.
168	Freight Cars.....	ICC.
182	Glycerin.....	Commerce.
99	Heavy Aluminum Aircraft Forgings.....	Commerce.
212	Heavy Steel Plates.....	Commerce.
122	High Voltage Switchgear.....	Commerce.
206	Laboratories Research and Development (Defense).....	Commerce.
187	Manganese Ore, Battery and Chemical Grade.....	Interior.
198	Medical Supplies and Equipment.....	Commerce.
64	Mercury.....	Interior.
16	Nickel.....	Interior.
65	Petroleum-Refining Capacity.....	Interior.
226	Oil and Gas Pipelines and Petroleum Storage Facilities (Specific Defense Programs).....	Interior.
225	Power Facilities for Military, Atomic Energy and Defense Related Needs.....	Interior.
224	Production Facilities for Military and Atomic Energy Procurement.....	Commerce.
163	Rutile.....	Interior.
176	Scientific Instruments.....	Commerce.
178	Selenium.....	Interior.
76	Steam Boilers.....	Commerce.

See footnotes at end of table.

List III—Open—Continued

Goal No.	Title	Delegate agency
74	Steam Turbines.....	Commerce.
181	Steel Castings.....	Commerce.
127	Tankers, Ocean-Going.....	Commerce.
134	Tapered Aluminum Sheet.....	Commerce.
215	Titanium Melting Facilities.....	Commerce.
223	Titanium Processing Facilities.....	Commerce.
178	Transformers, Distribution.....	Commerce.
91	Welded Aluminum Tubing.....	Commerce.

¹ Previously suspended on Aug. 11, 1955.² New goal.³ Superseded by Goal No. 226.

DMO VII-6, Supp. 3, 20 F.R. 7370, Oct. 4, 1955]

**DMO VII-6, SUPP. 3, AMDT. 1—EXPANSION GOALS
FOR TAX AMORTIZATION**

By virtue of the authority vested in me by Executive Order 10480 of August 14, 1953, as amended, the following is hereby ordered in connection with expansion goals and the issuance of necessity certificates pursuant to Section 168 of the Internal Revenue Code of 1954:

1. DMO VII-6, Supplement 3 of September 29, 1955 is hereby amended by striking paragraph 1 and substituting therefor the following:

1. *Closed and suspended goals.* The issuance of necessity certificates shall be discontinued immediately in connection with the expansion goals included in List I attached to DMO VII-6, Supplement 3, and all other goals previously closed on August 11, 1955 by Supplement 1 to DMO VII-6, except that any application filed with the Government prior to August 12, 1955, shall be considered for certification under the terms and conditions of the expansion goal involved. This means that all applications pending as of August 11, 1955, will be eligible for certification on the basis of priority of filing and other factors to the extent of the unfilled portion of the goal as of that date.

Applications in the foregoing categories which may have been denied prior to this date are now eligible for reconsideration upon receipt of a letter by ODM requesting such action.

[DMO VII-6, Supp. 3, Amdt. 1, 21 F.R. 607, Jan. 27, 1956]

**DMO VII-6, SUPP. 3, AMDT. 2—EXPANSION GOALS
FOR TAX AMORTIZATION**

By virtue of the authority vested in me by Executive Order 10480 of August 14, 1953, as amended, the following is hereby ordered in connection with expansion goals and the issuance of necessity certificates pursuant to Section 168 of the Internal Revenue Code of 1954:

1. Expansion Goals in List I attached were closed by Supplement 3 to DMO-VII-6 issued on September 29, 1955. Any application for a necessity certificate which was filed with the Government prior to September 30, 1955 under the expansion goals in List I, attached, shall be considered for certification under the terms and conditions of the expansion goal involved.

2. Amendment 1 to Supplement 3 to DMO-VII-6 is modified accordingly.

LIST I

CLOSED

Goal No.	Title	Delegate agency
220	Airport Facilities.....	Commerce.
112	Antimony.....	Interior.
92	Bauxite.....	Interior.
10	Cobalt.....	Interior.
4	Coke By-product.....	Interior.
83	Cryolite, Synthetic.....	Commerce.
130	Electrolytic Tin Plate.....	Commerce.
171	Gas Utility Industry, Pipe Lines.....	Interior.
214	Grain-Oriented Steel Sheets.....	Commerce.
204	Gray Iron Castings (3,000 lbs. and over).....	Commerce.
218	Inland Waterway Terminal Facilities.....	ICC.
98	Inland Waterway Vessels (Specific Types).....	ICC.
132	Iron Ore.....	Interior.
152	Locomotives, Diesel.....	ICC.
96	Lumber and Wood Products (Debarking and Chipping Facilities).....	Commerce.
216	Motor Truck Terminal and Repair Facilities.....	ICC.
65C	Natural Gas Liquids Capacity.....	Interior.
65D	Oil Pipe Line (Domestic).....	Interior.
65E	Oil Storage Facilities (Domestic).....	Interior.
90	Ore Carriers, Great Lakes.....	ICC.
113	Ore Carriers, Ocean-going.....	Commerce.
219	Port Facilities.....	ICC.
221	Railroad Passenger Cars.....	ICC.
135	Railroad Terminal and Road Facilities.....	ICC.
114	Special Manufacturing Facilities—Metal Cans.....	Commerce.
121	Titanium Metal.....	Interior.
217	Warehousing and Storage Facilities.....	ICC.

[DMO VII-6, Supp. 3, Amdt. 2, 21 F.R. 2242, Apr. 6, 1956]

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