

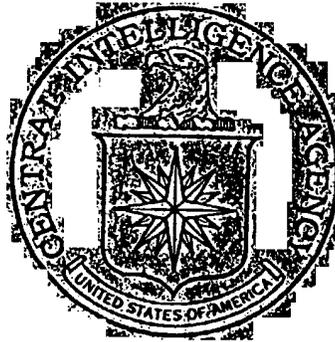
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ECONOMIC INTELLIGENCE REPORT

THE SODA ASH
AND CHEMICAL CAUSTIC SODA INDUSTRY
IN THE USSR

CIA HISTORICAL REVIEW PROGRAM
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CIA/RR 29

(ORR Project 22.4.1)

CENTRAL INTELLIGENCE AGENCY

Office of Research and Reports

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FOREWORD

Caustic soda may be produced by either of two basic processes -- the electrolytic, in which caustic soda is produced by the electrolysis of brine, with chlorine as a coproduct, or the chemical, in which it is produced by the chemical conversion of soda ash. The USSR produces substantial quantities of caustic soda by the electrolytic process. It is estimated that Soviet production by this process in 1950 was between 170,000 and 180,000 metric tons, which would represent about 60 percent of the total production of caustic soda in the USSR for that year. This phase of the industry was discussed in CIA/RR PR-4, The Caustic Soda and Chlorine Industries in the USSR, 12 December 1951, S, and is not considered in this report.

Soviet production of caustic soda obtained by the chemical process and Soviet production of soda ash are discussed together in this report because of their close relationship in the chemical industry.

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THE SODA ASH AND CHEMICAL CAUSTIC SODA INDUSTRY IN THE USSR*

Summary

The production of soda ash and the production therefrom of chemical caustic soda are essential to a diversified economy. Soda ash is used in large quantities not only in the production of chemical caustic soda but also in the manufacture of glass, alumina, and a variety of other uses. Both soda ash and caustic soda are used in the manufacture of soaps, cleansers, paper textiles, and film. Caustic soda is used in the manufacture of rayon and various petroleum products. The total supply of soda ash in the USSR in 1953 is estimated to be approximately 1 million tons,** of which 945,000 tons are domestic production and 55,000 tons are imports. The total supply of chemical caustic soda in the USSR in 1953 is estimated to be 160,000 tons, of which 155,000 tons are estimated to be domestic production and 5,000 tons are estimated to be imports. The manufacture of 155,000 tons of chemical caustic soda requires 217,000 tons of soda ash, leaving 783,000 tons of soda ash for other uses.

The principal raw materials consumed in the manufacture of the 945,000 tons of soda ash produced in the USSR in 1953 have been estimated to be as follows: salt, 1,640,000 tons; limestone and chalk, 1,215,000 tons; 100 percent ammonia, 4,600 tons; anthracite coal, 110,000 tons; bituminous coal, 115,000 tons; and mazut (residual fuel oil), 35,000 tons. The principal raw materials consumed in the manufacture of the 155,000 tons of chemical caustic soda produced in 1953 have been estimated to be as follows: soda ash, 217,000 tons; limestone, 96,000 tons; bituminous coal, 30,000 tons; and mazut, 35,000 tons.

The estimates of production of soda ash and chemical caustic soda made in this report indicate that the USSR failed to meet planned production goals in 1950 and may fail in 1955. A serious shortage of these commodities existed after World War II, but this situation was to have

* This report contains information available as of 1 October 1953.

** Tonnages throughout this report are given in metric tons.

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been alleviated by the Fourth Five Year Plan (1946-50). Failure to achieve this Plan would seem to indicate that conditions of short supply continue to exist. The 1953 estimated supply of soda ash of 1 million tons and of chemical caustic soda of 160,000 tons was probably sufficient to meet all necessary requirements under conditions of closely controlled allocation. If the new plant at Berezniki starts production, the shortage will be greatly relieved. Direct military requirements of these commodities are not great, and it is believed that the USSR has sufficient domestic production of soda ash and chemical caustic soda to sustain a prolonged war effort.

The USSR is self-sufficient in the production of soda ash and chemical caustic soda, and the industry is, therefore, not subject to economic warfare. Although this industry is physically an ideal target for bombing, it is not believed that it is strategically important enough to justify extended bombing.

It is not considered likely that any conclusions regarding Soviet intentions can be drawn from the soda ash and chemical caustic soda industry, because of the nearly complete lack of information concerning the allocation of these commodities in the USSR.

I. Introduction.

Soda ash (Na_2CO_3 , sometimes termed calcined soda or sodium carbonate) and caustic soda (NaOH) are two important basic heavy chemicals, and they are essential to the manufacture of a wide variety of industrial products. Both commodities find extensive use as alkalies in the manufacture of chemical end products, petroleum products, alumina for the production of aluminum, soaps and cleansers, pulp and paper, textiles, and reclaimed rubber. In addition, large quantities of soda ash are consumed in the manufacture of glass and in the manufacture of chemical caustic soda. One of the largest uses for caustic soda is in the manufacture of viscose rayon.

The production of soda ash in the US in 1951 was about 4,950,000 tons, and the production of caustic soda was about 3,410,000 tons,

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of which approximately 790,000 tons were chemical caustic soda. 1/* In a typical consumption pattern of the production of soda ash in the US, 2/ approximately 28 percent would be used in the manufacture of glass, 24 percent in the manufacture of caustic soda and sodium bicarbonate, and 22 percent in the manufacture of other chemicals. The remaining production would be used in the manufacture of the following products: pulp and paper, nonferrous metals, soaps, cleansers and modified sodas, water softeners, textiles, and petroleum. A similar breakdown of the consumption pattern of caustic soda in the US 3/ would reveal that approximately 22 percent would be used in the manufacture of other basic chemicals, 22 percent in the manufacture of rayon and film, 8 percent in the refining of petroleum, and 7 percent in the manufacture of pulp and paper. About 6 percent of the production is used in the manufacture of lye and cleansers, 6 percent in the manufacture of soap, and 5 percent in the manufacture of textiles. The remaining production is accounted for by small quantities used in the reclamation of rubber, the preparation of vegetable oils, and export.

Soda ash is a white to grayish-white powder which may easily be shipped in bulk in boxcars, in barrels, or in paper bags. Caustic soda, on the other hand, is available commercially in both solid and liquid (solution) forms and must be protected during shipment from the action of the moisture and carbon dioxide in the air. Solid caustic soda is transported in drums and barrels, whereas liquid caustic soda is generally shipped in tank cars or drums. Both soda ash and caustic soda are available in various concentrations suitable for industrial use.

Before 1947 the plants producing soda ash and chemical caustic soda in the USSR were subordinate to the Main Administration of Basic Chemistry (Glavkhimprom) of the Ministry of the Chemical Industry (prior to 1946, the Peoples' Commissariat of the Chemical Industry). 4/ In 1947, however, the Main Administration of the Soda Industry (Glavsoda) was established within the Ministry and presumably took over control of the soda plants. 5/ The existence of the Main Administration of the Soda Industry was confirmed as late as May 1951, and the Administration is presumed to be still operating. 6/

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

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II. Technology.

1. Ammonia, or Solvay, Process for the Production of Soda Ash.

At present the only process of commercial importance for the production of soda ash in the USSR is the ammonia, or Solvay, process, which has now largely displaced the older LeBlanc process throughout the world. In the Solvay process, first ammonia and then carbon dioxide are passed through a saturated salt brine to form a precipitate of sodium bicarbonate and a solution of ammonium chloride. These steps take place in large ammonia-absorbing towers and carbonating towers. The carbon dioxide is produced by heating limestone or chalk in lime kilns to produce carbon dioxide and calcium oxide (lime). The sodium bicarbonate is filtered and calcined to produce soda ash and carbon dioxide. The carbon dioxide is then returned to the carbonating towers, and the soda ash is further processed to commercial specifications. The ammonium chloride solution is treated with slaked lime (calcium hydroxide) to produce ammonia and calcium chloride. The ammonia is returned to the absorbers and the calcium chloride is either sold or thrown away.

Although production methods in the USSR are comparable to those in this country, apparently the operation of the plants is not so efficient. Soviet consumption of ammonia per ton of soda ash varies from 2 to 10 times that in US practice. The consumption of salt is also noticeably higher in the USSR, about 1.78 tons of salt per ton of soda ash as compared to 1.5 tons in the US. 7/ An internationally known expert, who had an opportunity to confer in 1949 with several Soviet engineers concerned with the production of soda ash, reached the conclusion that the Soviet engineers were "third rate" and that the USSR was in 1949 technically inferior to the US in the production of soda ash. 8/

Technical standards for soda ash in the USSR are given in Table 1.* 9/

2. Production of Natural Soda Ash.

Natural soda ash is extracted from several Siberian lakes in the Kulunda Steppes and Transbaikal regions. The extraction is a relatively simple process because in the winter the soda settles

* Table 1 follows on p. 5.

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Table 1

Technical Standards for Soda Ash a/
in the USSR (OST-4892) b/

<u>Factor</u>	<u>Percent</u>
Soda Ash (Na_2CO_3) (Not Less Than)	98 <u>c/</u>
Salt (NaCl) (Not Less Than)	1 <u>c/</u>
Sodium Sulfate (Na_2SO_4) (Not More Than)	0.1
Weight Loss After Calcination	4

a. After calcination in a double crucible.

b. OST is the Russian abbreviation for Obshchesoyuznyy Standart (All-Union Standard).

c. Soda ash produced in the US generally contains about 99 percent soda ash and 0.4 to 0.6 percent salt.

in solid form to the bottom of the lake and is then extracted. Little purification of the solid is undertaken, and therefore a low-quality product results. 10/

3. Ferrite, or Levig, Process for the Production of Chemical Caustic Soda.

Until the postwar years, the ferrite, or Levig, process was the principal method for the production of chemical caustic soda in the USSR. This process is not generally used in other countries, because it has been replaced by the more economical lime-soda process. Since 1946 the USSR has begun to employ the lime-soda process, but even now it is believed that at least three plants, Donsoda at Verkhneye, the Voroshilov Chemical Combine at Berezniki, and the New

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Slavyansk Soda Plant, still manufacture chemical caustic soda by the obsolete ferrite method. 11/ Judging from Soviet postwar statements, it is probable that these plants eventually will undergo conversion to the lime-soda process. 12/

Production of chemical caustic soda by the ferrite process as practiced in the USSR is accomplished by calcining a mixture of 3 parts of ferric oxide to 1 part of soda ash in a large rotating furnace, or tambour, at a temperature of 1,000° to 1,200°C to give a melt of sodium ferrite (NaFeO_2). The sodium ferrite is then decomposed in hot water to form a solution of caustic soda and a precipitate of ferric oxide. The oxide is returned for use in the calcining furnaces, and the caustic soda solution is concentrated and purified. 13/

Considerably more fuel is used in the ferrite process than in the modern lime-soda process. By 1946 this disadvantage had been recognized by the Russians, as evidenced in an article on the caustic soda industry which stated that it would be necessary to change over from the antiquated ferrite process to the lime-soda process, which was more economical in respect to expenditure of fuel. 14/ No evidence of any such change has been found at plants already employing the ferrite process. It is probable, however, that any new plants under construction, such as that at Sterlitamak and the new unit at Berezniki, will be equipped for production by the lime-soda process.

4. Lime-Soda Process for the Production of Chemical Caustic Soda.

In the lime-soda process, a solution of soda ash is treated with slaked lime to yield a precipitate of calcium carbonate and a solution of caustic soda. This solution is then filtered and concentrated to various commercial strengths or evaporated to give solid caustic soda. This process is relatively simple, and it may be assumed that Soviet technology is comparable to that of the US or Western Europe.

In the USSR, caustic soda must satisfy the requirements given in Table 2.* 15/

* Table 2 follows on p. 7.

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Table 2

Technical Standards for Caustic Soda
in the USSR (GOST 2263-43) a/

Factor	Percent			
	Solid Caustic Soda <u>b/</u>		Liquid Caustic Soda <u>b/</u>	
	Grade A	Grade B	Grade C	Grade D
Caustic Soda (Not Less Than)	95	92	<u>c/</u>	<u>c/</u>
Soda Ash (Not More ^{More} Than)	3	4	2	4
Sodium Chloride (Not More Than)	1.5	3.75	4	2
Oxides of Iron, Aluminum, and Manganese (Not More Than)	0.03	<u>d/</u>	<u>d/</u>	<u>d/</u>
Iron as Ferric Oxide (Not More Than)	<u>d/</u>	0.2	0.2	0.2
Color	<u>e/</u>	<u>f/</u>		

- a. GOST is the Russian abbreviation for Gosudarstvennyy Obshchесо-
yuznyy Standart (State All-Union Standard).
b. Solid caustic soda produced in the US generally contains 98 per-
cent caustic soda, 1.2 percent soda ash, and only 0.2 percent salt.
Liquid caustic soda produced in the US varies considerably in concen-
tration but in general is comparable with Soviet standards.
c. Six hundred and ten grams per liter.
d. Not determined.
e. Bluish color allowed.
f. Color shade allowed.

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III. Supply.

1. Production.

a. 1913-27.

During the period 1913-27 there were three soda ash plants operating in the USSR. The plant at Berezniki was finished in 1883, the plant at Verkhneye in 1892, and the plant at Slavyansk in 1899. By 1913 these plants were turning out about 160,000 tons of soda ash and 50,000 to 55,000 tons of chemical caustic soda per year. 16/ During World War I and the ensuing civil war, production dropped until 1919, when only 4,000 tons of soda ash were produced, all of which came solely from the natural soda lakes of Siberia, because all 3 chemical plants were inoperative. Production steadily increased after 1919, and in 1927 the USSR produced 179,000 tons of soda ash. The production of chemical caustic soda in 1927 is not known but probably was about equal to the 1913 level of 50,000 to 55,000 tons. No additional plants for the production of soda ash or chemical caustic soda were constructed during this period. The following figures for the production of soda ash from 1913 to 1927 have been published by the USSR 17/:

<u>Year</u>	<u>Production (Thousand Tons)</u>
1913	160
1914	157
1915	128
1917	102
1918	19
1919	4
1920	11
1922	37
1923	61
1924	83
1925	108
1927	179

b. First, Second, and Third Five Year Plans (1928-42).

During the period of the First Five Year Plan (1928-32), Krasnyy Khimik No. 23 at Slavyansk was enlarged and re-equipped, and

by 1936 it was producing at its present rate of 60,000 to 70,000 tons a year. 18/ Both the Donsoda (Donets Soda) Plant at Verkhneye and the Voroshilov Chemical Combine at Berezniki were greatly enlarged during the first 2 Five Year Plans, and by 1937 they were producing soda ash at an annual rate of 375,000 tons and 100,000 tons respectively. Thus the pre-World War I production of soda ash at the Donsoda Plant had been quadrupled by 1937 and that of the Voroshilov Chemical Combine increased to 2.5 times the prewar level. 19/ During the same period, the production of chemical caustic soda at these 3 plants increased from about 64,000 tons in 1929 to about 100,000 tons in 1940. 20/ Although this increase is not so great as that shown by soda ash, it must be borne in mind that during the 1930's a great many electrolytic caustic soda plants were constructed, so that by 1940 as much electrolytic as chemical caustic soda was being produced.

In 1936, construction of a fourth soda ash and chemical caustic soda plant, the New Slavyansk Soda Plant, was started at Slavyansk. This plant was to be completed by the end of the Third Five Year Plan (1938-42) and was to contribute to the planned increase of 218 percent of the production of soda ash during this period. In addition, 3 smaller soda ash plants were to be built during this period, 1 in the Urals and 2 in the Baku area. 21/ The outbreak of war in June 1941 prevented completion of the New Slavyansk Soda Plant. The equipment and machinery were moved to storage in the Urals to prevent destruction. As far as the 3 smaller plants are concerned, no evidence is available to indicate that construction was even started. Production of soda ash during the period of the Third Five Year Plan increased only slightly over the previous years and decreased substantially in 1941 and 1942 after the war started. The production of soda ash in the USSR from 1928 to 1940 was as follows 22/:

<u>Year</u>	<u>Production</u> <u>(Thousand Tons)</u>	<u>Year</u>	<u>Production</u> <u>(Thousand Tons)</u>
1928	212	1935	422
1929	238	1936	505
1930	270	1937	517
1931	275	1938	536
1932	288	1939	550
1933	331	1940	530
1934	398		

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The 218-percent increase in the production of soda ash predicted by the Third Five Year Plan indicated a planned production in 1942 of 1,125,000 tons. By 1940 this very optimistic figure had been discarded, and the 1941 State Plan called for a production in that year of only 673,000 tons of soda ash, 650,000 tons of which were to be produced by the Peoples' Commissariat of the Chemical Industry and 23,000 tons by the Peoples' Commissariat of Nonferrous Metallurgy and by local industry. The 23,000 tons probably represent the planned production of the natural soda installations in Siberia. With the advent of war in 1941, even this modest goal was not achieved. By the fall of 1941 the German armies had overrun the plants at both Verkhneye and Slavyansk, eliminating 75 to 80 percent of the soda ash capacity of the USSR.

c. World War II (1941-45).

Production of soda ash and chemical caustic soda in the first 3 quarters of 1941 probably was at about the same rate as in 1940: that is, 530,000 tons of soda ash per year and 100,000 tons of chemical caustic soda per year. In the fourth quarter of 1941, however, the only producing units in the USSR were the plants at the natural soda lakes of Siberia, and the Voroshilov Chemical Combine at Berezniki. The combined production of these remaining plants probably did not exceed 130,000 tons of soda ash per year, or about 105,000 tons from the Voroshilov Chemical Combine, and 25,000 tons from the plants at the natural soda lakes. Production of chemical caustic soda at the Voroshilov Chemical Combine in 1941 was at a rate of about 45,000 tons a year, while that at the plants at the natural soda lakes was probably between 1,000 and 5,000 tons.* Soviet production of soda ash in 1941 may be estimated, therefore, at 430,000 tons and the production of chemical caustic soda at 87,000 tons. Production of these commodities in 1942 and 1943 is estimated to have been 130,000 tons of soda ash and 48,000 tons of chemical caustic soda. By late 1943 and early 1944 the Donsoda Plant at Verkhneye and Krasnyy Khimik No. 23 at Slavyansk were again in Soviet hands, and by the fall of 1944 Donsoda was producing soda ash at the rate of 75,000 tons per year. 23/ Krasnyy Khimik No. 23, however, did not resume operations until late in 1946 and then only on a limited scale. It is believed that the chemical caustic soda department of Donsoda did not resume operations until 1946, and that of Krasnyy Khimik No. 23 until 1947. The production of soda ash in 1944 may be estimated, therefore, to have been 150,000 tons, and the production of chemical

* See plant studies, Appendix A.

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caustic soda to have been 48,000 tons. Thus, calculating from plant output and assuming that the plant at Verkhneye increased its rate of production during that year, Soviet production of soda ash in 1945 was somewhat over 205,000 tons, and the production of chemical caustic soda remained at 48,000 tons.

The shortage of chemical caustic soda in the USSR during the war was partially alleviated by Lend-Lease shipments of approximately 90,000 tons between 1941 and 1945. Only 2,000 tons of soda ash were shipped. 24/

d. Fourth Five Year Plan (1946-50).

The published goal of the Fourth Five Year Plan was to increase the production of soda ash to 800,000 tons per year by 1950. The production of caustic soda was to be increased to 390,000 tons a year by 1950, but no breakdown between electrolytic and chemical caustic soda was given. This Plan was to be accomplished by completing the reconstruction of the damaged plants at Verkhneye and Slavyansk, by finishing the construction of the New Slavyansk Soda Plant, and by building a completely new plant at Sterlitamak (name not available) in the Urals. The plant at Sterlitamak was to have an ultimate capacity of 400,000 tons of soda ash per year, with a rate of 200,000 tons to be achieved by 1950. 25/ In addition, work was to be started on a second new plant at Berezniki in the Urals.

The reported yearly percentages of increase in the production of soda ash and caustic soda (both chemical and electrolytic) are given in Table 3.*

Assuming that these reported increases are reasonably accurate, then only 1 year's production need be known in order to provide a series for the complete Plan period. The production in 1949 can be arrived at from plant studies. Donsoda at Verkhneye and Krasnyy Khimik No. 23 at Slavyansk were producing at full postwar rate by 1949. The Voroshilov Chemical Combine at Berezniki and the natural soda plants probably continued to produce throughout the postwar period at about 130,000 tons per year. On the basis of the plant study in Appendix A, it is estimated that the New Slavyansk Soda Plant turned out about 100,000 tons of soda ash in 1949. The new plant at Sterlitamak was not planned until 1950, so that it

* Table 3 follows on p. 12.

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Table 3

Reported Percentage Increase
in the Production of Soda Ash and Caustic Soda a/ in the USSR
over the Preceding Year
1946-50

	Percent				
	<u>1946</u>	<u>1947</u>	<u>1948</u>	<u>1949</u>	<u>1950</u>
Soda Ash	109 <u>26/</u>	121 <u>b/ 27/</u>	144 <u>28/</u>	131 <u>29/</u>	117 <u>30/</u>
Caustic Soda <u>31/</u>	109	125 <u>b/</u>	125	127	115

a. Both chemical and electrolytic caustic soda.

b. Based on the average of the reported increases for the first three quarters of 1947.

need not be considered in an estimate for 1949. The total estimated production for 1949 is, therefore, as follows:

<u>Plant</u>	<u>1949 Production</u> <u>(Thousand Tons)</u>
Donsoda	265
Krasnyy Khimik No. 23	65
New Slavyansk Soda Plant	100
Voroshilov Chemical Combine	105
Subtotal	<u>535</u>
Natural Soda	25
Total	<u>560</u>

By using this estimated figure with the reported percentage increases given in Table 3, the estimated production of soda ash in 1945 and during the Fourth Five Year Plan can be computed as follows:

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<u>Year</u>	<u>Production (Thousand Tons)</u>
1945	225 (203 to 247)*
1946	245 (220 to 270)
1947	297 (267 to 327)
1948	427 (384 to 470)
1949	560 (504 to 616)
1950	655 (590 to 720)

An arbitrary range of plus or minus 10 percent has been applied to these figures.

As previously stated, the 1950 Plan goal of 800,000 tons was based on a production of soda ash of 200,000 tons from the new plant at Sterlitamak and about 600,000 tons from the remaining plants. If production in 1950 was only 655,000 tons, it is apparent that the new plant at Sterlitamak did not fulfill its quota, and that only 50,000 to 60,000 tons of soda ash instead of 200,000 tons were produced by this unit in 1950.

Information concerning the production of chemical caustic soda during the Fourth Five Year Plan is somewhat more vague than that concerning the production of soda ash. The plant studies in Appendix A indicate that 1950 production of chemical caustic soda in the USSR was probably between 100,000 and 130,000 tons, depending on the amount produced at the new plant at Sterlitamak, if any. Production in 1945 in the USSR has previously been estimated at 45,000 to 50,000 tons, so that a 1945 to 1950 series may be obtained by interpolation. Utilization of the reported percentage increases, however, would probably give a somewhat better interpretation of what actually occurred even though these statistics apply to total production of caustic soda: that is, caustic soda produced by both the chemical and the electrolytic processes. Starting with the previously determined production for 1945 of 48,000 tons and applying the percentage increases, the following pattern of production for chemical caustic soda is obtained:

* This estimate agrees fairly closely with the production estimate (III, 1, c,) developed from individual plant estimates for 1945.

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<u>Year</u>	<u>Production</u> <u>(Thousand Tons)</u>
1945	48 (45 to 50)
1946	52 (45 to 55)
1947	65 (55 to 70)
1948	81 (70 to 90)
1949	103 (90 to 115)
1950	118 (100 to 130)

The 1950 estimated production obtained through use of the reported percentage increases (118,000 tons) substantiates fairly well the estimate of 100,000 to 130,000 tons arrived at by plant studies.

e. Fifth Five Year Plan (1951-55).

The published goal of the Fifth Five Year Plan is to increase the production of soda ash by 84 percent and the total production of caustic soda by 79 percent. Such an increase in soda ash would give a production in 1955 of 1.2 million tons. If the production of chemical caustic soda increases at the same rate as the total production of both chemical and electrolytic caustic soda, the production of chemical caustic soda in 1955 will be 210,000 tons. The completion of the new plant at Sterlitamak will give the USSR a total capacity of 1 million tons of soda ash per year. It is apparent that the fulfillment of the goal set by the Fifth Five Year Plan for soda ash will require that the new plant at Berezniki yield at least 200,000 tons of soda ash by 1955. Inasmuch as the planned capacity of this plant is 500,000 tons per year, the Russians apparently have planned to have only part of it operating by 1955. The planned goals for the production of soda ash have not been met in the past, so that the goal of the Fifth Five Year Plan of 1.2 million tons of soda ash has been assumed to be the maximum estimate. By 1955 the new plant at Sterlitamak will be completed, but it is not certain that the new plant at Berezniki will be producing as planned. Production in 1955 can be estimated, then, to be between 1 million and 1.2 million tons, or approximately 1.1 million tons.

The planned production of chemical caustic soda from the new plant at Sterlitamak is not known, and, therefore, it is impossible to estimate to what extent the output of the new plant at Berezniki will influence the success of the Fifth Five Year Plan. It is likely,

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however, that the Plan will not be fulfilled if the new plant at Berezniki fails to produce by 1955.

The reported yearly percentage increases in the production of soda ash were 109 percent in 1951 and 121 percent in 1952. 32/ On the basis of these figures, the production of soda ash in 1951 and 1952 is estimated to be as follows:

<u>Year</u>	<u>Production</u> <u>(Thousand Tons)</u>
1951	715 (645 to 785)
1952	865 (780 to 950)

Production of soda ash in 1955 is estimated to be about 1.1 million tons so that 1953 and 1954 production estimates may be derived by interpolation as follows:

<u>Year</u>	<u>Production</u> <u>(Thousand Tons)</u>
1953	945 (850 to 1,035)
1954	1,020 (925 to 1,115)
1955	1,100 (1,000 to 1,200)

The reported yearly percentage increases in the total production of caustic soda were 108 percent in 1951 and 111 percent in 1952. 33/ If these increases apply equally to chemical caustic soda and if the yearly increase through 1955 will continue to be approximately 10 percent, then the production of this commodity during the Fifth Five Year Plan can be estimated as follows:

<u>Year</u>	<u>Production</u> <u>(Thousand Tons)</u>
1951	128 (109 to 147)
1952	141 (120 to 162)
1953	155 (132 to 178)
1954	170 (144 to 196)
1955	188 (160 to 216)

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A summary of production estimates for soda ash and chemical caustic soda is presented in Table 4, and a graph of the production of soda ash is given in the accompanying chart.*

Table 4

Estimated Production of Soda Ash and Chemical Caustic Soda
in the USSR
Selected Years, 1913-55

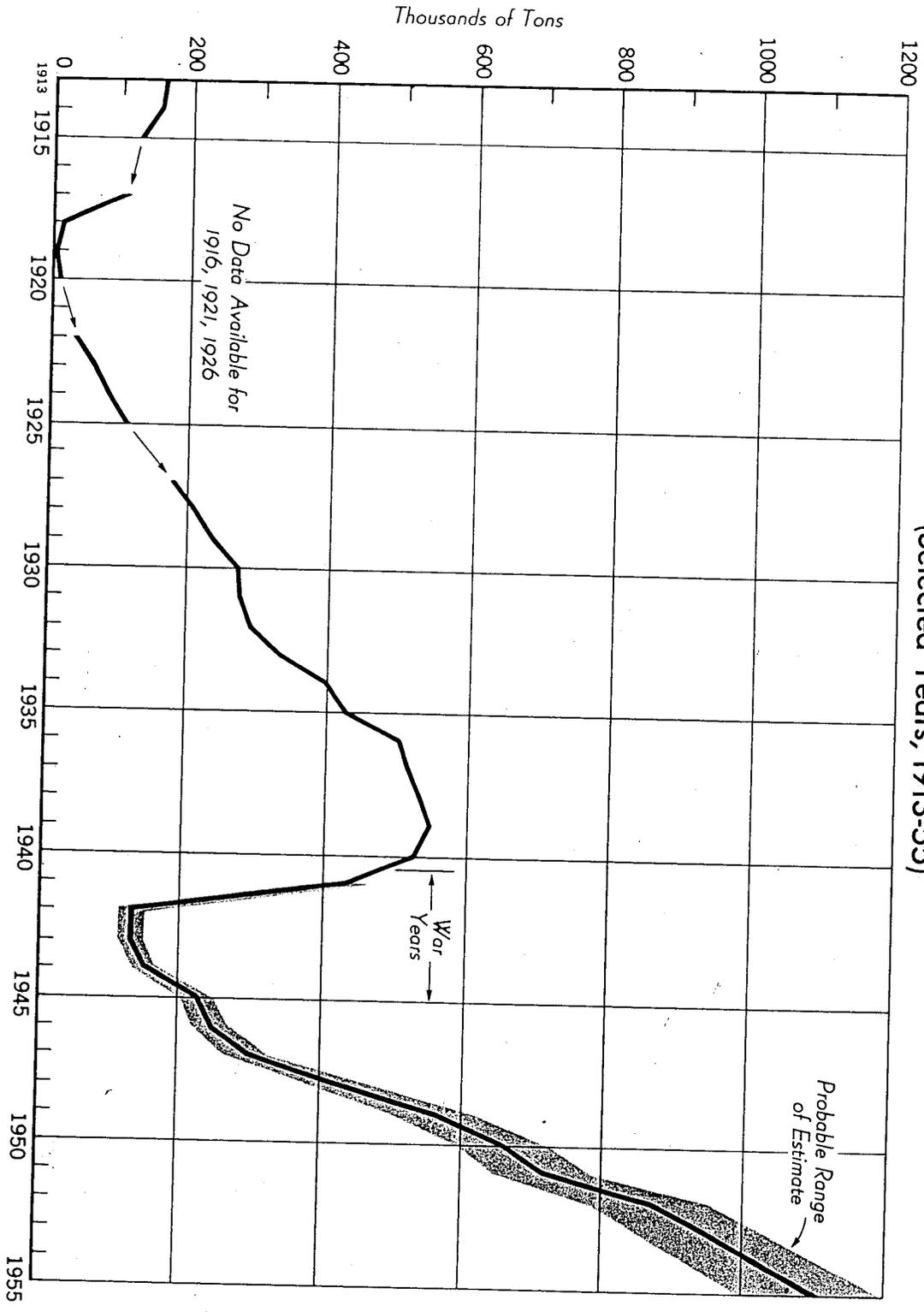
Year	Thousand Tons	
	Soda Ash	Chemical Caustic Soda
1913	160	50 to 55
1914	157	N.A.
1915	128	N.A.
1917	102	N.A.
1918	19	N.A.
1919	4	N.A.
1920	11	N.A.
1922	37	N.A.
1923	61	N.A.
1924	83	N.A.
1925	108	N.A.
1927	179	50 to 55
1928	212	N.A.
1929	238	64
1930	270	N.A.
1931	275	N.A.
1932	288	N.A.
1933	331	N.A.
1934	398	N.A.
1935	422	N.A.
1936	505	N.A.
1937	517	N.A.
1938	536	N.A.
1939	550	N.A.
1940	530	100 (90 to 110)
1941	430 (400 to 460)	87 (80 to 95)

* Following p. 16.

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ESTIMATED PRODUCTION OF SODA ASH IN THE USSR (Selected Years, 1913-55)



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Table 4
Estimated Production of Soda Ash and Chemical Caustic Soda
in the USSR
Selected Years, 1913-55
(Continued)

Year	Thousand Tons	
	Soda Ash	Chemical Caustic Soda
1942	130 (115 to 145)	48 (40 to 55)
1943	130 (115 to 145)	48 (40 to 55)
1944	150 (135 to 165)	48 (40 to 55)
1945	225 (203 to 247)	48 (40 to 55)
1946	245 (220 to 270)	48 (40 to 55)
1947	297 (267 to 327)	52 (55 to 75)
1948	427 (384 to 470)	65 (55 to 75)
1949	560 (504 to 616)	81 (69 to 93)
1950	655 (590 to 720)	103 (88 to 118)
1951	715 (645 to 785)	118 (100 to 136)
1952	865 (780 to 950)	128 (109 to 147)
1953	945 (850 to 1,035)	141 (120 to 162)
1954	1,020 (925 to 1,115)	155 (132 to 178)
1955	1,100 (1,000 to 1,200)	170 (144 to 196)
		188 (160 to 216)

2. Comparison of Soviet Production with US Production.

Comparisons of the production of soda ash and chemical caustic soda in the USSR with production in the US are given in Table 5* and 6** below.

3. Location and Estimated 1953 Production of Soda Ash and Chemical Caustic Soda Plants.

The location and the estimated 1953 production of soda ash and chemical caustic soda plants in the USSR are given in Table 7.***

- * Table 5 follows on p. 18.
** Table 6 follows on p. 18.
*** Table 7 follows on p. 19.

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Table 5

Comparison of the Production of Soda Ash in the USSR
with the Production of Soda Ash in the US
1940, 1946-53

<u>Year</u>	<u>Soviet Production (Thousand Tons)</u>	<u>US Production (Thousand Tons)</u>	<u>Soviet Production as a Percent of US Production</u>
1940	530	2,860	18.5
1946	245	4,060	6.0
1947	297	4,280	6.9
1948	427	4,300	9.9
1949	560	3,700	15.1
1950	655	3,930	16.7
1951	715	4,950	14.4
1952	865	4,320	20.0
1953	945	4,260 a/	22.2

a. Estimate based on production in first 4 months.

Table 6

Comparison of the Production of Chemical Caustic Soda in the USSR
with the Production of Chemical Caustic Soda in the US
1940, 1946-53

<u>Year</u>	<u>Soviet Production (Thousand Tons)</u>	<u>US Production ^{35/} (Thousand Tons)</u>	<u>Soviet Production as a Percent of US Production</u>
1940	85	470	18.1
1946	52	800	5.9
1947	65	905	7.2
1948	81	930	8.7
1949	103	670	15.4
1950	118	570	20.7
1951	128	790	16.2
1952	141	464	30.3
1953	155	486 a/	31.9

a. Estimate based on production in first 4 months.

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Table 7

Location and Estimated Production of Soda Ash
and Chemical Caustic Soda Plants
in the USSR
1953

		Thousand Tons	
<u>Economic Region* and City</u>	<u>Plant Name</u>	<u>Estimated 1953 Production</u>	
<u>South (III).</u>			
Slavyansk	Krasnyy Khimik No. 23	Soda Ash	65
		Caustic Soda	14
Slavyansk	New Slavyansk Soda Plant	Soda Ash	132
		Caustic Soda	18
Verkhneye	Donsoda	Soda Ash	265
		Caustic Soda	26
<u>Urals (VIII).</u>			
Berezniki	Voroshilov Chemical Combine	Soda Ash	105
		Caustic Soda	45
Sterlitamak	N.A.	Soda Ash	353
		Caustic Soda	49
<u>West Siberia (IX) and East Siberia (XI).</u>			
N.A.	Natural Soda Plants	Soda Ash	25
		Caustic Soda	3 <u>a/</u>

a. The production of chemical caustic soda from the natural soda plants is estimated to be from 1,000 to 5,000 tons.

* The economic regions referred to in this report are those defined and numbered on CIA Map 12048, 9-51 (First Revision 7-52), USSR: Economic Regions.

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4. Regional Distribution of Production.

The estimated regional distribution of the production of soda ash and chemical caustic soda for the years 1940, 1950, and 1953 is given in Tables 8 and 9.*

Table 8

Estimated Distribution of Production of Soda Ash
by Economic Regions
1940, 1950, and 1953 a/

<u>Economic Region</u>	<u>Production 1940 (Thousand Tons)</u>	<u>Percent of Total</u>	<u>Production 1950 (Thousand Tons)</u>	<u>Percent of Total</u>	<u>Production 1953 (Thousand Tons)</u>	<u>Percent of Total</u>
South (III)	410	77	462	70	462	49
Urals (VIII)	100	19	168	26	458	48
West Siberia (IX) and East Siberia (XI)	20	4	25	4	25	3
<u>Total</u>	<u>530</u>	<u>100</u>	<u>655</u>	<u>100</u>	<u>945</u>	<u>100</u>

a. Based on plant studies in Appendix A.

Tables 7, 8, and 9 clearly show the increasing importance of Region VIII as a source of soda ash and chemical caustic soda production. When the new plant at Berezniki is producing at full-scale, this region will account for 65 to 70 percent of the total production of soda ash, or over 1 million tons per year. This production will be concentrated at the two plants in Sterlitamak and Berezniki. Both locations have ample supplies of salt and limestone, the principal raw materials. The large quantity of water necessary for the production of soda ash is provided by the Belaya River at Sterlitamak and by the Kama River at Berezniki.

* Table 9 follows on p. 21.

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Table 9

Estimated Distribution of Production of Chemical Caustic Soda
by Economic Regions
1940, 1950, and 1953 a/

<u>Economic Region</u>	<u>Production 1940 (Thousand Tons)</u>	<u>Percent of Total</u>	<u>Production 1950 (Thousand Tons)</u>	<u>Percent of Total</u>	<u>Production 1953 (Thousand Tons)</u>	<u>Percent of Total</u>
South (III)	52	52	58	49	58	37
Urals (VIII)	45	45	57	48	94	61
West Siberia (IX) and East Siberia (XI)	3	3	3	3	3	2
Total	<u>100</u>	<u>100</u>	<u>118</u>	<u>100</u>	<u>155</u>	<u>100</u>

a. Based on plant studies in Appendix A.

Approximately 23 percent of the total production of soda ash in the USSR is used in the same plants in the production of caustic soda. The remaining 77 percent of the soda ash plus all the caustic soda must be shipped out by rail or water to the consuming industries, particularly to the glass, petroleum, aluminum, and chemical industries. In 1953, about 728,000 tons of soda ash and 152,000 tons of caustic soda were shipped from the 3 plants in the Ukraine and the 2 plants in the Urals to points throughout the USSR.

5. Stockpiling of Soda Ash and Chemical Caustic Soda in the USSR.

No information is available regarding the stockpiling of soda ash or chemical caustic soda in the USSR.

6. Trade.

a. With Non-Soviet Bloc Countries.

No trade in soda ash or chemical caustic soda of any substantial amount between the USSR and non-Soviet Bloc countries in

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recent years has been uncovered. The only shipment reported is one of approximately 7,000 tons of soda ash through Belgium to the USSR in 1952. 36/ The country of origin is unknown.

b. With Soviet Bloc Countries.

Throughout 1951 small quantities of soda ash were shipped from the USSR to East Germany to alleviate serious shortages there. The quantities shipped in 1950 and 1951 are estimated to have been 6,000 tons per year. 37/ These shipments apparently ceased in 1952 and 1953, however, because of the increased domestic production of soda ash in East Germany. Trade in caustic soda with the European Satellites has been negligible.

Since about 1949, large quantities of soda ash and chemical caustic soda have been shipped to the USSR by the Sino-Soviet Far East Soda Works in Dairen, Manchuria. This plant was leased about 1949 from the Peiping government by the USSR at a rental of 3 percent of the production. 38/ Virtually all of the remaining 97 percent of the production is believed to be shipped to the USSR. The output of this plant in 1952 and 1953 is estimated to have been 57,000 tons of soda ash and 5,200 tons of chemical caustic soda. Approximately 55,000 tons of soda ash and 5,000 tons of chemical caustic soda are therefore shipped annually to the USSR from Dairen. 39/ How long these shipments will continue is unknown, but it is assumed that the above quantities were shipped at least through 1953.

7. Total Supply.

The total supply of soda ash in the USSR in 1953 is estimated to be 1 million tons, made up of the 945,000 tons of domestic production plus the 55,000 tons imported from the Sino-Soviet Far East Soda Works in Dairen.

The total supply of chemical caustic soda in 1953 is estimated to be 160,000 tons, made up of the 155,000 tons of domestic production plus the 5,000 tons imported from the soda plant at Dairen. It should be noted that production of 155,000 tons of chemical caustic soda required approximately 217,000 tons of the 1 million tons of soda ash listed above, leaving about 783,000 tons of soda ash for uses other than in the manufacture of chemical caustic soda.

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IV. Consumption of Raw Materials.

The estimated consumption of raw materials for the production of 920,000 tons of soda ash in 1953* is given in Table 10.

Table 10

Estimated Consumption of Raw Materials
for the Production of Soda Ash
in the USSR a/
1953

<u>Material</u>	<u>Tons</u>	<u>In Thousands</u>
		<u>Kilowatt-Hours</u>
Salt (NaCl)	1,640	
Chalk (85 Percent Calcium Carbonate)	635	
Limestone (95 Percent Calcium Carbonate)	580	
Ammonia	4	
Anthracite Coal	110	
Bituminous Coal	115	
Mazut (Residual Fuel Oil)	35	
Steam	2,300	
Cooling Water	88,000	
Electricity		92,000

a. The calculation of these requirements may be found in Appendix B.

The estimated consumption of raw materials for the production of 155,000 tons of chemical caustic soda in 1953 is given in Table 11.**

* Total production of soda ash of 945,000 tons less 25,000 natural soda ash taken from lakes.

** Table 11 follows on p. 24.

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Table 11

Estimated Consumption of Raw Materials
for the Production of Chemical Caustic Soda
in the USSR a/
1953

<u>Material</u>	<u>Tons</u>	<u>In Thousands</u>
		<u>Kilowatt-Hours</u>
Soda Ash	217	
Limestone	96	
Ferric Oxide	1.8	
Steam	510	
Mazut	35	
Bituminous Coal	30	
Water	49,000	
Electricity		11,500

a. The calculation of these requirements may
be found in Appendix B.

V. Consumption.

1. Soda Ash.

Estimates of the consumption of soda ash in various uses
are given in Table 12* below.

2. Caustic Soda.

It is not considered feasible to distinguish, in a consumption
pattern, between chemical and electrolytic caustic soda. Table 13**
gives the estimated consumption of caustic soda by industry and in-
cludes the current estimated supply of electrolytic caustic soda
based on an earlier report. 40/

* Table 12 follows on p. 25.

** Table 13 follows on p. 25.

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Table 12

Estimated Consumption of Soda Ash in the USSR
1953

<u>Industry</u>	<u>Thousand Tons</u>	<u>Percent of Total</u>
Chemical Caustic Soda	217	21.7
Glass	178	17.8
Alumina	85	8.5
Chemicals, Cleansers and Washing Soda, Pulp and Paper, Water Softeners, Textiles, and Miscellaneous	520	52.0
Total	<u>1,000</u>	<u>100.0</u>

Table 13

Estimated Consumption of Total Caustic Soda
(Chemical and Electrolytic)
in the USSR
1953

<u>Industry</u>	<u>Thousand Tons</u>	<u>Percent of Total</u>
Soap	73.5	19
Chemicals	62.0	16
Rayon	50.3	13
Petroleum Refining	31.0	8
Lye and Cleansers	19.4	5
Textiles	19.3	5
Pulp and Paper	15.4	4
Vegetable Oils	15.4	4
Reclaimed Rubber	7.7	2
Miscellaneous	93.0	24
Total	<u>387.0</u>	<u>100</u>

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VI. Capabilities, Vulnerabilities, and Intentions.

The estimates of the production of soda ash and chemical caustic soda developed in this report indicate that the USSR failed to meet production goals in 1950 and may fail in 1955. Although serious shortage of these commodities existed after World War II, the shortage was to be alleviated by the Fourth Five Year Plan. Failure to achieve the goals set by the Plan would seem to indicate that conditions of short supply continue to exist. The 1 million tons of soda ash and the 160,000 tons of chemical caustic soda, which constitute the estimated 1953 supplies of these commodities, are sufficient probably to meet all necessary requirements under conditions of closely controlled allocation. When the new plant at Berezniki starts production, the shortage will be greatly relieved. Because direct military requirements for these commodities are not great, it is probable that the USSR has a domestic production of soda ash and chemical caustic soda sufficient to sustain a prolonged war effort.

The USSR is self-sufficient in the production of soda ash and chemical caustic soda, and is therefore not subject to economic warfare. Although this industry is an important segment of the Soviet economy in both peace and war, disruption of its facilities would not immediately or directly affect the war effort.

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APPENDIX A

SODA ASH AND CHEMICAL CAUSTIC SODA PLANTS IN THE USSR

I. Chemical Plants Producing Soda Ash and Chemical Caustic Soda.

1. Krasnyy Khimik No. 23. 41/

a. Location. Slavyansk, Stalino Oblast, Ukrainian SSR (III).

b. Coordinates. 48°51' N - 37°38' E.

c. Estimated 1953 Production. Soda Ash: 65,000 tons.
Chemical Caustic Soda: 14,000 tons.

d. Operation. Krasnyy Khimik No. 23 was constructed in 1899. It was blown up by the Russians in 1941 and by the Germans in 1943. The Germans apparently tried to reconstruct the plant but were forced to evacuate before production commenced. By August 1946 the plant was in operation on a small scale, and by June 1947 reportedly 70 percent of the reconstruction had been completed.

e. Comments. The estimate of production of soda ash is based on the statement of a Soviet engineer that the plant is capable of producing 200 tons of soda ash per day. It is assumed that the plant was in full-scale production at least by 1948.

No basis for a postwar estimate of production of chemical caustic soda has been found, but it has been assumed that the chemical caustic soda department has been restored to the prewar production of 14,000 tons per year. The plant produces chemical caustic soda by the lime-soda method.

No evidence of expansion at this plant has been found; so it has been assumed that production of soda ash and chemical caustic soda in 1954 and 1955 will be about the same as in 1953.

No information is available on which to base an estimate of production of soda ash and chemical caustic soda from 1945 to 1948.

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2. New Slavyansk Soda Plant. 42/

- a. Location. Slavyansk, Stalino Oblast, Ukrainian SSR (III).
- b. Coordinates. 48°51' N - 37°39' E.
- c. Estimated 1953 Production. Soda Ash: 132,000 tons.
Chemical Caustic Soda: 18,000 tons.
- d. Operation. This plant was in partial production by the end of 1946 and probably in full-scale production by 1950.
- e. Comments. Construction of the New Slavyansk Soda Plant was begun by the USSR in the middle 1930's. The plant, however, had not begun production by 1941. When World War II started, the equipment was moved to the Ural mountain area and stored there. In 1945, construction once again started at Slavyansk, and by the end of 1946 this installation was producing about 80 tons of soda ash per day (a rate of 26,000 tons per year). At the end of 1949 a Soviet engineer stated that the plant was still under construction. The plant was probably completed and in full-scale production of soda ash by 1950.

The estimate of production of soda ash is based on the statement of a Soviet engineer that the plant will be able to produce 400 tons of soda ash per day.

The estimate of production of chemical caustic soda is based on the reported existence of 4 rotating furnaces, or tambours, which yield about 54 tons of 100 percent chemical caustic soda per day or 18,000 tons per year. Even though the ferrite, or Levig, process of producing caustic soda is now considered obsolete in the USSR, it must be borne in mind that this plant was designed and built during the middle 1930's, when this process was still in vogue in the USSR.

Production of soda ash at this installation for 1947 and for 1950-52 can be estimated on the basis of the above reports, and production for 1948-49 can be estimated by interpolation.

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<u>Year</u>	<u>Production</u> <u>(Thousand Tons)</u>
1946	0
1947	26
1948	63
1949	100
1950	132
1951	132
1952	132

No information concerning production of chemical caustic soda for the period 1946-49 is available. For the period 1950-52 it can be assumed to have been about 18,000 tons per year.

No evidence of expansion at this plant has been found. Production of soda ash and chemical caustic soda in 1954 and 1955 can therefore be estimated to be equal to that of 1953.

3. Donsoda (Donets Soda Plant). 43/

- a. Location. Verkhneye, Voroshilovgrad Oblast, Ukrainian SSR (III).
- b. Coordinates. 48°54' N - 38°29' E.
- c. Estimated 1953 Production. Soda Ash: 265,000 tons.
Caustic Soda: 26,000 tons.

d. Operation. Donsoda was first operated in 1892. It was considerably expanded during the period of the First, Second, and Third Five Year Plans, until in 1939 and 1940 it was capable of producing about 375,000 tons of soda ash per year. During World War II this plant was almost completely destroyed. Reconstruction was started as soon as the USSR recaptured the area and was virtually finished by the beginning of 1949. The first year of full postwar production for this plant is considered to be 1949. It has not been rebuilt to its former size.

e. Comments. The 1953 estimate of the production of soda ash at Donsoda is based on the statement of a Soviet engineer that this plant was rebuilt to produce 800 tons per day.

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In late 1944 the Russians reported that this plant was producing 230 tons of soda ash per day. Based on this report and several prisoner-of-war reports, 1945 production is assumed to have been at the rate of 75,000 tons per year. In 1949 the plant was apparently producing at a rate of 800 tons per day or 265,000 tons per year. By interpolating for 1946, 1947, and 1948, the following estimates of postwar production at this plant can be made.

<u>Year</u>	<u>Production</u> <u>(Thousand Tons)</u>
1945	76
1946	123
1947	170
1948	217
1949	265
1950	265
1951	265
1952	265

No evidence of expansion of facilities for producing soda ash has been found. Production of soda ash in 1954-55 can therefore be estimated to be equal to that of 1953.

The estimate of the production of chemical caustic soda for this plant is based on the reported existence of 6 rotating furnaces, which yield about 80 tons of 100 percent caustic soda per day or 26,000 tons per year. It is assumed that production of chemical caustic soda has been at about this rate since 1949 and will continue to be the same for 1954 and 1955. No information concerning production before 1949 is available.

4. Voroshilov Chemical Combine. 44/

- a. Location. Berezniki, Molotov Oblast (VIII).
- b. Coordinates. 59°24' N - 56°44' E.
- c. Estimated 1953 Production. Soda Ash: 105,000 tons.
Chemical Caustic Soda: 45,000 tons.

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d. Operation. Originally constructed in 1883, the Voroshilov Chemical Combine was repeatedly expanded during the First, Second, and Third Five Year Plans. During World War II, this installation was the only large producer of soda ash in the USSR.

e. Comment. The 1953 estimate of production of soda ash at the Voroshilov Chemical Combine is based on the statement of a Soviet engineer that the Berezniki plant is capable of producing 320 to 350 tons of soda ash per day. Since World War II this plant has experienced some production difficulties because of poor maintenance and lack of brick, and the lower figure, 320 tons per day, was therefore chosen as probably being closer to actual fact.

Postwar information is not available concerning chemical caustic soda production at Berezniki. Because there is no reason to believe that this plant has been expanded, however, current production is estimated to be at about the prewar rate of 45,000 tons per year.

The same Soviet engineer who gave the plant estimates stated that a new plant was being built at Berezniki with a daily soda ash capacity of 1,500 tons (a yearly production rate of about 500,000 tons). No indication of completion date was given. This new installation was also mentioned in the Fourth Five Year Plan as follows: "work on the building of a new soda plant [in the Urals] [shall be] begun." In planning an 84-percent increase in the production of soda ash during the Fifth Five Year Plan, the Russians must have assumed that almost one-half of this projected plant would be operating by 1955. Previously they had planned to have one-half of the plant at Sterlitamak operating by 1950, but failed to do so. There is no reason to assume that the goal will be achieved in this instance. Apparently no expansion has taken place in the old soda ash and caustic soda works at Berezniki, so that production of both products from 1945 to 1955 may be estimated at 105,000 tons and 45,000 tons per year, respectively.

5. Name of Plant Is Not Available. 45/

- a. Location. Sterlitamak, Bashkir ASSR (VIII).
- b. Coordinates. 53°37' N - 55°58' E.
- c. Estimated 1953 Production. Soda Ash: 353,000 tons.
Chemical Caustic Soda: 49,000 tons.

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d. Operation. The first half of the plant of Sterlitamak was slated to start operating in 1950. On the basis of the 1950-52 production figures and the yearly percentage increases in the production of soda ash, however, it is apparent that the first half of the plant was not in full production until 1952 and also that the second half started limited production in that year.

e. Comments. According to the statement of a Soviet engineer, this plant is to have a production of 400,000 tons of soda ash per year when completed. The 1953 estimate is calculated by subtracting the known production of the other plants producing soda ash from the total production of 945,000 tons. The other plants produced 592,000 tons, leaving 353,000 tons to be accounted for by the plant at Sterlitamak.

The 1953 estimated production of chemical caustic soda is calculated in the same way. The known production of plants producing chemical caustic soda was 155,000 tons. The other plants produced 106,000 tons, leaving 49,000 tons to be accounted for by the plant at Sterlitamak.

II. Natural Soda Plants. 46/

There are at least 2 or 3 natural (or lake) soda plants located in East and West Siberia. In West Siberia, at least 1 and possibly 5 plants are located in the so-called Petukhovskiy and Mikhaylovskiy lake area between Omsk and Semipalatinsk near Slavgorod. In East Siberia, at least one installation for natural soda production is operating near Doroninskoye (Chita Oblast) in the Transbaikal area. It has not been possible to pinpoint the location of these plants. It is almost certain, however, that the production of soda from these units is of little importance to the Soviet economy. A Soviet text on the production of soda ash has indicated that the production of natural soda is expensive and difficult and that it yields a product of low quality that is only of local importance. Not only did the 1941 State Plan indicate that only 23,000 tons of soda ash would be produced outside of the large chemical plants, but also the Fourth Five Year Plan apparently planned only 25,000 to 30,000 tons of production outside of the 5 chemical plants planned to be operating by 1950. On the basis of these figures, it is estimated that the natural soda plants in Siberia are capable of producing approximately 25,000 tons of soda ash per year.

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It is known that at least one of these plants produces chemical caustic soda, but no basis for an estimate of production is available. Captured German information indicates that a substantial share of the soda ash is shipped out of these plants, so that only a small amount can be converted to chemical caustic soda. Production of chemical caustic soda from these units can be roughly estimated to be between 1,000 and 5,000 tons per year.

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APPENDIX B

METHODOLOGY

I. Calculation of Input Requirements.

1. Soda Ash.

a. Input of Salt.

A postwar Soviet text on the production of soda ash has stated that the consumption of salt brine per ton of soda ash is equal to about 5.5 to 6 cubic meters of brine containing 310 grams of salt per liter, or 1.78 tons of 100 percent salt. ^{47/} On this basis, the 1953 estimated production of 920,000 tons of soda ash required about 1,640,000 tons of 100 percent salt.

b. Input of Calcium Carbonate (Limestone or Chalk).

The above Soviet text also stated that the consumption of carbon dioxide from lime kilns is about 700 to 800 cubic meters of gas containing 33 to 35 percent carbon dioxide, or about one-half ton of carbon dioxide per ton of soda ash. ^{48/} Approximately 1.2 tons of calcium carbonate was required to produce this quantity of carbon dioxide.

It is known that the plants at Verkhneye and Slavyansk use a local chalk containing 85 to 90 percent calcium carbonate to provide carbon dioxide for the soda ash units. ^{49/} It is estimated that in 1953 these plants produced about 462,000 tons of soda ash and therefore required about 635,000 tons of chalk.

The Voroshilov Chemical Combine, the new plant at Berezniki, and the new plant at Sterlitamak are known to be using local limestone probably containing about 95 percent calcium carbonate. ^{50/} It is estimated that in 1953 these plants produced about 458,000 tons of soda ash and therefore required about 580,000 tons of limestone.

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c. Input of Ammonia.

The above Soviet text states that make-up consumption of ammonia in the production of soda ash is equal to about 5 kilograms of ammonia per ton of soda ash. 51/ The 1953 production of 920,000 tons of soda ash therefore required about 4,600 tons of 100 percent ammonia.

d. Input of Fuel.

Fuel is used in the manufacture of soda ash in two operations, the burning of lime in the lime kilns to produce carbon dioxide and the calcining of sodium bicarbonate. The same Soviet text indicates that the consumption of anthracite coal in the lime kilns is equal to about 10 percent of the weight of calcium carbonate charged. 52/ Previous calculations show that a 1953 production of 920,000 tons of soda ash required 1.1 million tons of calcium carbonate. Anthracite coal requirements may therefore be estimated at 110,000 tons.

The Voroshilov Chemical Combine at Berezniki and Donsoda at Verkhneye use mazut, a residual fuel oil, for the calcination of sodium bicarbonate, whereas Krasnyy Khimik No. 23 and the new Slavyansk Soda Plant at Slavyansk and probably the new plant at Sterlitamak use bituminous coal. 53/ The consumption of mazut is given in the Soviet text as 90 to 100 kilograms per ton of soda ash and the consumption of bituminous coal as 200 to 220 kilograms per ton of soda ash. 54/ The plants at Berezniki and Verkhneye are estimated to have required 35,000 tons of mazut in 1953, and the plants at Slavyansk and Sterlitamak 115,000 tons of bituminous coal.

e. Input of Electricity.

The input of electricity for the production of soda ash is given in the Soviet text as 100 kilowatt-hours per ton of soda ash. 55/ The estimated total input of electricity for 1953 was therefore 92 million kilowatt-hours.

f. Input of Steam.

The input of steam is given in the Soviet text as 2.5 tons of steam per ton of soda ash. The estimated total input for 1953 was therefore 2.3 million tons of steam. 56/

g. Input of Water.

Large quantities of cooling water are required in the production of soda ash. Soviet statements indicate that the plants in the Ukraine require about 75 to 80 cubic meters* of water per ton of soda ash in winter and about 140 to 150 cubic meters in summer. The plants in the Urals use water from rivers that run cold the year round so that their requirements are only approximately 75 to 80 cubic meters per ton throughout the year. 57/ Requirements of cooling water in 1953 are estimated therefore to have been 88 million cubic meters.

2. Chemical Caustic Soda.

The requirements for chemical caustic soda for both the ferrite and lime-soda processes have been published in the Soviet text. 58/ The production of 1 ton of chemical caustic soda manufactured by the ferrite process requires the following:

<u>Material</u>	<u>Amount</u>
Soda Ash	1,400 Kilograms
Ferric Oxide	20 Kilograms
Electricity	80 to 100 Kilowatt-Hours
Steam	2,400 Kilograms
Standard Fuel (with a total heating value of 7,000 kilocalories)	870 to 880 Kilograms

The fuel actually used is believed to be mazut, which has a heating value of about 15,000 to 16,000 kilocalories, therefore only 395 kilograms per ton of caustic soda are actually necessary. It is believed that Donsoda at Verkhneye, the Voroshilov Chemical Combine at Berezniki, and the new Slavyansk Soda Plant at Slavyansk produce chemical caustic soda by the ferrite process. It is estimated that these plants produced 89,000 tons of chemical caustic soda in 1953 and required the following materials:

* A cubic meter of water weighs 1 metric ton.

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<u>Material</u>	<u>Amount</u>
Soda Ash	125,000 Tons
Ferric Oxide	1,800 Tons
Electricity	8,000,000 Kilowatt-Hours
Steam	210,000 Tons
Mazut	35,000 Tons

According to the same Soviet text, the production of 1 ton of chemical caustic soda by the lime-soda process has the following requirements:

<u>Material</u>	<u>Amount</u>
Soda Ash	1,400 Kilograms
Limestone	1,450 Kilograms
Steam	4 to 5 Tons
Water	70 to 80 Cubic Meters
Electricity	50 to 55 Kilowatt-Hours
Standard Fuel for the Fusion of Caustic Soda (with a total heating value of 7,000 kilo- calories)	300 Kilograms

Although it is felt that this list is reasonably accurate, one item has apparently been neglected. About 150 kilograms of coal are required to convert limestone to the lime needed in the process. It is estimated that in 1953 approximately 66,000 tons of chemical caustic soda were produced by the lime-soda process in the USSR and required (including the coal needed to convert the limestone to lime) the following materials:

<u>Material</u>	<u>Amount</u>
Soda Ash	92,000 Tons
Limestone	96,000 Tons
Steam	300,000 Tons
Water	4,900,000 Cubic Meters
Electricity	3,500,000 Kilowatt-Hours
Coal	30,000 Tons

II. Calculation of Consumption Patterns for Soda Ash.

1. Glass.

It is estimated that the production of plate glass in the USSR in 1953 was 510,000 tons. The production of bottles is calculated by using the 1941 Plan of 684.8 million bottles as a base and increasing this amount by the increase in beverage production for 1951 over the 1941 Plan. The 1941 Plan called for a production of alcoholic beverages of 237.1 million decaliters, and it is estimated that production in 1951 was 208.7 million decaliters. Estimates of the production of alcoholic beverages for 1952 and 1953 were calculated by using the reported percentage of increase in production of 1952 over 1951. During this period the production of beer increased 106 percent; wine, 128 percent; and alcohol, 110 percent. On this basis the 1953 estimate of the production of alcoholic beverages is 252.3 decaliters. If the production of bottles increases at the same rate from 1941 to 1953 as the production of alcoholic beverages, 730 million bottles were produced in 1953. Assuming that these are primarily liter bottles with an estimated weight of 19 ounces each, 394,000 tons of bottles were produced in 1953. It is also estimated that 675 million glass containers of food were packed in 1953. If the glass in each container weighs 7.5 ounces, the estimated production of glass containers for 1953 was 144,000 tons. The total estimated production of glass in 1953 was therefore 1,048,000 tons. Based on US practice, the manufacture of this amount of glass consumed 178,000 tons of soda ash.

2. Alumina.

It is estimated that the primary aluminum production in the USSR in 1953 was 300,000 tons. Based on US practice, this amount required approximately 85,000 tons of soda ash for treatment of the bauxite ore.

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APPENDIX C

GAPS IN INTELLIGENCE

The principal gaps in intelligence concerning the Soviet soda ash and chemical caustic soda industry are as follows:

1. Detailed information on Soviet requirements for these two commodities.
2. Information concerning production of soda ash and chemical caustic soda and start of production at Sterlitamak and the new Berezniki plant.
3. Specific information on quantities of soda ash and chemical caustic soda shipped from Manchuria to the USSR. Also information on how long this agreement will continue.
4. Information concerning stockpiling of these commodities in the USSR.

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APPENDIX D

SOURCES AND EVALUATION OF SOURCES

1. Evaluation of Sources.

a. Soviet Publications.

This group includes textbooks, periodicals, Plan and Plan fulfillment data, and press and radio statements. Although subject to interpretation, these sources are considered reliable. The textbooks and the Plan and Plan fulfillment data were especially helpful throughout the report.

b. Reports Received through CIA Channels.

These reports form the main basis for the plant studies and were of considerable value. They are considered to be reliable.

c. Prisoner-of-War Interrogation Reports.

These reports contributed to the plant information. Taken as a group, they can provide a reliable picture of plant operations.

2. Sources.

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

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

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