ALUMINUM IN THE SINO-SOVIET BLOC

1950–65

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CENTRAL INTELLIGENCE AGENCY

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FOREWORD

This report is concerned with the recent and projected developments in the aluminum industry of the Sino-Soviet Bloc. The following aspects of these developments are discussed: (1) the achievements in 1950-60 in production of primary aluminum, alumina, and aluminum-bearing ore; (2) the prospects for fulfilling the goal for production of aluminum in 1965; (3) the total and average unit investment outlays in the aluminum industries of the Bloc; (4) the actual trend during 1950-60 and the probable trend during 1961-65 in the average cost of producing primary aluminum; and (5) the trade in aluminum among the countries of the Bloc and between the Bloc and the Free World during recent years and the probable trend of that trade during 1961-65.

Two aspects of the aluminum industry of the Bloc that are not included in this report are production of secondary aluminum and production of alumina and ore used in the manufacture of abrasives, ceramics, and commodities other than aluminum metal.

The Soviet Decree on State Secrets in 1956 and similar decrees of earlier years have severely restricted the publication of data on aluminum and other nonferrous metals. The latest absolute data to be released by the USSR on production of aluminum, for example, are for 1937.

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ALUMINUM IN THE SINO-SOVIET BLOC
1950-65

Summary and Conclusions

Production of aluminum in the Sino-Soviet Bloc increased from only 170,000 tons* in 1950 to nearly 1 million tons in 1960 -- an average annual rate of growth of 19 percent. In comparison, production of aluminum in the Free World increased from about 1.3 million tons in 1950 to about 3.5 million tons in 1960 -- an average annual rate of about 11 percent. Of the total production of aluminum in the Bloc in 1960, the USSR and China contributed about 73 percent and 10 percent, respectively, and the European Satellites contributed the remainder.

The Bloc plans to continue the rapid growth in production of aluminum during 1961-65, the goal for 1965 being about 2 million tons, or roughly twice the level of production achieved in 1960. Increases are planned by each of the countries currently producing aluminum, and some of these increases are rather large, particularly that planned by the USSR. Also during 1961-65, Rumania plans to begin production, leaving Albania and Bulgaria as the only European Satellites without plans for producing aluminum. The estimates of output in 1960 and of the planned output in 1965 in the Bloc, by country, are as follows:

	Thousand Tons	
Country or Area	1960	1965 Plan
USSR	700	1,400 to 1,500
Communist China	100	250
European Satellites	166	290 to 300
Czechoslovakia	56	85
East Germany	35	55
Hungary	49.5	55
Poland	26.0	75
Rumania	0	20 to 30
Total	970	2,000 to 2,100

* Tonnages are given in metric tons throughout this report.

The total production of aluminum by the Bloc in 1965 probably will fall short of the established goal. The USSR, Hungary, Czechoslovakia, East Germany, and Poland probably will expand their production as rapidly as planned. This probability is strengthened by such positive considerations as the availability of large reserves of ore and apparently good prospects for obtaining the larger supplies of electric power needed and also for completing most of the construction and modernization programs in the aluminum industries. Communist China, on the other hand, probably will not expand production as rapidly as planned, and Rumania probably will not succeed in initiating production, largely because of failures in construction. In Communist China, construction for the aluminum industry undoubtedly has been severely disrupted as a result of the general decline of the economy, a condition that may well prevail for at least 3 or 4 years. Capacity and, therefore, production in Communist China in 1965 probably will be much less than planned.

A major exception to the favorable outlook in the USSR is that the planned expansion of mining capacity may not be fully accomplished. To offset any resulting deficits in production of ore, the USSR may import bauxite, either from Greece, as was done during 1954-60, or from countries such as Guinea and Ghana, where large reserves of high-grade bauxite exist.

In contrast to the practice by the Free World of using only bauxite as a commercial source of aluminum, the Bloc has used and will continue to use both bauxite and nonbauxite ores. During 1961-65 the bulk of the aluminum in the Bloc will continue to be produced from bauxite, but the plan is to raise the proportion produced from nonbauxite ore to nearly 30 percent by 1965, or about double that in 1960. The USSR, continuing to rely mainly on bauxite, plans to be using by 1965 such nonbauxite ores as nepheline,* alunite,** and possibly also sillimanite.*** All production by Communist China is to continue to come from indigenous nonbauxite ores, and that by the European Satellites from bauxite.

Planners in the Bloc apparently feel that the disadvantages of using nonbauxite ores, which generally have a smaller content of alumina and a larger content of reactive silica, are outweighed by a number of factors. First, the enormous reserves of nonbauxite ore will support the continued expansion of production for many years; second, the deposits can be mined by comparatively low-cost strip methods; and third, the deposits, particularly in the USSR, generally are near sources of

* A silicate of sodium, potassium, and aluminum.
** A hydrous sulfate of aluminum and potassium.
*** An aluminum silicate.

low-cost fuel and power. Finally, a substantial share of the total costs of producing alumina from nonbauxite ores is offset by the gain of valuable byproducts, such as raw materials for cement and caustic soda. These byproducts are recovered from nonbauxite ores by newly developed technologies and are urgently needed for the continued expansion of the economies of the Bloc.

The expansion of capacity in the aluminum industries of the Bloc probably will require lower average investment outlays during 1961-65 than in earlier years. This decrease would result mainly from economies associated with such factors as the construction of large strip mines and large refineries and smelters. Reductions in investment, however, probably will be less than planned in the USSR and Poland and possibly in other countries of the Bloc as well.

The rise in production of aluminum in the countries of the Bloc during 1961-65 is expected to be accompanied by a reduction in the average cost of production, thus continuing the general trend of 1950-60. In the USSR, average costs should decrease mainly because of investment in large, highly mechanized strip mines and in advanced production equipment (particularly reduction cells) and rectifiers and because of lower unit costs for fuel and power. Varying combinations of these factors, together with improvements in operating procedures, should contribute to reducing the average costs in the European Satellites also. In Communist China, however, the average cost may not change appreciably during 1961-65, but a small reduction may result if production by the less efficient plants is curtailed.

In contrast to its trade position as a net exporter of aluminum throughout 1955-59, the Bloc may be a net importer throughout most of 1961-65, just as it apparently was in 1960. The quantities of aluminum required by the countries of the Bloc during 1961-65, primarily for programs calling for the substitution of aluminum for costlier metals such as copper, probably will exceed production in most years. The USSR plans to increase substantially its consumption of aluminum, particularly in electric power transmission systems, but probably will be able to continue exporting to countries outside the Bloc. Accomplishment of similar plans of the European Satellites is partly dependent on substantially larger imports from the USSR, particularly by East Germany, and also may require continued imports from countries outside the Bloc. Communist China certainly will have to continue importing aluminum from outside the Bloc to offset deficits in production. The imports of aluminum from outside the Bloc by the European Satellites and China may well exceed the exports by the USSR to non-Bloc countries throughout most of 1961-65.

I. Production: Expansion During 1950-60 and Planned for 1961-65

A. Aluminum

1. 1950-60

Production of primary aluminum by the Sino-Soviet Bloc expanded rapidly during 1950-60, growing from 170,000 tons in 1950 to a total of about 970,000 tons in 1960. This rapid growth, at an average annual rate of about 19 percent, resulted mainly from the expansion of production in the USSR and Hungary and also from the initiation and expansion of production in Czechoslovakia, East Germany, Poland, and Communist China. For data on production by the Bloc in selected years during 1950-60, see Table 1.*

Although the USSR remained the predominant producer of aluminum in the Bloc, the Soviet share of the total output decreased from about 90 percent in 1950 to about 73 percent in 1960. The Chinese Communist share of the total output grew from 2 percent to 10 percent during 1955-60. Similarly, during 1950-60 the European Satellite share of the total Bloc production grew from about 10 percent to 17 percent, with Hungary accounting for the largest share in most years.

During 1950-60 the average rate of growth of production of primary aluminum was higher in the Bloc than in the Free World. As a result, the Bloc share of the total world production grew from about 12 percent in 1950 to about 22 percent in 1960. Nevertheless, in absolute production the lead of the Free World widened substantially, as shown in Table 2.**

Primary aluminum was produced by the Bloc in 1960 in a relatively large number of reduction plants, but the bulk of that output came from a comparatively small number of the plants. In that year, perhaps as many as 50 reduction plants were in operation, including 10 in the USSR, 6 in the European Satellites, and probably more than 30 in Communist China. Among individual plants, production ranged between 20,000 and 160,000 tons in the USSR, 10,000 and 56,000 tons in the European Satellites, and 1,000 and 40,000 tons in Communist China. About two-thirds of the total production in the USSR was accounted for by four large plants, including two in the Urals Economic Region and one each in the Volga and West Siberia Economic Regions.*** About 40 percent of production in China took place in the plant at Fu-shun in

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* Table 1 follows on p. 6.

** Table 2 follows on p. 7.

*** The numbers and titles of the economic regions used in this report are those that existed before the changes announced in the Soviet press in May 1961.

Table 1

Production of Primary Aluminum in the Sino-Soviet Bloc a/
Selected Years, 1950-60, and 1965 Plan

Thousand Metric Tons

Country or Area	1950	1955	1958	1959	1960	1965 Plan
USSR	155	430	510	600	700	1,400 to 1,500
Communist China	0	10	50	70.4	100	250
European Satellites	16.7	108.2	123	145	166	290 to 300
Czechoslovakia	0	24.4	26.4	41	56	85
East Germany	0	26.4	35	35.3	35	55
Hungary	16.7	37.0	39.5	45.7	49.5	55
Poland	0	20.4	22.4	22.8	26.0	75
Rumania	0	0	0	0	0	20 to 30
Total	170	550	690	820	970	2,000 to 2,100

a. For the methodology, see Appendix A. Because of rounding, components may not add to the totals shown.

Table 2

Production of Primary Aluminum in the Sino-Soviet Bloc and the Free World a/
Selected Years, 1950-60

Thousand Metric Tons

Country or Area	1950	1955	1959	1960
Free World b/	1,290	2,580	3,230	3,500
US	652	1,420	1,772	1,828
Canada	360	556	544	691
Others	279	608	910	1,000
Sino-Soviet Bloc c/	170	550	820	970
USSR	155	430	600	700
Others	17	120	215	266
Total	1,460	3,130	4,050	4,500

a. Because of rounding, components may not add to the totals shown.
b. Data on production in the Free World in 1950, 1955, and 1959 are from source 1/*; for production in 1960, from source 2/.
c. Data on production in the Bloc are from Table 1, p. 6, above.

Liaoning Province. Two plants, one in Czechoslovakia and the other in East Germany, contributed about 55 percent of production in the European Satellites. Details on production by plants are given in Table 3,** and the locations of the plants are shown on the map.***

2. Planned for 1961-65

Under current plans of the Bloc, the rapid expansion in production of aluminum is to be continued during 1961-65. The goal for the total production in 1965, estimated to be about 2.0 million to 2.1 million tons, will necessitate an average annual rate of increase during 1961-65 of about 16 percent, which, though more moderate than the average rate of 19 percent that was achieved during 1950-60, is still imposing. The rise in the total production is to be brought†

* For serially numbered source references, see Appendix B.
** Table 3 follows on p. 8.
*** Inside back cover.
† Text continued on p. 11.

Table 3

Production of Aluminum in the Sino-Soviet Bloc, by Plant a/*
1960

Country	Economic Region b/	Plant	Location c/	Production (Thousand Metric Tons)
USSR	Ia (Northwest)	Kandalaksha Aluminum Plant	Kandalaksha, Murmanskaya Oblast	20
		Nadvoitsy Aluminum Plant	Nadvoitsy, Karelian ASSR	20
		Volkhov Aluminum Plant	Volkhov, Leningradskaya Oblast	25
	III (South)	Dnepr Aluminum Plant	Zaporozh'ye, Zaporozhskaya Oblast, Ukrainian SSR	60
	V (Transcaucasus)	Sumgait Aluminum Plant	Sumgait, Azerbaydzhan SSR	60
		Kanaker Aluminum Plant	Yerevan, Armenian SSR	20
		Kirovabad Aluminum Plant	Kirovabad, Azerbaydzhan SSR	0 d/ e/
	VI (Volga)	Stalingrad f/ Aluminum Plant	Stalingrad, Stalingradskaya Oblast	100 g/
	VIII (Urals)	Bogoslovskiy Aluminum Plant	Krasnotur'insk, Sverdlovskaya Oblast	120
		Urals Aluminum Plant	Kamensk-Ural'skiy, Sverdlovskaya Oblast	110
	IX (West Siberia)	Stalinsk h/ Aluminum Plant	Stalinsk, Kemerovskaya Oblast	160 g/
		Myski Aluminum Plant	Myski, Kemerovskaya Oblast	0 d/
	Xa (Kazakhstan)	Pavlodar Aluminum Plant	Pavlodar, Pavlodarskaya Oblast, Kazakh SSR	0 d/
	XI (East Siberia)	Bratsk Aluminum Plant	Bratsk, Irkutskaya Oblast	0 d/
		Irkutsk Aluminum Plant	Shelekhov, Irkutskaya Oblast	0 d/
		Krasnoyarsk Aluminum Plant	Krasnoyarsk, Krasnoyarskiy Kray	0 d/
		Total, USSR		700

* Footnotes for Table 3 follow on p. 10.

Table 3

Production of Aluminum in the Sino-Soviet Bloc, by Plant a/
1960
(Continued)

Country	Plant	Location c/	Production (Thousand Metric Tons)
Communist China	Fu-shun Aluminum Plant	Fu-shun, Liaoning Province	40
	Others i/		60
	Total, Communist China		100
European Satellites			
Czechoslovakia	Ziar Aluminum Plant	Ziar nad Hronom	56
East Germany	VEB Elektrochemisches Kombinat	Bitterfeld	35
	Lauta Aluminum Plant	Lauta	0 d/
	Total, East Germany		35
Hungary	Inota Aluminum Plant	Inota	30
	Ajka Aluminum Plant	Ajka	10
	Tatabanya Aluminum Plant	Tatabanya	10
	Total, Hungary		50
Poland	Skawina Aluminum Plant	Skawina	26
	Konin Aluminum Plant	Konin	0 d/
	Total, Poland		26
Rumania	N.A.	Slatina	0 d/
	Total, European Satellites		166
	Grand Total		970

Table 3

Production of Aluminum in the Sino-Soviet Bloc, by Plant a/
1960
(Continued)

a. For the methodology, see Appendix A. Because of rounding, components may not add to the totals shown.
b. The economic regions listed in this column are those that existed before the changes announced in the Soviet press in May 1961.
c. Unless otherwise indicated, locations in the USSR are in the RSFSR.
d. These plants either were under construction in 1960 or were to be constructed during 1961-65.
e. Originally this plant was intended to produce alumina and several byproducts from alunite, but an article in the Soviet press of April 1961 states that the plant will be producing aluminum as well. 3/ Whether or not aluminum will be produced during the current planning period is unknown.
f. In November 1961, Stalingrad was renamed Volgograd, and Stalingradskaya Oblast was renamed Volgogradskaya Oblast.
g. As a result of new capacity brought into operation during 1960, these plants together probably can produce annually at least 70,000 tons of aluminum more than they produced in 1960.
h. In November 1961, Stalinsk was renamed Novokuznetsk.
i. Additional reduction plants have been identified at the following locations. Except for those for which coordinates are unknown (indicated by an asterisk), the locations are shown on the map, inside back cover.

Ch'ang-ch'un	Yung-jen (Ch'u-chou)	Kuei-yang	Peking (experimental)	Tsam-kong*
Cheng-chou	Ho-fei	Lan-chou	Sian	Wu-han
Ch'eng-tu	Hsia-ling*	Nan-ch'ang-fang*	T'ai-yuan	Yang-ch'uan
Ching-yuan*	Huan-pu	Pao-ting	T'ang-shan	

about by an increase of about 110 percent* in Soviet production, 150 percent in Chinese Communist production, and 78 percent* in European Satellite production. For specific information on the planned output of aluminum in the Bloc, by country, see Table 1.**

B. Alumina and Ore

1. 1950-60

Production of alumina by the Bloc is estimated to have increased from about 350,000 tons in 1950 to about 2 million tons in 1960, a trend paralleling production of aluminum. The initiation and expansion of production of alumina by Communist China, East Germany, and Czechoslovakia took place during 1950-60. The USSR remained the largest producer in the Bloc and Hungary the second largest, even though the shares of these two countries in the total production of the Bloc decreased appreciably. Data on production of alumina in selected years during 1950-60 are given in Table 4.***

Production and consumption of alumina in 1960 were about equal for the Bloc as a whole but not for all of the individual countries. In 1960, production of alumina by Hungary exceeded its domestic requirements as in previous years, and part of the surplus was used to supplement East German production and to satisfy all Polish requirements.† In the USSR, Czechoslovakia, and China, production apparently equaled requirements.

In 1960, alumina was produced in the Bloc in a large number of plants, including 6 in the USSR, 5 in the European Satellites, and probably 20 to 30 in Communist China. The titles and locations of the known alumina plants, together with the types of raw material processed by each, are given in Table 5,†† and the locations of the plants are shown on the map.†††

During 1950-60, production of aluminum-bearing ore in the Bloc expanded rapidly but not so rapidly as requirements. By 1960,

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* This percentage is calculated from the midpoint of the planned range for production.

** P. 6, above.

*** Table 4 follows on p. 12.

† The total export of alumina by Hungary, 121,000 tons, 4/ exceeded substantially the import requirements of East Germany and Poland. Some part of these exports probably went to the Free World.

†† Table 5 follows on p. 14.

††† Inside back cover.

Table 4

Production of Alumina in the Sino-Soviet Bloc a/
Selected Years, 1950-60, and 1965 Plan

Thousand Metric Tons

Country or Area	1950	1955	1958	1959	1960	1965 Plan
USSR	310	880	1,000	1,200	1,400	2,900 to 3,100
Communist China	0	30	110	140	200	500
European Satellites	34.4	200.3	221.2	330	390	520 to 540
Czechoslovakia	0	0	0	80	110	170
East Germany	0	46.2	51.5	55.3	58.9	60
Hungary	34.4	154.1	169.7	191.6	218	250
Rumania	0	0	0	0	0	40 to 60
Total	350	1,100	1,400	1,700	2,000	4,000 to 4,200

a. For the methodology, see Appendix A. Because of rounding, components may not add to the totals shown.

as shown in Table 6,* the total production of ore in the Bloc was about 6.4 million tons, or about 280 percent more than in 1950. Beginning in 1955, however, in order to meet the total requirements, the Bloc supplemented domestic production with imports, averaging about 361,000 tons annually during 1955-60. These imports, consisting entirely of Soviet imports of bauxite from Greece, were as follows (in thousand tons)**:

Year	Amount	Year	Amount
1955	122	1958	450
1956	306	1959	454
1957	405	1960	432

These imports represented about 3 percent of the total supply of ore in the Bloc in 1955 and 6 percent in 1960.

In 1960, large underground bauxite mines in the Urals Region of the USSR and in northwestern Hungary supplied most of the ore in the Bloc. Strip mines, probably including many small mines in Communist China, supplied the remainder.***

The variety of ores used by the Bloc for producing alumina increased during 1950-60, as shown in Table 6. Whereas only bauxite was used in 1950, nepheline concentrate, shale, and clay represented about 16 percent of the total supply of ore used in 1960. In the USSR in 1960, about 93 percent of the alumina was produced from bauxite, and the remaining 7 percent was produced from nepheline concentrate; in Communist China, all of the alumina output was produced from shale and clay.

Nonbauxite ores generally are inferior to bauxite because in the former the content of alumina is lower† and the content of reactive silica is greater. For each part of reactive silica content, 1 to 2 parts of alumina and 0.7 to 1.75 parts of caustic soda, an††

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* Table 6 follows on p. 16.

** Data for 1955-59 were compiled from source 5/, and the figure for 1960 was obtained from source 6/.

*** The locations of the principal mines are shown on the map, inside back cover.

† An important exception to this is China's shale and clay, the alumina content of which apparently is about as large as that for bauxite.

†† Text continued on p. 17.

Table 5

Alumina Refineries in the Sino-Soviet Bloc
1960 and Planned for 1961-65

Country or Area	Economic Region [a]/*	Plant	Location [b]	Basic Raw Material
USSR	Ia (Northwest)	Tikhvin Alumina Plant	Boksitogorsk, Leningradskaya Oblast	Bauxite
		Pikalevo Alumina Plant	Pikalevo, Leningradskaya Oblast	Nepheline concentrate
		Volkhov Aluminum Plant	Volkhov, Leningradskaya Oblast	Nepheline concentrate
	III (South)	Dnepr Aluminum Plant	Zaporozh'ye, Zaporozhskaya Oblast, Ukrainian SSR	Bauxite
	V (Transcaucasus)	Akhtinsk Mineral-Chemical Combine [c]	Razdan, Armenian SSR	Nepheline syenite
		Kirovabad Aluminum Plant [c]	Kirovabad, Azerbaydzhan SSR	Alunite
	VIII (Urals)	Bogoslovskiy Aluminum Plant	Krasnotur'insk, Sverdlovskaya Oblast	Bauxite
		Urals Aluminum Plant	Kamensk-Ural'skiy, Sverdlovskaya Oblast	Bauxite
	Xa (Kazakhstan)	Pavlodar Aluminum Plant [c]	Pavlodar, Pavlodarskaya Oblast, Kazakh SSR	Bauxite
	XI (East Siberia)	Achinsk Alumina Plant [c]	Achinsk, Krasnoyarskiy Kray	Nepheline

* Footnotes for Table 5 follow on p. 15.

Table 5

Alumina Refineries in the Sino-Soviet Bloc
1960 and Planned for 1961-65
(Continued)

Country or Area	Plant	Location b/	Basic Raw Material
Communist China	Fu-shun Alumina Plant	Fu-shun, Liaoning Province	Shale and clay
	Kuei-yang Alumina Plant	Kuei-yang, Kweichow Province	Shale and clay
	Nan-ting Alumina Plant	Nan-ting, Shantung Province	Shale and clay
	T'ang-shan Alumina Plant	T'ang-shan, Hopeh Province	Shale and clay
	Wei-pei Alumina Plant	Wei-pei, Shensi Province	Shale and clay
	Others d/		
European Satellites			
Czechoslovakia	Ziar Aluminum Plant	Ziar nad Hronom	Bauxite
East Germany	VEB Chemiewerk Lauta	Lauta	Bauxite
Hungary	Almasfuzito Alumina Plant	Almasfuzito	Bauxite
	Ajka Aluminum Plant	Ajka	Bauxite
	Mosonmagyarovar Alumina Plant	Mosonmagyarovar	Bauxite
Rumania	N.A. c/	Crisana Regiunea	Bauxite

a. The economic regions listed in this column are those that existed before the changes announced in the Soviet press in May 1961.
b. Unless otherwise indicated, locations in the USSR are in the RSFSR.
c. These plants either were under construction in 1960 or were to be constructed during 1961-65.
d. The names and locations of additional alumina refineries have not been identified in the Chinese Communist press, but the majority of the aluminum reduction plants listed in Table 3, footnote i, p. 10, above, are believed to have integrated alumina refineries. On this basis, about 25 additional alumina refineries may be estimated for 1960.

Table 6

Production of Aluminum-Bearing Ore in the Sino-Soviet Bloc a/
Selected Years, 1950-60, and 1965 Plan

Thousand Metric Tons

Country or Area	Type of Ore	1950	1955	1958	1959	1960	1965 Plan
USSR	Bauxite	1,100	2,600	3,000	3,600	4,100	8,000 to 9,000
	Nepheline concentrate b/	0	130	160	240	400	3,000
	Other c/	0	0	0	0	0	
Total USSR		1,100	2,700	3,200	3,800	4,500	11,000 to 12,000
Communist China	Shale and clay	0	110	380	490	700	1,800
European Satellites		577.8	1,241	1,053	956.7	1,189	1,650 to 1,720
Hungary	Bauxite	577.8	1,241	1,053	956.7	1,189	1,510
Rumania	Bauxite	0	0	0	0	0	140 to 210
Total		1,700	4,100	4,600	5,300	6,400	14,500 to 15,500

a. For the methodology, see Appendix A. Because of rounding, components may not add to the totals shown.
b. This material is a byproduct obtained by the mineral fertilizer industry from processing apatite-nepheline ore.
c. Including nepheline, nepheline syenite, and alunite.

important input, are lost during processing. Thus the quantity of ore processed is greater, the loss of soda is greater, and the recovery of alumina is smaller when a nonbauxite ore is used for producing alumina.

The conventional methods used for producing alumina from bauxite -- for example, the Bayer process, the modified Bayer process, and the lime-soda-sinter process -- are not suitable for processing ores that contain as much reactive silica as is found in the nonbauxite ores used by the USSR and Communist China. Exploitation of the nonbauxite ores thus followed development of new processing techniques in the USSR and (with Soviet aid) in Communist China. The use of these techniques results in production not only of alumina but also of large quantities of such byproducts as soda, potash, and raw materials for producing cement and bricks. Proceeds from the sale of these byproducts apparently offset a large share of the higher cost of producing alumina from nonbauxite ore. 7/

2. Planned for 1961-65

The achievement of the estimated goal for production of aluminum in the Bloc in 1965 would require about 4.0 million to 4.2 million tons of alumina in 1965, or about twice the quantity produced in 1960. Consequently, the USSR probably plans to increase its output of alumina by about 110 to 125 percent, China by about 150 percent, Czechoslovakia by 55 percent, Hungary by 14 percent, and East Germany by merely 2 percent. Rumania proposes to begin producing alumina during 1961-65.*

If these goals are achieved, the proportional distribution of the total production by the Bloc in 1965 will be roughly the same as in 1960. The only important exception is that Communist China will be the second largest (after the USSR) and Hungary the third largest producer of alumina in the Bloc, thus reversing their relative standings in 1960. Furthermore, the USSR and Hungary will have enough alumina not only to satisfy their own requirements and those of Poland but also to supplement production in East Germany. Czechoslovakia, Communist China, and Rumania will have enough to satisfy their respective requirements.

On the assumption that the Bloc intends to rely on its own production for supplies of ore, the goal for the total production of ore by the Bloc in 1965 should be about 14.5 million to 15.5 million tons, or 130 to 140 percent above production in 1960. Concomitantly the relative importance of nonbauxite ores is certain to rise. The European Satellites will continue to use only bauxite, and Communist

* See Table 4, p. 12, above.

China only shale and clay, for producing alumina. The USSR, however, plans to expand the variety of ores used to include not only bauxite and nepheline concentrate as was the case in 1960 but also nepheline, nepheline syenite, alunite, and possibly sillimanite. By 1965, non-bauxite ores may account for about 27 to 30 percent of the total supply of ore in the USSR and 30 to 35 percent of that in the Bloc. The share of the total production of aluminum in the Bloc derived from nonbauxite ores, however, will be somewhat smaller than 30 percent.*

* For estimates of production of ore planned in 1965, see Table 6, p. 16, above.

II. Prospects for 1961-65

Production of aluminum probably will expand about as rapidly as planned during 1961-65 in each of the countries of the Bloc except Rumania and Communist China. With production shortfalls in these countries, the total production of aluminum in the Bloc in 1965 will be below the planned range of 2.0 million to 2.1 million tons. This estimate is based on an evaluation of the following: the requirements for aluminum-bearing ore and electric power and the available reserves of ore and the supply of power, respectively, as well as the prospects for achieving plans for the expansion and modernization of capacity and for more intensive use of existing capacity.

A. Reserves of Ore

1. Current Reserves

a. USSR

As of January 1961 the largest reserves of aluminum-bearing ores in the Bloc were in the USSR. Soviet reserves included about 600 million tons of bauxite,* having an estimated aluminum content of about 80 million tons,** or more than 100 times the quantity of aluminum produced by the USSR in 1960. Those reserves also included several low-quality ores, such as nepheline, alunite, and sillimanite, whose combined content of aluminum probably was several times as large as the content in the reserves of bauxite.

Soviet reserves are dispersed among many regions. The general locations of the principal deposits are as follows***:

Type of Ore	Locations of Deposits 11/
Bauxite	Sverdlovskaya Oblast, RSFSR Boksitogorsk, Leningradskaya Oblast, RSFSR Turgay, Kustanayskaya Oblast, Kazakh SSR
Nepheline	Kola Peninsula, Murmanskaya Oblast, RSFSR Uzhur, Krasnoyarskiy Kray, RSFSR Kiya Shaltyr, Kemerovskaya Oblast, RSFSR
Alunite	Zaglik, Azerbaydzhan SSR

* This estimate is based on (1) the report that reserves of bauxite in 1929 were 1.815 million tons 8/; (2) the report that reserves near the end of 1957 were 287 times those in 1929, or about 520 million tons 9/; and (3) the evidence that reserves increased in 1958-59. 10/

** The content of aluminum in the reserves of bauxite is a rough approximation based on an assumed ratio of bauxite to aluminum of 7 to 1.

*** These and other locations are shown on the map, inside back cover.

b. European Satellites

Additional reserves of aluminum-bearing ore are in the European Satellites. These reserves include about 115 million tons of bauxite in Hungary, 12/ most of which are in the Bakony and Vertes Mountains in the western part of the country. 13/ The reserves also include about 20 million tons of bauxite in Rumania, 14/ the principal deposits being located in Crisana Regiunea.* The average quality of the Hungarian bauxite probably is higher than that of the Rumanian bauxite.

The remaining European Satellites, however, apparently do not have reserves of aluminum-bearing ores of industrial significance. Some of them have deposits of low-grade shale and clay but lack the technologies for economic production. A new technology for processing low-quality clay has been developed in Poland and is to be applied in a pilot plant recently constructed at Gorka, 15/ but the prospects for achieving economic production cannot be judged at this time.

The reserves in Hungary, however, are large enough to support the expansion of the entire aluminum industry of the European Satellites planned for 1961-65. The estimated reserves in Hungary in 1960 were about 100 times as large as the quantity of bauxite used in that year by Hungary, East Germany, Poland, and Czechoslovakia together for producing aluminum.

c. Communist China

Communist China also has reserves of aluminum-bearing ores that unquestionably are large enough to support the expansion of its aluminum industry planned for 1961-65. The reserves of aluminum-bearing shale and clay in China probably total at least several billion tons,** or hundreds of times as much as required for production planned in 1961-65. The major deposits of shale and clay are dispersed among the provinces of Liaoning, Hopeh, Shantung, Shansi, Anhwei, Chekiang, Kweichow, Szechwan, Yunnan, and Shensi, and additional deposits of unknown size are in the provinces of Tsinghai, Kansu, and Sinkiang.* 17/

* These locations are shown on the map, inside back cover.
** This estimate is based on (1) the report that reserves in the late 1940's in the Shantung Peninsula alone were about 810 million tons 16/ and (2) the presence of major deposits in most of the remaining provinces.

2. Future Reserves

The reserves of aluminum-bearing ores in the Sino-Soviet Bloc, particularly the nonbauxite ores in the USSR and Communist China, probably will increase during 1961-65 as a result of further geological exploration and advances in technology which would broaden the grades and types of ore that could be processed economically. Advances in technology also may result in an increase in the proportion of the alumina recovered from the ore. Such advances in technology occurred during 1950-60 and may be anticipated during 1961-65.

B. Supply of Electric Power

The expansion in production of aluminum planned by the Bloc for 1961-65 probably will not be retarded by shortages of electric power. The aluminum reduction plants to be expanded or constructed during 1961-65 generally are situated fairly close to hydroelectric or thermal powerplants that are to be expanded or constructed during that period. These powerplants should be able to supply the large additional quantities of electric power that will be needed by the aluminum reduction plants and other important consumers. The outlook appears to be particularly favorable in the USSR, where, for example, the aluminum industry will be able to obtain large quantities of power from plant developments at or near Stalingrad,* Pavlodar, Krasnoyarsk, and Irkutsk. The European Satellites may not succeed in expanding production of electric power during 1961-65 as rapidly as planned. In spite of possible shortfalls in production of power in that area, however, most of the requirements of the aluminum industry probably will be met.

Furthermore, during 1961-65 the task of supplying the electric power needed by the aluminum industry of the USSR particularly, as well as by the aluminum industries of the European Satellites, should be eased somewhat because the growth in the total consumption of power by the aluminum industry probably will not be so great as the growth in the total production of aluminum. The introduction of more efficient reduction cells and rectifiers and more extensive application of improved operating procedures in Soviet and European Satellite plants should result in a reduction in the average quantity of electric power consumed per unit of aluminum produced.

In Communist China the supply of electric power probably will be adequate for achieving the planned expansion in production of aluminum.

* In November 1961, Stalingrad was renamed Volgograd.

C. Expansion of Capacity

1. Construction Plans

a. Aluminum Reduction

During 1961-65, new capacity for production of primary aluminum in the Bloc is to be added mainly through construction of new plants. Of the total increment in production planned, about 85 percent* probably will be obtained from new capacity, two-thirds of which is represented by new plants and the remainder by expansion and modernization of existing plants. Most of the new plants planned are large compared with existing plants in the Bloc, and the predominant share of capacity to be added to existing plants is earmarked for the largest plants. Except in Communist China, plans call for the installation of production and auxiliary equipment of advanced design and for extensive introduction of mechanization and automation.

In the USSR during 1961-65, more than 700,000 tons of the planned production increment apparently will have to come from new reduction capacity. Four new reduction plants under construction in the eastern regions of the USSR may account for about three-fourths of the total capacity planned for the entire country. These plants are at Pavlodar in Kazakh SSR; at Myski in West Siberia; and at Krasnoyarsk in Krasnoyarskiy Kray and Shelekhov in Irkutsk Oblast, both in East Siberia, as shown on the map.** The remaining one-fourth of the total probably will consist of additions to capacity at existing plants, most of which are to take place at the four largest plants in the country, which include the two reduction plants in the Urals and the plants at Stalinsk and Stalingrad.*** If current plans are realized, these plants together with the four new plants may account for nearly 80 percent of the total Soviet production of primary aluminum in 1965.

The Soviet press has stressed both the size of the reduction cells and the type of rectifiers† that are to be installed during 1961-65. The reduction cells are designed to operate at current loads of 120,000 to 130,000 amperes 18/ and should have an annual output of about 300 to 320 tons each,†† whereas cells in use at many of

* Of the remaining 15 percent of the production increment planned, about one-half is to be obtained from more intensive use of existing capacity (see D, p. 30, below) and the remainder from new capacity brought into operation during 1960.

** Inside back cover.

*** In November 1961, Stalinsk was renamed Novokuznetsk, and Stalingrad was renamed Volgograd.

† A rectifier is a device used for converting alternating current (AC) to direct current (DC).

†† Output per cell-year is calculated by using the approximate ratio of 2.5 tons to 1,000 amperes.

the existing plants range in size from 40,000 to 80,000 amperes* and have an annual output of only 100 to 200 tons. Moreover, a larger cell, designed to operate at about 150,000 amperes 21/ and to produce about 375 tons of aluminum annually, may be installed in reduction lines during the current planning period. Installation of rectifiers of advanced design (including semiconductor rectifiers) that are more efficient than converters** and rectifiers now in use at many plants, 22/ also is planned.

The expansion of the capacities of existing Soviet reduction plants is to be achieved not only by construction of new reduction lines but also by modernization measures designed to increase the current load at which the reduction lines operate. The Dnepr plant in the Ukrainian SSR, for example, proposes to effect measures whereby the current load on existing lines will be raised 20 percent, resulting in a corresponding increase in output. 23/

The Soviet program provides also for high levels of mechanization and automation at new plants and for more extensive use of mechanization and automation at existing plants. 24/ The object of these measures is to increase the productivity of labor, thus reducing labor costs and alleviating labor supply problems, even though labor costs are not a major component of the total costs and even though labor requirements are relatively small. Because the problem of labor supply is more serious in the eastern regions, where skilled labor not only is in short supply but also is difficult to attract from other regions, 25/ greater emphasis is being given to the mechanization and automation of the plants in those areas. The potential availability of large supplies of low-cost power in the eastern regions is a further inducement for more extensive application of mechanization and automation.

Although the standard electrolytic method of reducing alumina to aluminum is being used in all existing Soviet plants and is to be used in those plants under construction, a radically different technique, called electrothermal reduction, may be instituted during 1961-65. In December 1960 a large experimental electrothermal unit began operating at the Irkutsk plant. In this unit, sillimanite ore is reduced directly to aluminum and silumin.*** The new reduction method is alleged by Soviet authors to result in substantial savings

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* The range was derived by using an index of the operating amperage of cells in use at each of the plants, reported in source 19/, and the operating amperage for the cells in use at one of those plants, reported in source 20/.

** A converter is a device used for converting alternating current (AC) to direct current (DC).

*** An alloy of aluminum and silicon.

in investment outlays, in labor and in power costs, and hence in lower average costs of producing both primary aluminum and silumin. 26/ The construction of two similar units, one at the Stalingrad* plant and the other at the Zaporozh'ye plant, is planned during 1961-65. 27/ The capacity for electrothermal reduction on an industrial scale may be installed at Irkutsk and other locations, possibly before the end of the current planning period, to supplement the capacity for electrolytic reduction of alumina. Success in this venture would broaden the resource base of the Soviet aluminum industry substantially by moving sillimanite and other ores from the category of ores considered to be too costly to process into the category of ores that can be processed economically.

In the European Satellites, about 100,000 to 110,000 tons of the production increment planned for 1961-65 are expected to come from new reduction capacity. About 70 percent of the new capacity planned by the European Satellites is represented by three new plants, one at Konin in Poland, another at Lauta in East Germany, and the third at Slatina in Rumania.** The remaining 30 percent will be accounted for by expansion of the only existing Czechoslovak plant.

In the Polish and East German plants also, the installation of modern equipment and the extensive use of mechanization and automation are planned. For example, cells designed to operate at 120,000 to 130,000 amperes are to be installed in the Konin plant in Poland 28/ and in the Lauta plant in East Germany.*** In contrast, the Skawina plant in Poland uses 60,000 ampere cells, and the Bitterfeld plant in East Germany probably uses 32,000 ampere cells. 30/ Production processes are to be partly automated and televisional techniques are to be employed at the Konin plant, 31/ and more extensive application of mechanization is planned at the Bitterfeld plant. 32/

In Communist China the estimated planned production increment of about 150,000 tons apparently will have to come from new reduction capacity planned for 1961-65. Of the total new capacity planned, at least a predominant share is to be obtained by expanding the reduction plants located at Sian, Kuei-yang, Lan-chou, Huan-pu, and Ho-fei. These five plants, at which small sections began operating either in 1959 or early in 1960, may produce as much as 200,000 tons by 1965. 33/

In sharp contrast to the Soviet and European Satellite programs, the Chinese Communist construction program apparently calls

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* In November 1961, Stalingrad was renamed Volgograd.

** These locations are shown on the map, inside back cover.

*** The operating load for the cells earmarked for the Lauta plant was derived from information contained in source 29/ on the number of cells and the annual output planned.

for the installation of very small reduction cells and for virtually no mechanization and automation. The reduction cell, designed to operate at a current load of about 5,000 amperes and to produce about 12.5 tons annually, is of the same type that was installed in the other plants constructed in the country since 1957. 34/

The decision of the Chinese Communists to install small reduction cells rather than larger cells of more advanced design is attributed to several factors. One of the most important factors is reported to be the much smaller requirements for capital investment associated with the use of smaller cells, 35/ and another is reported to be a shorter time period required for bringing new capacity into operation. 36/ Certainly the choice of small reduction cells also is prompted by the shortage of skilled labor, technicians, and engineers and by the general availability of cheap, unskilled labor. As a final consideration, the small cells provide greater flexibility in responding to changes in the supply of power.

b. Alumina Refining

During 1961-65, perhaps as much as 95 percent of the planned increment in production of alumina in the Bloc will come from new capacity. Of this new capacity, about two-thirds may consist of new plants, the majority of which are intended to process nonbauxite ores by new technologies. The remaining one-third of new capacity may be obtained by the expansion and modernization of existing alumina plants, primarily the largest plants. In general, the Bloc plans to install equipment of advanced design and, except in Communist China, to use mechanization and automation extensively.

In the USSR, of the increment in production of alumina planned for 1961-65, 1.5 million to 1.7 million tons, about 95 percent may come from new capacity. About two-thirds of the new capacity may be represented by four plants that are under construction -- large plants at Pavlodar and Achinsk in the eastern regions and smaller plants at Kirovabad and Razdan in the Caucasus.* The remaining one-third of the new capacity is expected to be obtained by expansion and modernization of existing plants, principally the large plants in the Urals Region.

The most modern equipment and technology are to be utilized in the new Soviet alumina facilities. For example, large modern processing units, such as rotary furnaces that are four to five times as productive as current models and grinding mills that are three

* For the titles of the new plants, see Table 5, p. 14, above, and for their locations, see the map, inside back cover.

times as productive as standard models, are planned for installation. 37/ Newly developed processes, such as fluosolid roasting, which is said to be much more efficient than standard processes, also are to be used. 38/ In addition, the extensive application of mechanization and automation, particularly at the new plants in the eastern regions, is planned. 39/

New technologies designed for processing nonbauxite ore are to be used in much of the new capacity planned by the USSR for 1961-65. Of the four alumina plants under construction, only one, the Pavlodar plant, is intended to process bauxite. The Achinsk plant will process nepheline; the Kirovabad plant, alunite; and the Akhtinsk plant, nepheline syenite. Moreover, the USSR probably is planning to expand capacity at the Pikalevo plant and possibly at the Volkhov plant, both of which produce alumina from nepheline concentrate, and evidently is considering the conversion of the Tikhvin plant from bauxite to nepheline concentrate. 40/ Finally, an experimental unit under construction at the Pavlodar plant is designed to extract alumina from nepheline syenite, 41/ large reserves of which are found nearby. If this unit proves to be successful, the Pavlodar plant probably will extract alumina from both bauxite and nepheline syenite. Any sillimanite exploited on an industrial scale by the Soviet aluminum industry before the end of the current planning period probably will be used for direct reduction to metal rather than for production of alumina.

Soviet planners apparently believe that output of a variety of useful byproducts compensates for some of the difficulties associated with the use of nonbauxite ore. At the Achinsk plant, where nepheline is to be processed, for example, with each ton of alumina, Soviet planners expect to obtain about 300 kilograms (kg) of caustic soda, 100 kg of potassium sulfate, 20 kg of soda-potash, and 6 to 9 tons of slime suitable for use in producing high-quality portland cement. 42/ Byproducts expected from processing other nonbauxite ores include sulfuric acid; yerevanite (a raw material for producing high-quality crystalline glass); silica for use in the manufacture of semiconductors; and certain rare elements. 43/ Furthermore, Soviet planners expect that the cost of these byproducts will be lower than the cost of producing them conventionally. 44/

In the European Satellites, about 100,000 to 120,000 tons of the planned increment in production of alumina during 1961-65 is to be obtained from new capacity. From 50 to 60 percent of the new capacity planned by the European Satellites probably will be obtained by expanding and modernizing the Ziar plant in Czechoslovakia and the Almasfuzito plant in Hungary, the two largest alumina plants in the European Satellites. The remaining new capacity is expected from a new plant planned by Rumania. Although the installation of modern equipment and the extensive use of mechanization and automation probably

are planned, the basic technology of producing alumina in the European Satellites during 1961-65 is expected to remain essentially unchanged.*

In Communist China the entire increment in production of alumina estimated for 1961-65, about 300,000 tons, probably will be produced in new capacity. Presumably all of the new capacity is to be obtained by the expansion and probably by the modernization of existing plants. A predominant share of this expansion and modernization may be designated for a comparatively small number of alumina plants or departments committed to supplying the reduction plants at Sian, Kuei-yang, Lan-chou, Huan-pu, and Ho-fei, which are to be expanded considerably during 1961-65.

c. Mining

New capacity probably will have to contribute virtually all of the 8 million to 9 million tons of the increment in production of aluminum-bearing ore expected in the Bloc during 1961-65, assuming that domestic supplies are to be relied on entirely during that period. The USSR probably will account for about eight-tenths of the increment in mining capacity, Hungary and China for approximately equal shares of practically all of the remainder, and Rumania for a very small share.

In the USSR the addition to mining capacity during 1961-65 is to be achieved partly by the expansion of existing mines and partly by construction of new mines.** Probably about half of the planned increase in mining capacity is to be attained by the expansion of the bauxite mines in the Urals Region. Most of the remainder is to be represented by five new strip mines that are under construction. The general locations of the new strip mines and the types of ore to be mined at those locations are as follows 45/:

Location	Type of Ore
Turgay, Kazakh SSR	Bauxite
Uzhur, Krasnoyarskiy Kray, RSFSR	Nepheline
Kiya Shaltyr, Kemerovskaya Oblast, RSFSR	Nepheline
Zaglik, Azerbaydzhan SSR	Alunite
Akhta, Armenian SSR	Nepheline syenite

* As noted in A, 1, b, p. 20, above, Poland recently completed a pilot plant intended to test a new technology for producing alumina from low-quality clay, but the outcome of this venture is not predictable at this time.

** The expansion in the scale of use of nepheline concentrate in the Northwest Economic Region planned for 1961-65, estimated to be at least 200,000 tons, apparently can be achieved by exploitation of the tailings dump at the Kirovsk Apatite Combine at Kirovsk in Murmanskaya Oblast of the RSFSR.

Should results from an experimental production unit now in operation at Irkutsk and another under construction at Pavlodar be considered by Soviet planners to be favorable, added capacity will be constructed for strip mining of sillimanite near Irkutsk and of nepheline syenite near Pavlodar.

2. Prospects for Construction

The prospects for construction during 1961-65 vary among the countries of the Bloc. In the USSR and the European Satellites, mainly because of continued improvements in construction performance, most of the additional capacity planned for the aluminum industry probably will be realized. The major exceptions are that the capacity for the Rumanian industry and some of the additional mining capacity for the Soviet industry may not be achieved. Similarly, because of continued shortages in the supply of equipment, plans for mechanization and automation in the USSR and the European Satellites and for the installation of rectifiers of advanced design in the USSR may be substantially underfulfilled. In Communist China, on the other hand, as a result of disruptions stemming from the general economic decline, most of the additions to capacity in the aluminum industry probably will not be attained.

In the USSR, recent construction performance has varied sharply among projects of the aluminum industry. On some projects, construction has lagged because of errors in planning and because of shortages of materials, labor, power, and production and construction equipment. For example, the plan for construction and installation at the new aluminum-alumina plant at Pavlodar was underfulfilled by 29.2 percent in 1959 and by about 35 percent in 1960. 46/ On other projects, construction has proceeded as scheduled or even faster. To illustrate, construction of each of the first three reduction buildings of the Sumgait plant took 2 years, but construction of the fourth took only 7 months. 47/ As a result, the Sumgait plant expects to attain by 1963 the level of production that had been planned for 1965. 48/ Similarly, construction of each of the first two reduction buildings of the Stalingrad plant took about 18 months, but construction of the third took only 7 months, 1 month less than scheduled. 49/ On balance, however, the scheduled construction of projects for the aluminum industry in the USSR definitely has lagged.

For 1961-65 the outlook for the expansion of capacity in the Soviet aluminum industry is considered to be better. The large projects have been under construction for several years -- those at Pavlodar, Krasnoyarsk, Achinsk, and Irkutsk are carryovers from the abandoned Sixth Five Year Plan (1956-60) -- so that most of the buildup of the construction base for these projects probably has been completed. Moreover, the

present construction schedules are more reasonable than those established earlier. Inadequate supplies of some important building materials may continue to handicap construction operations. Supplies of cement at several construction sites should improve, however, inasmuch as cement is to be a byproduct of the exploitation of nonbauxite ore during the latter part of the current planning period. Supplies of construction equipment should improve more than envisioned earlier because of the recent supplemental allocation of investment to the construction equipment industry. 50/ To add to its own output of production equipment, the USSR plans to import equipment from France. 51/

During 1961-65 the USSR probably will succeed in expanding the capacity for refining alumina and for reducing aluminum as planned but probably will not succeed in expanding capacity for mining. As a result, Soviet ore may have to be supplemented by imports, probably in the form of bauxite from Greece, as in the past. A more speculative possibility is that the USSR will begin importing bauxite from Guinea or Ghana, both of which have huge reserves of high-grade bauxite that could be substituted advantageously for the comparatively lower quality Soviet ores, particularly those of the nonbauxite varieties.

The outlook for the realization of the planned additions to capacity for 1961-65 is considered to be generally favorable in the European Satellites also. This estimate is based on the probability of a continuation of the generally rapid rates of economic growth and on evidence that the construction program will be supported by both the USSR 52/ and France. 53/ The lone important exception to this outlook is that the capacity for producing ore, alumina, and aluminum planned by Rumania is not likely to be completed as scheduled during 1961-65. In fact, it is doubtful that Rumania will produce any aluminum at all by 1965.

Although Soviet and European Satellite plans for adding capacity in the aluminum industry during 1961-65 are expected to be fulfilled generally, plans for extensive mechanization and automation both in the USSR and in the European Satellites and plans for the installation of rectifiers of advanced design in the USSR may be significantly underfulfilled. The equipment needed to implement these plans probably will continue to be in short supply during 1961-65. Failure to carry out plans for mechanization and automation would result in underfulfillment of goals for labor productivity both in the USSR and in the European Satellites. In the USSR the failure to provide rectifiers of advanced design would mean somewhat higher investment outlays than planned and larger consumption of electric power than anticipated.

In Communist China, in sharp contrast to the general outlook in most of the Bloc, the chances of accomplishing the estimated additions to capacity that are programed for 1961-65 appear to be highly unfavorable. Severe shortages in the supply of construction materials and production equipment, resulting from a continuing decline in the economy, preclude the possibility that more than an insignificant share of the additional capacity will be constructed.

D. Increased Production from Existing Capacity

In addition to the increments in production of aluminum and alumina that are to be obtained from new capacity, some gains in production from existing capacity during 1961-65 also are provided for in the plans of the Bloc and probably will be realized. About 80,000 tons of aluminum, or 8 percent of the total increment planned for 1961-65, probably will be obtained by more efficient use of existing capacity, by improvements in supply, and by better organization of production. The USSR is to account for about 94 percent and Hungary for the remainder of the increment in production of aluminum expected from existing capacity. Similarly, about 130,000 tons of alumina, or more than 5 percent of the total increment planned for 1961-65, may be obtained by more intensive and efficient use of existing capacity. Of the added production of alumina expected from existing capacity during 1961-65, the USSR is expected to contribute about three-fourths and Czechoslovakia the remainder.

III. Trade

The Sino-Soviet Bloc, a net exporter of aluminum throughout 1955-59, apparently was a net importer in 1960. Moreover, the Bloc may continue to be a net importer throughout most of 1961-65, even should the large planned increases in output of aluminum be achieved. The USSR, the principal exporter of aluminum to the Free World, has planned to increase both its domestic consumption of aluminum and its exports of aluminum to the European Satellites during 1961-65. Communist China, the principal importer of aluminum from the Free World, undoubtedly will be forced to continue to rely on markets of the Free World to satisfy a part of its requirements.

A. 1959

Essentially because of the surplus production in the USSR, the Bloc in 1959 was a net exporter of aluminum to the extent of about 16,000 tons. The total exports to the Free World were about 42,000 tons, including 35,000 tons from the USSR, and the total imports from the Free World were only 26,000 tons. Data on trade in aluminum between the Bloc and the Free World in 1959 are given in Table 7.*

Although the Bloc as a whole was a net exporter of aluminum in 1959, some of the individual countries were net importers. In that year, as shown in Table 8,** five Bloc countries were entirely dependent on imports, and three countries, East Germany, Poland and Communist China, were partly dependent. The imports of aluminum by the European Satellites in 1959 originated almost entirely within the Bloc, mainly from the USSR and Hungary. The imports by Communist China in 1959, on the other hand, originated almost entirely in the Free World.

Soviet exports of aluminum to the Free World in 1959 continued a trend that began in 1955, when the goal of the Fifth Five Year Plan (1951-55) for production of aluminum was exceeded by about 6.5 percent. The USSR exported an average of about 29,000 tons annually to the Free World during 1955-59, as shown in the following tabulation (in thousand tons) 55/:

	1955	1956	1957	1958	1959
Exports	5.2	28.3	29.5	49.3	34.7***

* Table 7 follows on p. 32.
** Table 8 follows on p. 33.
*** Text continued on p. 34.

Table 7

Trade in Aluminum Between the Sino-Soviet Bloc and the Free World a/
1959

Thousand Metric Tons

	Exports			Imports						
Destination	USSR	Czechoslovakia	Total	Origin	Bulgaria	Communist China	East Germany	Poland	Rumania	Total
Belgium	2.8	0	2.8	Austria	0	0.4	0	0.2	0.5	1.1
Finland	6.8	0	6.8	Benelux	0	0.3	0	0.2	0	0.4
Greece	0.2	0	0.2	Canada	0.2	9.4	0	1.2	0	10.8
India	1.0	0	1.0	France	0	0.8	0	0	0	0.8
Netherlands	6.5	0	6.5	Italy	0	0.3	0	0	0	0.3
UK	17.1	0	17.1	Norway	0	7.8	0	2.0	1.1	11.0
West Germany	0	7.6	7.6	Switzerland	0	0	0	0.7	0	0.7
Yugoslavia	0.3	0	0.3	Yugoslavia	0	0	0.9	0	0	0.9
Total	34.7	7.6	42.3		0.2	18.9	0.9	4.2	1.7	25.8

a. Data were compiled from source 54/. Because of rounding, components may not add to the totals shown.

Table 8

Origin and Distribution of Aluminum in the Sino-Soviet Bloc a/
1959

Thousand Metric Tons

Country or Area	Origin					Distribution			
		Imports					Exports		
		Bloc							
	Production b/	USSR c/	Hungary	Non-Bloc d/	Total Supply	Internal Use	To Countries of the Bloc e/	To Countries Outside the Bloc f/	Production as a Percent of Internal Use g/
USSR	600		0	0	600	515	50.3	34.7	116
Communist China	70.4	1.3	0	18.9	90.6	90.6	0	0	78
North Korea and North Vietnam	0	0.6	0	0	0.6	0.6	0	0	0
European Satellites	145	48.4		6.9	200 h/	192.5		7.6	75
Albania	0	0	0	0	0	0	0	0	0
Bulgaria	0	1.7	0	0.2	1.9	1.9	0	0	0
Czechoslovakia	41	6.6	0	0	47.6	40.0	0	7.6	102
East Germany	35.3	30.0	6.4 i/	0.9	72.6	72.6	0	0	49
Hungary	45.7	0		0	45.7	37.4	8.3	0	122
Poland	22.8	5.4	1.9 j/	4.2	34.3	34.3	0	0	67
Rumania	0	4.7	0	1.7	6.3	6.3	0	0	0
Total	820			26	841 k/	799		42	102

a. The trade within the Bloc included rolled aluminum, Duralumin, and bare aluminum wire, as well as primary aluminum. The trade between the Bloc and the Free World included primary aluminum and unwrought alloys. Because of rounding, components may not add to the totals shown.
b. Data in this column are from Table 1, p. 6, above.
c. Data in this column were compiled from source 56/.
d. Data in this column are from Table 7, p. 32, above.
e. Data in this column are from source 57/.
f. Data in this column are from Table 7, p. 32, above.
g. The percentages in this column are derived by dividing the respective figures in Column 1 by those in Column 6.
h. Excluding trade among the European Satellites.
i. This quantity is the difference between the total export by Hungary (as shown in Column 7) and its export to Poland (as shown in Column 3). The import by East Germany was assumed because the available data on trade by the remaining countries of the Bloc and by the Free World failed to show any imports from Hungary.
j. 58/
k. Excluding trade within the Bloc.

B. 1960

In contrast to its trade position throughout 1955-59, the Bloc apparently was a net importer of aluminum in 1960. Although the available data on trade in aluminum between the Bloc and the Free World in 1960 are incomplete, the total import by the Bloc was at least 29,000 tons and the total export about 18,000 tons, thus leaving a net import of at least 11,000 tons of aluminum.

C. Prospects for 1961-65

The Bloc may continue to be a net importer of aluminum throughout most of 1961-65. The large increase in production of aluminum planned by 1965 in the USSR and the European Satellites may be achieved, but this increase is necessary to provide the supplies of aluminum that will be needed for their internal programs. In the USSR, for example, more than 1 million tons of aluminum are earmarked for use in construction of electric power transmission systems during 1959-65. This allocation partly reflects the plans to use aluminum as a substitute for about 300,000 tons of lead in cable sheathing and about 400,000 tons of copper in cable conductors. 59/ Soviet planners expect that the use of aluminum and plastics combined will reduce the amount of lead required by the cable and battery industries by about 100,000 tons in 1965 alone. 60/ The Soviet authorities also plan to expand the use of aluminum in the manufacture of vehicles so that by 1965 the amount used per vehicle will be double that used in 1958. 61/ The USSR also plans to increase the use of aluminum in the manufacture of machinery and consumer goods and in shipbuilding and construction. 62/ Similar plans for increasing consumption of aluminum in the European Satellites 63/ are based in part on the promise of larger imports from the USSR. In Communist China, as a consequence of a sharp reduction in requirements stemming from a continuing general decline of the economy, consumption of aluminum undoubtedly will not rise so rapidly as had been planned. To offset certain deficits in production, Communist China will be forced to continue to import aluminum from the Free World. During most of 1961-65, therefore, the imports of aluminum by the Bloc from the Free World may exceed the exports to the Free World, as was true in 1960.

Data on the plans for allocating aluminum among the countries of the Bloc during 1961-65 are not available, but the general pattern of allocation can be estimated. The bulk of Soviet production during 1961-65 probably will be used to satisfy internal requirements, with most of the remainder going to East Germany, Bulgaria, and Albania, and possibly other European Satellites (for example, Rumania) that might suffer shortfalls in production. The USSR has already agreed to supply 85,000 tons of aluminum to East Germany in 1965. 64/ Such a quantity is 69 percent greater than the total export in 1959 by the USSR to all countries of the Bloc. Communist China and the European Satellites are expected to use the entire output of aluminum that they produce.

IV. Investment

For each unit of investment outlay in the aluminum industry of the Bloc, the increments in capacity during 1961-65 probably will be larger than in previous years but smaller than planned, with the result that supplemental funds may be needed to carry out the planned expansion of the aluminum industry of the Bloc. Because the expansion program apparently has been assigned a high priority, needed funds presumably would be allocated.

A. Total Investment

Data on investment are available for only two countries, the USSR and Poland. The USSR allocated about 20 billion rubles* to carry out the expansion planned for 1959-65, and Poland allocated about 370 million zlotys** to effect the expansion planned for 1961-65. The investment allocation for the Soviet aluminum industry represents a much larger proportion of the total allocation for the nonferrous metals industry for 1959-65 than was true in 1952-58. The sum of 20 billion rubles is about 35 percent of the planned total of 55 billion rubles allocated to the Soviet nonferrous metals industry, 66/ whereas in 1952-58 the Soviet aluminum industry received only about 8 billion rubles,*** or about

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* Pre-1961 rubles in 1955 prices. This figure was derived by multiplying the planned capital outlay of 20,000 rubles per ton for 1959-65, (see B, p. 36, below) by the increment in production of 900,000 to 1 million tons planned for 1959-65 (see Table 1, p. 6, above).

** This figure, expressed in 1958 prices, was obtained by multiplying the capital outlay of 12,200 zlotys per ton planned for the Konin plant (see B, p. 36, below) by the estimated production of 30,000 tons planned for that plant in 1965. A much larger figure of 2.5 billion zlotys has been reported as the planned total investment for the Konin plant, 65/ but this figure apparently is the total cost of the complex planned for Konin, including not only reduction facilities but also fabricating facilities and possibly others. Also, it may cover reduction facilities and other capacity scheduled for construction after 1965.

*** This figure (X) was estimated by using the formula X = ABC, where

A = 20,000 rubles, the average investment outlay per ton of capacity planned for 1959-65 (see B, p. 36, below);

B = 1.25, the factor expressing the approximate ratio of unit investment outlays made in 1952-58 to unit outlays planned for 1959-65, based on the report that unit investment outlays planned for 1959-65 are 20 to 22 percent below the actual outlays of 1952-58 67/; and [footnote continued on p. 36]

25 percent of the total investment of about 30 billion rubles* in the nonferrous metals industry.

B. Average Investment Outlays

In both the USSR and Poland the planners expect that the average investment outlays per unit of capacity in their aluminum industries will be much smaller in 1961-65 than in previous years. Similar results probably are anticipated by the planners in other countries of the Bloc. Soviet planners expect that the cost for all capacity in mining, alumina refining, and aluminum reduction during 1959-65 will average about 20,000 rubles per ton, 70/ or about 20 percent below the average for 1952-58. 71/ Polish planners expect that investment outlays per ton of new capacity for aluminum reduction will average about 12,200 zlotys, or 13 percent less than the average investment outlay planned for the second section of the Skawina plant and 34 percent less than the actual average investment outlay for the first section of the Skawina plant, which was completed in 1954. 72/ A comparison of the capital outlays planned in the USSR and Poland with the average outlay in the US of about $1,700 per ton for all capacity for mining, alumina refining, and aluminum reduction (which included about $900 for a ton of capacity for aluminum reduction) indicates a ruble-dollar ratio of about 12 to 1** and a zloty-dollar ratio of about 14 to 1, expressed in 1958 prices.

The reduction in the average investment outlays planned by the USSR is to be accomplished by the construction of large strip mines and of plants having larger capacities; by the installation of larger equipment and of less expensive rectifiers; and by the expansion of capacities of existing plants, particularly by modernization. The installation of large reduction cells alone, according to a Soviet publication, reduces the investment cost 12 to 13 percent. 73/ The planned reduction in the

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C = 320,000 tons, the increment in production achieved in 1952-58. Production in 1958 was about 510,000 tons, as shown in Table 1, p. 6, above. Production in 1951 was estimated to have been about 190,000 tons, by assuming that production increased at the constant rate of 24.5 percent between 1950, when production was 155,000 tons (see Table 1, p. 6, above), and 1954, when production was about 370,000 tons, or 2.4 times production in 1950. 68/

* The derivation of this figure is based on the information that the total investment in the nonferrous metals industry planned for 1959-65, 55 billion rubles, is 1.8 times the investment for 1952-58. 69/

** This ratio was calculated by assuming that the 1958 ruble prices did not differ appreciably from the 1955 ruble prices.

average investment outlays per unit of capacity in Poland, and probably in other countries of the Bloc, reflects similar anticipated savings.

The reductions in average investment outlays for new capacity may be realized during 1961-65, but the reductions probably will not be so large as the Bloc planners anticipate. In the USSR, for example, the planned reduction rests in significant measure on investment costs for several large plants under construction in the eastern regions. For example, the average investment outlay for one of these, the Krasnoyarsk plant, is expected to be 17 to 25 percent below that for other plants under construction and 50 percent below that for existing plants. 74/ Because the construction work in the eastern regions is retarded by many problems, the expectation of such lower investment costs in those regions is considered to be visionary.

V. Trends in the Average Cost of Production

The average cost of producing aluminum probably will decrease in the Bloc during 1961-65, continuing the estimated general trend of 1950-60, but the reductions probably will not be so large as planned. The reduction projected for 1961-65 should result mainly from investment in more efficient equipment and modernization, from improvements in the quality of materials, from lower transportation costs brought about by better juxtaposition of plants and sources of supply, and from generally lower unit costs of power and fuel. Most of these factors also contributed to the reduction of costs achieved during 1950-60.

A. 1950-60

The average cost of producing aluminum in the Bloc is believed to have decreased generally during 1950-60. In the USSR the average cost decreased 30.5 percent during 1950-55 75/ and apparently continued to decrease generally during 1956-60.* From the limited evidence of increasing efficiency during that period, 77/ it is estimated that the average cost of producing aluminum decreased generally during 1950-60 in the European Satellites and in Communist China but that the reductions were not large.

In the USSR by 1958 the average cost of production was much lower for aluminum than for several other major nonferrous metals. In that year the average cost of producing a ton of aluminum was reported to be about 90 percent of that for copper, 65 percent of that for lead, and 5 percent of that for tin. 78/**

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* The estimate that average costs decreased during 1956-60 is based on numerous reports in the Soviet press of rising efficiency in the Soviet aluminum industry during 1956-58, particularly with respect to consumption of electric power, and on the report that average costs decreased during 1959-60. 76/

** The relative cost of producing aluminum apparently was even less than is indicated in this comparison. One of the components of the cost of producing these metals, the cost of electric power, was calculated not on the basis of the rates actually charged for the electric power but on the basis of the actual costs of producing the electric power. These actual costs are higher than the preferential rates charged to consumers of large quantities of electric power, such as aluminum reduction plants. Thus the figure for the average cost of producing aluminum used in making the comparison was greater than the actual cost of producing aluminum. These comparisons, therefore, favored copper, lead, and tin, production of which does not require large quantities of electric power.

The approximate levels of the average costs of producing aluminum in the USSR and China in 1960, together with the respective cost/US price ratios for 1960, are presented in the following tabulation:

Country	Average Cost per Ton	Cost/US Price Ratio*
USSR	4,000 rubles**	7.0 : 1
China	4,000 yuan***	7.0 : 1

The general downward trend of the average cost of producing primary aluminum in the USSR during 1950-60 came about mainly through decreased costs for alumina and electric power, each of which represents a major part (about 30 percent) of the total cost. The reduction in the cost of alumina appears to have been rather large, judging from the reported reductions in the average cost of producing alumina at individual plants.† A reduction of at least 12 percent in the cost of electric power per ton of aluminum during 1950-60 is indicated by reports on the average quantity of power consumed during 1950-59. 82/

Lower costs for alumina and electricity, in turn, were brought about by a variety of factors. The reduction in the average cost of producing alumina in the USSR during 1950-60 resulted primarily from the following: (1) lower average costs for producing bauxite, brought about principally by investment in mechanization and improvements in organization, and (2) greater efficiency in using steam and fuel,

* The US price used for deriving the ratios shown in this column is $573 a ton, based on the price of $0.26 a pound.

** This estimate is based on information presented in source 79/. The average cost apparently may have been reduced to approximately this level as early as 1957 and probably did not decrease appreciably between 1957 and 1960.

*** This figure is a rough approximation derived by using available data on the consumption of electric power in reduction, on rates for electric power, and on the proportion of the total cost represented by the cost of electric power in the Chinese aluminum industry. 80/

† The average cost of producing alumina was 29.2 percent lower at the Urals Plant and 52.1 percent lower at the Bogoslovskiy plant in 1955 than in 1950 and was 27.2 percent lower at the Dnepr plant in 1959 than in 1956. 81/

primarily because of investment in more efficient processing units. 83/ The reduction in the average quantity of electric power consumed was brought about (1) by investment in more efficient reduction cells, (2) by replacement of motor converters with more efficient mercury-arc rectifiers, (3) by improvements in the quality of the electrolyte and anodes, and (4) by improvements in operating procedures. 84/ In view of the intra-Bloc cooperation in the nonferrous metals industry, 85/ these factors are presumed to have contributed to reductions in the average cost of producing aluminum in other countries of the Bloc as well.

B. Prospects for 1961-65

Throughout the Bloc, in a continuation of the general trend of 1950-60, the plan is that the average cost of producing aluminum will be lower in 1965 than in 1960. Under the Seven Year Plan (1959-65) of the USSR the average cost of producing aluminum by 1965 is to be reduced 20 to 22 percent compared with 1958. 86/ Plans to reduce the average cost of producing aluminum in the European Satellites either have been announced or may be inferred from stated goals to reduce the cost of industrial production. 87/ The Chinese press declares that much emphasis is to be given to reducing the cost of producing aluminum. 88/

The sharp reduction planned by the USSR in the average cost of producing aluminum is predicated largely on several expected developments within the industry and on one important expected development outside the industry. Within the industry, reductions are anticipated in (1) the average quantity of electric power consumed per unit of aluminum produced, primarily through the use of improved reduction cells, rectifiers, electrolytes, and anodes 89/; (2) the average cost of producing alumina, partly through investment in modernization and equipment of advanced design and partly through exhaustive exploitation of nonbauxite ores for byproducts (for example, caustic soda, cement, and sulfuric acid) as well as alumina 90/; (3) the average cost of mining, as a result of lower labor and capital costs that are to be achieved by emphasis on strip-mining 91/; and (4) the average freight cost, reflecting fewer ton-kilometers per ton of aluminum produced (by 1965 a decrease of 30 percent is expected from the level of 1957), 92/ because of improvements in the location of plants relative to sources of ore, coal, soda, and other materials. Also, economies of scale -- from the use of more specialized types of capital and increased specialization of labor, for example -- are expected to contribute to lower costs.

The important development outside the industry is a reduction in the unit costs of electric power, fuel, and steam. This reduction reflects (1) an expected decrease in the average cost of producing fuels and electric power to result from the general shift of the fuel balance from coal toward the less costly oil and natural gas and (2) the expectation that costs of fuel, steam, and particularly electric

power in the eastern regions, where several large plants and mines are under construction, will be much lower than similar costs elsewhere in the country.

Varying combinations of the factors involved in reducing the cost of producing aluminum in the USSR also apparently are expected to bring about similar reductions in the European Satellites and Communist China. Improved operating procedures, however, probably are expected to play a greater relative role in reducing average costs in the European Satellites and in China than in the USSR.

Soviet planners apparently expect that the average cost of producing aluminum will remain below that for certain other major nonferrous metals, and at the same time they expect some changes in the cost relationships for those metals. Along with the reduction of about 21 percent* in the average cost for aluminum, a reduction of 15 percent for lead and of about 25 percent for copper is planned by 1965 compared with costs in 1958. 93/ Should these reductions be achieved, the average cost of producing aluminum in 1965 would be about 94 percent of that for copper (compared with about 90 percent in 1958) and about 61 percent of that for lead (compared with 65 percent in 1958).

The expectation of the Bloc for a reduction in the average cost of producing aluminum during 1961-65 appears in general to be optimistic. In the European Satellites, primarily because of shortcomings in the construction and modernization programs, the gains in efficiency, and hence the planned reductions in average cost, will be smaller than planned. In Communist China the average cost of producing aluminum may not change significantly by 1965 compared with costs in 1960. Production of aluminum probably will be curtailed during at least the first half of 1961-65. Such a curtailment can be expected to affect mainly the less efficient plants and to result in some small reduction in the average cost of producing aluminum. In the USSR, for several reasons, the reduction almost certainly will be much smaller than planned. First, prices to the Soviet aluminum industry for fuel and electric power probably will be higher than anticipated by the planners because costs of producing fuel and power are not likely to be so low as now foreseen. Second, efficiency in consumption of electric power in the Soviet aluminum industry probably will not rise so much as planned, for the installation of rectifiers of advanced design probably will fall short of plans because of shortages in supply. Third, planned improvements in the quality of anode materials, necessitated by increasing reliance on carbon obtained from crude oil from the Urals and Volga regions, which has a high sulfur content, will be difficult and costly to effect. Finally, the average cost of producing alumina from nonbauxite ore almost certainly will be much higher than now foreseen by Soviet planners.

* The midpoint of the planned range of 20 to 22 percent.

APPENDIX A

METHODOLOGY

The figures in Tables 1, 3, 4, and 6, rounded before presentation, were derived as follows:

1. Table 1*: Production of Primary Aluminum

   a. USSR

   1950: estimated by using the equation X = ABCD, where

   X = the level of production in 1950;
   A = 37,700 tons, production in 1937 94/;
   B = 1.59, the factor relating production in 1940 to that in 1937 95/;
   C = 1.44, the factor relating production in 1945 to that in 1940 96/; and
   D = 1.80, the factor relating production in 1950 to that in 1945. 97/

   1955: 2.77 times production in 1950. 98/

   1958: 3.3 times production in 1950. 99/

   1959: based on (1) the assumption that the increase planned for 1959 was about 16 percent, roughly the average annual rate of increase required to reach the 1965 goal, (2) the report that the 1959 production goal was met, 100/ and (3) evidence that new capacity was brought into operation during the year. 101/

   1960: based on (1) the assumption that the increase in production planned for 1960 was about 16 percent, roughly the average annual rate of increase required to reach the level of production planned for 1965; (2) the report that the level of production planned for 1960 was reached on 26 December 1960 102/; and (3) evidence in the Soviet press that new capacity was commissioned during the year. 103/

   1965 Plan: 2.8 to 3.0 times production in 1958. 104/

* P. 6, above.

b. Communist China

1955: based on (1) the prewar annual capacity of China's one plant, at Fu-shun, 15,000 tons 105/; (2) the assumption that originally the designed capacity of the plant constructed at Fu-shun in the postwar period and partly restored to operation late in 1954 106/ was the same as its capacity in the prewar period; and (3) the assumption that the plant was operating well below capacity in 1955.

1958: 71 percent of production in 1959, as indicated by the report that production in 1959 was 41.2 percent above that in 1958. 107/

1959: 108/

1960: based on (1) evidence that Communist China constructed 24 aluminum plants during 1959 109/ and (2) the estimate that each of those plants is capable of producing about 1,000 tons per year and that all of the plants were fully operational by the beginning of 1960.

1965 Plan: derived as the sum of

(1) 65,000 tons, including 40,000 tons for the Fu-shun plant and about 25,000 tons for a group of 24 small plants, assuming that no change from the levels of production reached in 1960 is planned for 1965;

(2) 145,000 tons, the production goal for five plants, including Sian, 100,000 tons; Lan-chou, 23,000 tons; Huan-pu, 10,000 tons; Ho-fei, 10,000 tons; and T'ang-shan, 2,000 tons 110/; and

(3) 40,000 tons, the estimated production goal for the plant under construction at Kuei-yang. The estimate is based on the interpretation of the term "large" used in describing the plant. 111/

c. European Satellites

(1) Czechoslovakia

1955: 112/

1958: 113/

1959: based on (a) production of 23,762 tons in the first 7 months 114/ and (b) the assumption that the average monthly production in the remaining 5 months was the same as in the first 7 months -- that is, 23,762 + (3,395 x 5) = 41,000 tons.

1960: based on the assumption that the planned level of production 115/ was achieved.

1965 Plan: 51 percent above production in 1960. 116/

(2) East Germany

1955: 117/

1958: 118/

1959: 119/

1960: based on the assumption that production in 1960 did not change substantially from that in 1959.

1965 Plan: based on (a) the estimated production of 35,000 tons in 1960 and on (b) the report that a new plant under construction at Lauta is designed to produce 20,000 tons per year. 120/

(3) Hungary

1950-59: 121/

1960: 122/

1965 Plan: 123/

(4) Poland

1955-59: 124/

1960: 125/

1965 Plan: 126/

(5) Rumania

1950-60: no production (see p. 52, below).

1965 Plan: 127/

2. Table 4*: Production of Alumina

a. USSR

1950: developed by assuming that production of alumina and requirements for alumina for production of aluminum are approximately equal. The requirement was estimated by assuming an approximate ratio of 2 to 1 for alumina to aluminum.

1955: 2.82 times production in 1950. 128/

1958: estimated requirement, derived by the same methodology used for 1950, above.

1959: developed as the sum of (1) the estimated requirement for production of aluminum (see 1950, above) and (2) 10,000 tons, the quantity exported to Poland. 129/

1960: estimated requirement, derived by the same methodology as used for 1950, above.

1965 Plan: developed as the sum of (1) the estimated requirement for production of aluminum (see 1950, above) and (2) 60,000 tons, the estimated planned export to Poland.

b. Communist China

1955: the sum of (1) 20,000 tons, the approximate requirement for production of aluminum developed by assuming a ratio of 2 to 1 for alumina to aluminum and (2) 10,000 tons, the quantity of alumina exported. 130/

1958: the sum of (1) 100,000 tons, the estimated requirement for production of aluminum (see 1955, above, for the description of the methodology) and (2) 10,000 tons, the quantity exported. 131/

1959, 1960, and 1965 Plan: the estimated requirement for production of aluminum (for the description of the methodology, see 1955, above).

* P. 12, above.

c. European Satellites

(1) Czechoslovakia

There was no production of alumina before 1959.

1959, 1960, and 1965 Plan: developed by assuming that production of alumina and requirements for alumina for production of aluminum are approximately equal. The requirement was estimated by assuming an approximate ratio of 2 to 1 for alumina to aluminum.

(2) East Germany

1955, 1958, and 1959: 132/

1960: 133/

1965 Plan: 134/

(3) Hungary

1950, 1955, 1958, and 1959: 135/

1960: 136/

1965 Plan: 137/

(4) Rumania

1950-60: no production (see p. 52, below).

1965 Plan: estimated by assuming that production of alumina and requirements for alumina for production of aluminum are approximately equal. The requirement was estimated by assuming an approximate ratio of 2 to 1 for alumina to aluminum.

3. Table 6*: Production of Aluminum-Bearing Ore

a. USSR

1950: 43 percent of the production of bauxite in 1955, as indicated by the report that production in 1955 was 2.33 times that in 1950. 138/

* P. 16, above.

1955: Bauxite: estimated production, derived by using the equation $X = [A - (B + C + D)] E$, where

X = total production of bauxite;

A = 880,000 tons, the estimated total production of alumina;

B = 65,000 tons, the estimated quantity of alumina produced from 200,000 tons of bauxite imported from Hungary, 139/ assuming an approximate ratio of 3 to 1 for ore to alumina;

C = 35,000 tons, the estimated quantity of alumina produced from 122,000 tons of bauxite imported from Greece, 140/ assuming an approximate ratio of 3.5 to 1 for ore to alumina;

D = 30,000 tons, the estimated quantity of alumina produced from nepheline concentrate (see Nepheline concentrate, below);

E = 3.5, the estimated ratio of bauxite to alumina.

Nepheline concentrate: estimated by using the equation $X = (A \div B) C$, where

X = the requirement for nepheline concentrate at the Volkhov Aluminum Plant, the only Soviet aluminum plant using this material for production of alumina;

A = 300,000 tons, the quantity of cement produced by the Volkhov plant 141/;

B = 9, the ratio of the quantity of cement produced to the quantity of alumina produced at the Volkhov plant 142/; and

C = 4, the approximate ratio of nepheline concentrate to alumina. 143/

1958: Bauxite: estimated production, derived by using the equation $X = [A - (B + C)] D$, where

X = total production of bauxite;

A = 1.03 million tons, the estimated quantity of alumina produced;

B = 130,000 tons, the estimated quantity of alumina produced from 450,000 tons of bauxite imported from Greece, 144/ assuming an approximate ratio of 3.5 to 1 for ore to alumina;

C = 40,000 tons, the estimated quantity of alumina produced from nepheline concentrate at the Volkhov plant. This estimate was derived by interpolating between production estimated for 1955, about 30,000 tons, and for 1960, about 50,000 tons.

D = 3.5, the approximate ratio of bauxite to alumina.

Nepheline concentrate: estimated quantity required for production of 40,000 tons of alumina, using the ratio of 4 to 1 for concentrate to alumina.

1959: Bauxite: estimated production, derived by using the equation $X = [A - (B + C)] D$, where

X = total production of bauxite;

A = 1.21 million tons, the estimated production of alumina;

B = 130,000 tons, the estimated quantity of alumina produced from 454,000 tons of bauxite imported from Greece, 145/ assuming an approximate ratio of 3.5 to 1 for ore to alumina;

C = 60,000 tons, the estimated quantity of alumina produced from nepheline concentrate, including 50,000 tons by the Volkhov plant and 10,000 tons by the Pikalevo plant;

D = 3.5, the approximate ratio of bauxite to alumina.

Nepheline concentrate: estimated quantity required for production of 60,000 tons of alumina, using the ratio of 4 to 1 for concentrate to alumina.

1960: Bauxite: estimated production, derived by using the equation X = [A - (B + C)]D, where

X = total production of bauxite;

A = 1.4 million tons, the estimated production of alumina;

B = 120,000 tons, the estimated quantity of alumina produced from 432,000 tons of bauxite imported from Greece, 146/ assuming an approximate ratio of 3.5 to 1 for ore to alumina;

C = 100,000 tons, the estimated production of alumina from nepheline concentrate. This figure includes 50,000 tons for the Volkhov plant, estimated on the basis of (1) the assumption that the designed capacity of that plant was about 30,000 tons, or about the same as the level of production reached in 1955 and (2) the report that production in 1960 exceeded the designed capacity by 70 percent. 147/ The remaining 50,000 tons is the estimated production of the Pikalevo plant.

D = 3.5, the approximate ratio of bauxite to alumina.

Nepheline concentrate: estimated quantity required for production of 100,000 tons of alumina, using the ratio of 4 to 1 for concentrate to alumina.

1965 Plan: Bauxite: estimated goal for production of bauxite, derived by using the equation X = (A - B) C, where

X = total production of bauxite;

A = 2.9 million to 3.1 million tons, the estimated goal for the total production of alumina;

B = 600,000 to 700,000 tons, the estimated quantity of alumina to be produced from nonbauxite ore. This figure is the sum of the estimated levels of production planned for the plants at Volkhov, Pikalevo, Razdan, and Achinsk that are to process nepheline and for the plant at Kirovabad that is to process alunite. The level of production planned at each of these alumina plants was estimated on the basis of the alumina requirement estimated

for the reduction plant identified as the intended consumer.

C = 3.5, the approximate ratio of ore to alumina.

Nonbauxite ore: estimated production, based on (1) the estimated level of production of alumina from nonbauxite ore planned for 1965, about 650,000 tons,* and (2) an approximate ratio of 5 to 1 for ore to alumina. The basis for using this ratio is the estimate that the average ratio of ore to alumina for the four nepheline processing plants will be in the range of 4 or 5 to 1, close to the actual ratio reported for the Volkhov plant, and the information that for alunite the ore to alumina ratio is 6.7 to 1. 148/

b. Communist China

Estimated production of aluminum-bearing ore, developed by assuming that production of ore and the requirement for ore for production of alumina are approximately equal. The requirement was developed by assuming an approximate ratio of 3.5 to 1 for ore to alumina, based on the information presented in source 149/.

c. European Satellites

(1) Hungary

1950, 1955, 1958, and 1959: 150/

1960: 151/

1965 Plan: 152/

(2) Rumania

Plan for production of bauxite in 1965, developed by assuming that production of ore and the quantity of ore required to achieve the level of production of primary aluminum planned for 1965, 20,000 to 30,000 tons, are approximately equal. The requirement was calculated by using an approximate ratio of 7 to 1 for ore to aluminum.

During 1950-60, bauxite was produced by Rumania. For a lack of evidence that the Rumanian ore was used in production of

* The midpoint of the estimated planned range of 600,000 to 700,000 tons.

aluminum, however, this production (most of which was exported) was not included in the Bloc totals but is shown for selected years during 1950-60 in the following tabulation (in metric tons) 153/:

1950	1955	1958	1959	1960
5,000	37,000	73,000	71,000	88,000

4. Table 3*: Production of Aluminum in the Sino-Soviet Bloc, by Plant, 1960

a. USSR

(1) Urals and Bogoslovskiy Aluminum Plants

Production by the two plants in the Urals (X) was estimated by using the equation X = ABCD, where

A = 490,000 tons, Soviet production of aluminum in 1957, or 13.2 percent above production in 1955 154/ (for production in 1955, see Table 1, p. 6, above).

B = 0.45, the approximate proportion of total production in 1957 contributed by the two plants in the Urals. One report stated that those plants contributed almost one-half of the total Soviet production, 155/ and another that they contributed more than 40 percent, 156/ in that year;

C = 1.055, the ratio of production in the Urals in 1959 to that in 1957, according to source 157/; and

D = 1.0, the ratio expressing the assumption that production in 1960 did not differ appreciably from that in 1959.

A slightly larger share of production in the Urals in 1960 was assigned to the Bogoslovskiy plant on the basis of a report that it was the larger of the two plants in the Urals Region. 158/

* P. 8, above.

(2) Stalinsk* Aluminum Plant

Production was estimated on the basis of (a) the assumption that production of this plant in 1959 was about as large as that of the Bogoslovskiy plant, or about 120,000 tons (see Table 3, p. 8, above); and (b) the report that production increased 31.2 percent in 1960, compared with 1959. 159/

The capacity of the new potline is estimated to be about 60,000 tons and the capacity of the plant at the end of 1960 about 180,000 tons, from (a) the assumption that the capacity of the Stalinsk plant at the beginning of 1960 was about 120,000 tons; (b) the estimated increase in production in 1960, about 40,000 tons; and (c) the commissioning of the first building of a new potline about mid-November 1959 and the second building of the new potline about mid-October 1960. 160/

(3) Stalingrad** Aluminum Plant

Production was estimated on the basis of (a) the assumption that this plant, which began operating at the beginning of 1959, 161/ accounted for about 50,000 tons of production in that year, or the bulk of the estimated increase in national production, about 90,000 tons (see Table 1, p. 6, above); and (b) the report that production in 1960 was twice that in 1959. 162/

If the estimate of 100,000 tons is reasonably close to the actual production of the plant in 1960, the evidence that there was brought into operation during the year a new potline, made up of one building commissioned in October and another in December, 163/ suggests that the capacity of the Stalingrad plant at the end of the year was in the range of 150,000 to 200,000 tons.

(4) Dnepr Aluminum Plant

Production was estimated (a) by assuming that this plant processed all of the 432,000 tons of bauxite imported from Greece in 1960 (see p. 13, above) and (b) by assuming an approximate ratio of 7 to 1 for Greek bauxite to aluminum.

* In November 1961, Stalinsk was renamed Novokuznetsk.
** In November 1961, Stalingrad was renamed Volgograd.

(5) Volkhov Aluminum Plant

Production of aluminum by this plant was estimated on the basis of (a) the estimated production of alumina by the plant in 1960, about 50,000 tons (see p. 50, above); (b) the assumption that all alumina used by the plant was obtained from its own alumina department; and (c) an approximate ratio of 2 to 1 for alumina to aluminum.

(6) Kanaker, Kandalaksha, Nadvoitsy, and Sumgait Aluminum Plants

The sum of the estimates of production by these four plants, about 125,000 tons, is calculated as a residual. The approximate distribution of this sum among these four plants was made as follows:

At the beginning of 1959 the Sumgait plant apparently had one potline in operation, the annual capacity of of which is assumed to be about 30,000 tons. A new potline, composed of one building commissioned early in June 1959 and another commissioned late in November 1959, 164/ is estimated to have an annual capacity approximately the same as the older potline, or about 30,000 tons. The combined period of operation by the two sections of the new potline is roughly equal to operation at full capacity of the entire potline for about 4 months, so that production in 1959 by the new potline can be estimated to have been about 10,000 tons and the total production by the plant about 40,000 tons. Planned production in 1960, 53.8 percent above production in 1959, 165/ or about 60,000 tons, was reported to have been achieved. 166/

The remaining 65,000 tons of the residual were distributed equally among the other three plants. New capacity was to be commissioned at the Nadvoitsy plant during 1960, 167/ but the commissioning had not been reported as of the end of 1960. Because of this delay, it is assumed that the new capacity at Nadvoitsy was not commissioned until after the end of the year.

b. Communist China

(1) Fu-shun Aluminum Plant

All production in Communist China in 1957, 39,700 tons, 168/ was accounted for by the Fu-shun plant. The capacity of this plant apparently has not changed since 1957.

(2) Others

The figure for the remaining plants is the residual but is not distributed among them.

c. European Satellites

(1) Hungary

(a) Ajka Aluminum Plant 169/

(b) Tatabanya Aluminum Plant 170/

(c) Inota Aluminum Plant

Production estimated as the residual.

(2) East Germany

All production of aluminum in the country was accounted for by the VEB Kombinat Bitterfeld.

(3) Czechoslovakia

All production of aluminum in the country was accounted for by the Ziar plant.

(4) Poland

The Skawina plant accounted for all production in the country. At the end of the year the annual capacity of this plant apparently was about twice that at the beginning of the year, 171/ or about 46,000 tons.

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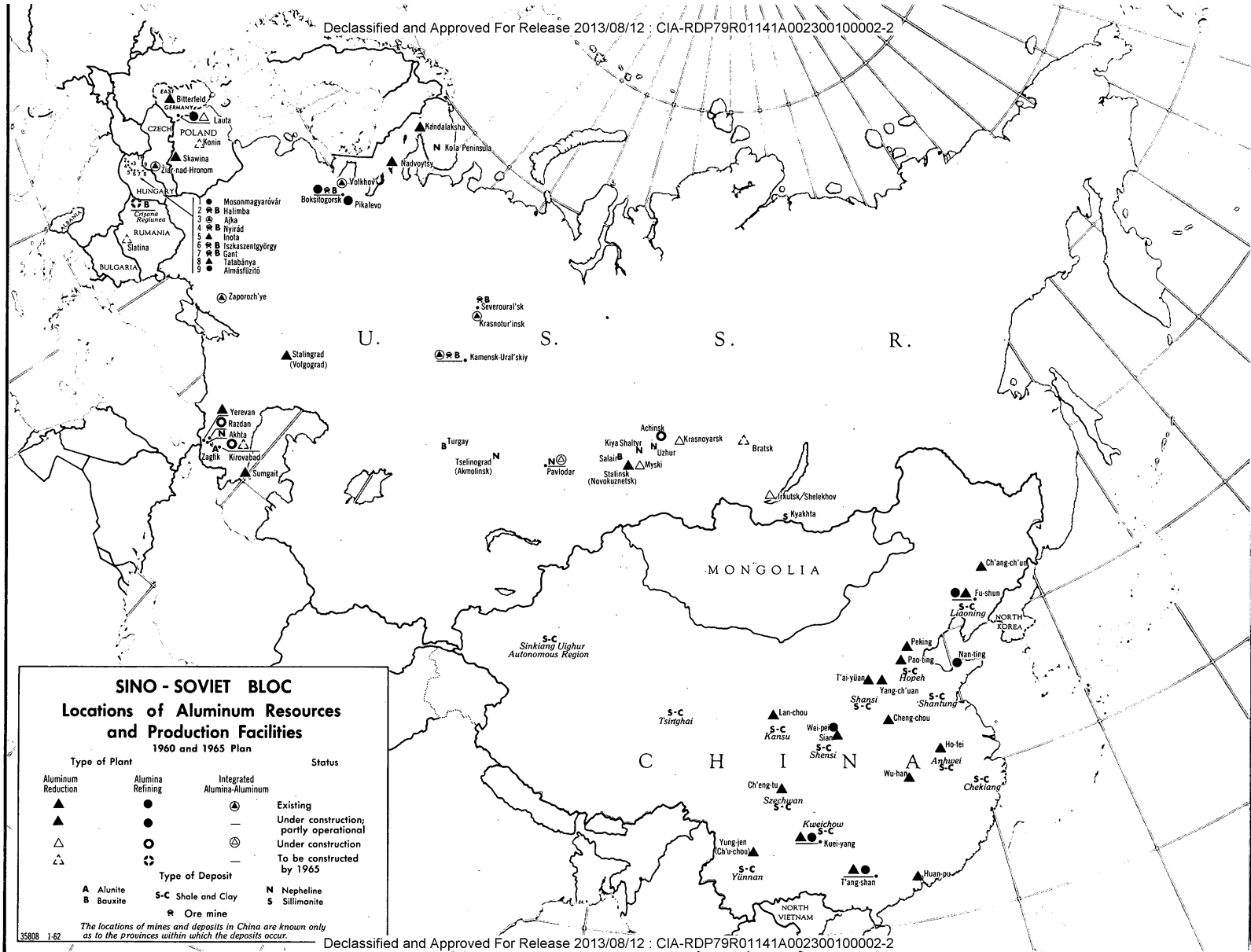

SINO - SOVIET BLOC
Locations of Aluminum Resources and Production Facilities
1960 and 1965 Plan

Type of Plant

Aluminum Reduction	Alumina Refining	Integrated Alumina-Aluminum	Status
▲	●	◬	Existing
▲	●	—	Under construction; partly operational
△	○	◬	Under construction
△	✪	—	To be constructed by 1965

Type of Deposit

A Alunite
B Bauxite
S-C Shale and Clay
N Nepheline
S Sillimanite
Ore mine

The locations of mines and deposits in China are known only as to the provinces within which the deposits occur.

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