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PROVISIONAL INTELLIGENCE REPORT

THE CAUSTIC SODA
AND CHLORINE INDUSTRIES
OF THE USSR



CIA/RR PR-122
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(ORR Project 22.455)

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FOREWORD

The caustic soda and chlorine industries of the USSR are discussed jointly in this report because the two industries are closely related technologically. Probably because of the strategic significance of chlorine, there are no published Soviet data on its production. Chlorine, however, is a coproduct in the production of caustic soda by the electrolytic process, and Soviet data on the total production of caustic soda are available. On the basis of those data, production of chlorine can be estimated.

Estimates of the production of caustic soda by the chemical method, a phase of the industry which is not discussed in detail in this report, are provided by CIA/RR 29, The Soda Ash and Chemical Caustic Soda Industry in the USSR, 20 January 1954, S/US ONLY.

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THE CAUSTIC SODA AND CHLORINE INDUSTRIES OF THE USSR*

Summary

Caustic soda and chlorine are two of the most important chemicals in any industrial economy. Caustic soda is used by the textile, soap, petroleum refining, chemical, and pulp and paper industries. Chlorine is used as a bleaching and purifying agent and in the manufacture of many chemical products such as petroleum refining catalysts, tetra-ethyl lead, synthetic rubber, and antifreeze. In addition, chlorine has special wartime uses in the manufacture of toxic chemical agents and screening smokes.

Soviet production of caustic soda in 1954 reached an estimated 533,000 metric tons,** equal to about 17.3 percent of US production, and imports provided an additional 5,000 tons. This supply was sufficient to meet all essential needs but may have been inadequate for some less essential demands. Production in 1955 will reach an estimated 600,000 tons. There are no direct military requirements of any significance for caustic soda. In the event of war within the next few years, therefore, the situation would not be critical, although the existing shortage would be aggravated.

Soviet production of chlorine in 1954 reached an estimated 296,000 tons, equal to about 11.3 percent of US production. Foreign trade was insignificant, and the supply was more than adequate for all requirements. Production in 1955 will rise to an estimated 329,000 tons.

Because chlorine is used extensively in the manufacture of nearly every important toxic gas and in several screening smokes, the supply of chlorine largely determines the potential for chemical warfare.

* The estimates and conclusions contained in this report represent the best judgment of ORR as of 1 June 1955.

** Unless otherwise stated, tonnages are given in metric tons throughout this report.

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In the event of war within the next few years, there would be no critical shortage of chlorine in the early stages of hostilities unless gas warfare were initiated on a large scale. Indirect military requirements would be met by reallocation of end products from civilian to military use. Direct military requirements could be met by diverting about 10 percent of the total supply to the manufacture of toxic chemical agents. The resulting shortage of end products for the civilian population would impose a considerable but probably not an unbearable hardship.

The Soviet caustic soda and chlorine industries are not vulnerable to external restrictions such as commodity control or blockade. Foreign trade in these commodities is insignificant, and all essential raw materials are available in sufficient quantities.

Soviet preparations for war might be revealed by trade in chlorine. The increased requirements which would result from preparations for war might be filled, at least in part, by imports from East Germany or, perhaps, from Czechoslovakia. Because the available supply of chlorine in the USSR is ample for peacetime purposes, Soviet imports of chlorine in any quantity might be indicative of military intentions.

I. Introduction.

A. Significance of the Commodities.

Caustic soda is second only to soda ash as the most important industrial alkali and is essential to many industrial processes requiring an acid neutralizing agent. It is used in large amounts in the manufacture of rayon, soap, lye, and cleansers; in petroleum refining; and in the textile, pulp and paper, and chemical industries. Caustic soda is produced as an aqueous solution in various concentrations or as a solid in different shapes. It is shipped as a liquid in tank cars or drums and as a solid in drums or barrels.

Chlorine, a yellow-green poisonous gas, is widely used as a bleaching agent by the pulp and paper and the textile industries, in

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the sterilization of water supplies and sewage wastes, and in the manufacture of many chemical intermediate products and end products. The most important of these products are tetraethyl lead, synthetic rubber, plastics, antifreeze, petroleum refining catalysts, insecticides, metal degreasers and other solvents, medicines, bleaching powders, synthetic fibers, glycerine, aniline, and phenol. There are special wartime requirements for chlorine in the production of toxic gases and screening smokes.

Chlorine normally exists as a gas and may be used in that state, but it is generally liquefied and shipped as a liquid in pressurized cylinders or tanks.

B. Organization of the Industries.

The plants producing chemical caustic soda in the USSR are subordinate to the Main Administration of the Soda Industry (Glavsoda) of the Ministry of the Chemical Industry. 1/*

The subordination of the plants producing chlorine and electrolytic caustic soda is not known. A study of the structure of the Ministry of the Chemical Industry does not reveal a logical place for these plants. It is possible that the First, the Second, or the Third Main Administration -- about which little is known -- controls the plants the principal product of which is chlorine. The chlorine plants -- which are attached to factories producing primarily cellulose and paper -- probably are subordinate to the Ministry of Paper and Wood Processing, and those attached to synthetic rubber and nitrogen factories probably are controlled by the Main Administrations of Synthetic Rubber and Nitrogen of the Ministry of the Chemical Industry.

C. Technology.

Caustic soda and chlorine are produced by several processes in the USSR. Caustic soda is produced by the electrolytic decom-

* For serially numbered source references, see Appendix D.

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position of a solution of common salt,* which produces chlorine as a coproduct, and by chemical methods from soda ash. Chlorine, in addition to being produced with caustic soda by the decomposition of salt solution, is also produced as a byproduct in the manufacture of sodium metal.**

Caustic soda and chlorine may be produced separately by other methods that are advantageous under certain economic conditions. In the US, for example, the demand for chlorine has grown at a greater rate than the demand for caustic soda. This has led to the development of processes, such as the nitrosyl chloride process, which produce chlorine without caustic soda. In the USSR, however, the demand for caustic soda has grown at a greater rate than the demand for chlorine. This situation has led to the investigation of processes such as the reduction of sodium sulfate, 2/ which produces caustic soda without chlorine and without requiring the use of soda ash, another material apparently in short supply.

In the design of electrolytic cells,*** Soviet technology apparently is far behind US technology -- as the result of the limited demand for chlorine. This limited demand is in itself a reflection of the underdeveloped state of the Soviet organic chemical industry. The only cell known to have been designed by Soviet engineers is the so-called "X-2," a cylindrical cell of the diaphragm type which has only about one-tenth of the capacity of the Hooker S-3 cell, the largest diaphragm cell used in the US. 3/

In the USSR, caustic soda is produced as an aqueous solution or as a solid. Technical standards for caustic soda in the USSR are

* Potassium chloride salt may also be electrolyzed, with a resulting production of potassium hydroxide and chlorine. The production of this material in the USSR is believed to be negligible.

** The general process for producing magnesium metal reuses the chlorine produced for chlorination of additional raw material. This may not be true in the USSR, because an alternate process may be used that would produce surplus chlorine. Without sufficient information on the process used in the magnesium plants of the USSR, it is assumed in this report that the Soviet magnesium industry consumes all the chlorine that it produces.

*** The electrolytic cells are the basic equipment in an electrolytic chlorine-caustic soda plant.

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shown in Table 1. According to the All-Union State Standard (Gosudarstvennyy Obshchesoyuznyy Standart -- GOST), the concentration of liquid caustic soda in the USSR is 610 grams per liter, equivalent to a concentration of 42 percent by weight, whereas in the US the concentration generally is about 50 or 70 percent by weight.

Table 1

Technical Standards for Caustic Soda in the USSR a/

Factor	Percent			
	Solid Caustic Soda		Liquid Caustic Soda	
	Grade A	Grade B	Grade C <u>b/</u> (Electrolytic)	Grade D <u>b/</u> (Chemical)
Caustic soda, minimum	95	92	<u>c/</u>	<u>c/</u>
Sodium carbonate, maximum	3	3	<u>2</u>	<u>4</u>
Sodium chloride, maximum	1.5	3.75	4	2
Combined iron, aluminum, and manganese oxides, maximum	0.03	<u>d/</u>	<u>d/</u>	<u>d/</u>
Iron, as ferric oxide	<u>d/</u>	<u>0.2</u>	<u>0.2</u>	<u>0.2</u>
Color	<u>e/</u>	<u>f/</u>		

a. 4/. GOST 2263-43.

b. C and D given instead of V and G, the third and fourth letters in the Russian alphabet.

c. 610 grams per liter.

d. Not standardized.

e. Bluish color allowed.

f. Color shade allowed.

Technical standards for liquid chlorine in the USSR are shown in Table 2.*

* Table 2 follows on p. 6.

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Table 2

Technical Standards for Liquid Chlorine
in the USSR a/

<u>Factor</u>	<u>Percent</u>
Chlorine, minimum by volume	99.5
Moisture, maximum by weight	0.06

a. 5/. OST (Obshchesoyuznyy Standart -- All-Union Standard) 40083.

II. Supply.

A. Production.

Soviet production of caustic soda before World War II was on a small scale, increasing from 61,000 tons in 1928 6/ to 80,800 tons in 1932. 7/ The Second Five Year Plan (1933-37) called for production of 354,000 tons in 1937, 8/ but this goal was not achieved; production in 1940 reached only about 200,000 tons.* Similarly, production of chlorine was practically negligible until the 1930's, and by 1940 annual production was only about 89,000 tons.*

In both the caustic soda and the chlorine industries, World War II caused a serious loss of production capacity, amounting to about 50 percent in each case.

Production of caustic soda since World War II may be estimated from information contained in the Fourth Five Year Plan (1946-50), in the announcement regarding fulfillment of this Plan,

* For methodology, see Appendix B.

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and in the annual announcements of plan fulfillment. If production for any postwar year can be established, production for the 1946-54 period may be estimated by applying the annual percentage increases announced by the USSR.*

The Fourth Five Year Plan set the goal for production of caustic soda in 1950 at 390,000 tons and stated that factories with a capacity of 278,000 tons would be put into operation during the 5-year period. ^{9/} The problem is to determine what percentage of this 278,000 tons of additional capacity was planned as actual production for 1950. If 100 percent was planned, production in 1945 was obviously 112,000 tons, the difference between 278,000 tons and 390,000 tons.** If 84 percent was planned, production in 1945 would have been 156,000 tons. In this event the announced percentage increases in production for successive years would indicate that the goal of 390,000 tons in 1950 was attained. The noticeable absence of any information on caustic soda in the announcement on fulfillment of the Fourth Five Year Plan suggests, however, that the goal was not reached. It is believed, therefore, that the planned increase in production of caustic soda for the years 1946-50 amounted to between 84 and 100 percent of 278,000 tons. On this basis it is assumed that the Fourth Five Year Plan provided for an increase amounting to 90 percent of the planned capacity increase of 278,000 tons. Thus it is estimated that the planned increase in production of caustic soda under the Fourth Five Year Plan was 250,000 tons and that production in 1945 was 140,000 tons, the difference between the 1950 goal of 390,000 tons and 250,000 tons.

Estimated and planned production of caustic soda in the USSR in 1940 and 1945-58 is shown in Table 3.*** Estimates for

* See Appendix B, Table 14, p. 32, below.

** It is possible but not probable that an actual increase of more than 278,000 tons was planned for the 5-year period. This would indicate that existing facilities were not being operated at full capacity, which would not have been consistent with the known shortage of caustic soda in 1945.

*** Table 3 follows on p. 8.

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Table 3

Estimated and Planned Production of Caustic Soda
in the USSR
1940 and 1945-58

Thousand Metric Tons		
<u>Year</u>	<u>Estimated Production a/</u>	<u>Planned Production</u>
1940	200	
1945	140	
1946	153	
1947	191 b/	
1948	238	
1949	303	
1950	348	390
1951	376	
1952	417	
1953	480	
1954	533	
1955	600	623 c/
1956	666	
1957	739	
1958	821	

a. Estimated range of error: 1945-51, plus or minus 10 percent; 1952-58, plus or minus 15 percent. For methodology, see Appendix B.

b. The percentage increase for 1947 was not given in the report on plan fulfillment for that year. An annual increase of 25 percent is estimated on the basis of announced quarterly increases of 21, 23, and 26 percent, respectively, for the first 3 quarters of 1947 over the corresponding quarters for 1946.

c. Estimated on the basis of an announced planned increase of 79 percent over production in 1950.

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1946-58 were derived by applying the annual percentage increases announced by the USSR* to the estimate of 140,000 tons for 1945. These estimates indicate that between 1945 and 1950 production of caustic soda increased by about 150 percent, from 140,000 tons to 348,000 tons, but this increase was not sufficient to meet the goal of 390,000 tons planned for 1950.

The Fifth Five Year Plan (1951-55) set the goal for production of caustic soda in 1955 at 79 percent above production in 1950. ^{10/} Based on an estimated production of 348,000 tons in 1950, the Plan for 1955 would be about 623,000 tons. The indicated production in 1954 was about 533,000 tons, and an increase of 90,000 tons, or 17 percent, over 1954 will be required to reach the goal for 1955. This is to be compared with an average annual increase of about 11 percent in 1950-54. From the past performance of the industry it appears unlikely, although not impossible, that the goal for 1955 will be achieved. Production in 1955 is estimated at 600,000 tons, a 12- to 13-percent increase over production in 1954. Soviet plans for the production of caustic soda after 1955 are not available. The current shortage of caustic soda indicates that expansion will continue, probably at a substantial rate. Production in 1956-58 is estimated on the basis of an assumed 11-percent increase per year, the average rate of increase attained in 1950-54.

As previously stated, chlorine is produced in the USSR principally by the electrolysis of a common salt solution which produces caustic soda as a coproduct. In addition, relatively small quantities of chlorine are produced as a byproduct in the manufacture of sodium metal. The nature of these two processes is such that for a given output of caustic soda or sodium metal the production of chlorine is fixed. If production of these two products can be established, therefore, the production of chlorine can be determined by a simple calculation.

Estimated production of caustic soda in the USSR, by type of process, in 1945-58 is shown in Table 4.** The esti-

* See Appendix B, Table 14, p. 32, below.

** Table 4 follows on p. 10.

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Table 4

Estimated Production of Caustic Soda
in the USSR, by Type of Process
1945-58

<u>Year</u>	<u>Process</u>		<u>Thousand Metric Tons</u>
	<u>Chemical a/</u>	<u>Electrolytic</u>	<u>Total</u>
1945	48	92	140
1946	52	101	153
1947	65	126	191
1948	81	157	238
1949	103	200	303
1950	118	230	348
1951	129	247	376
1952	156	261	417
1953	185	295	480
1954	204	329	533
1955	234	366	600
1956	269	397	666
1957	310	429	739
1958	356	465	821

a. For methodology, see Appendix B.

mates of electrolytic production were derived by subtracting estimates for the production of chemical caustic soda from the estimates of total production of caustic soda developed in the preceding paragraphs.

For each ton of electrolytic caustic soda, about 0.888 ton of chlorine is produced. In addition, an estimated 4,000 tons of chlorine are produced each year in the sodium and lead-sodium alloy

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plants at Dzerzhinsk.* Estimated production of chlorine in the USSR, by type of process, in 1940 and 1945-58 is shown in Table 5.

Table 5

Estimated Production of Chlorine
in the USSR, by Type of Process
1940 and 1945-58

<u>Year</u>	<u>Process</u>		<u>Thousand Metric Tons</u>
	<u>Caustic Soda</u>	<u>Sodium Metal</u>	<u>Total</u>
1940	89	Negligible	89
1945	82	4	86
1946	90	4	94
1947	112	4	116
1948	139	4	143
1949	178	4	182
1950	204	4	208
1951	219	4	223
1952	232	4	236
1953	262	4	266
1954	292	4	296
1955	325	4	329
1956	353	4	357
1957	381	4	385
1958	413	4	417

* Plant studies are available in CIA files.

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B. Comparison of Soviet and US Production.

1. Caustic Soda.

A comparison of production of caustic soda in the USSR and in the US in 1945-54 is shown in Table 6. In 1954 Soviet production of caustic soda was about 17 percent of US production.

Table 6

Comparison of Production of Caustic Soda
in the USSR and in the US
1945-54

<u>Year</u>	<u>Soviet Production (Thousand Metric Tons)</u>	<u>US Production ^{a/} (Thousand Metric Tons)</u>	<u>Soviet Production as a Percent of US Production</u>
1945	140	1,691	8.3
1946	153	1,699	9.0
1947	191	1,908	10.0
1948	238	2,156	11.0
1949	303	2,017	15.0
1950	348	2,278	15.3
1951	376	2,818	13.3
1952	417	2,750	15.2
1953	480	2,960	16.2
1954	533 ^{b/}	3,079	17.3

a. 11/

b. The estimated production of caustic soda in the USSR in 1954 amounted to about 57 percent of the total Soviet Bloc production.

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2. Chlorine.

A comparison of production of chlorine in the USSR and in the US in 1945-54 is shown in Table 7.

Table 7

Comparison of Production of Chlorine
in the USSR and in the US
1945-54

<u>Year</u>	<u>Soviet Production (Thousand Metric Tons)</u>	<u>US Production ^{a/} (Thousand Metric Tons)</u>	<u>Soviet Production as a Percent of US Production</u>
1945	86	1,080	8.0
1946	94	1,050	9.0
1947	116	1,310	8.9
1948	143	1,490	9.6
1949	182	1,600	11.4
1950	208	1,940	10.7
1951	223	2,280	9.8
1952	236	2,370	10.0
1953	266	2,540	10.5
1954	296 ^{b/}	2,626	11.3

a. ^{12/}

b. The estimated production of chlorine in the USSR in 1954 was about 52 percent of total Soviet Bloc production.

C. Stockpiles and Inventories.

There is no information available concerning stockpiles and inventories of caustic soda and chlorine in the USSR.

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Caustic soda may be stored in tanks or drums without difficulty, and it is probable that a stockpile of undetermined size exists in the USSR. Chlorine would require heavy pressurized tanks or cylinders for storage. There is, moreover, a hazard involved in the storage of a poisonous gas under pressure in any sizable amounts. Thus it is doubtful that there is a stockpile of chlorine over and above the normal amounts in operating tanks and supply lines.

D. Trade.

1. Free World.

The only known trade in caustic soda between the USSR and the Free World in recent years was in 1952, when the USSR imported 1,025 tons from Belgium and approximately 2,000 tons from France. 13/ The trade agreement with Yugoslavia signed on 1 October 1954 provided for the export of 500 tons of caustic soda by Yugoslavia to the USSR. 14/

There has been no trade reported in chlorine between the USSR and the Free World in recent years.

2. Sino-Soviet Bloc.

Caustic soda has been imported by the USSR from the Far East Soda Works in Dairen, Manchuria, since 1949. The USSR imported an estimated 5,000 tons in 1953 15/ and probably received the same amount in 1954.

Caustic soda and chlorine were reported to have been shipped from the USSR to Bulgaria in 1953, but the amounts were not stated. 16/

E. Total Supply.

The total supply of caustic soda in the USSR in 1954 is estimated at 538,000 tons, of which 533,000 tons were produced domestically and 5,000 tons were imported from Communist China.

The total supply of chlorine in the USSR in 1954 is estimated at 296,000 tons, all of domestic origin.

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III. Consumption.

A. Current Use Patterns.

The estimated use pattern of caustic soda in the USSR in 1954 is shown in Table 8. The estimated use pattern of chlorine in the USSR in 1954 is shown in Table 9.*

Table 8

Estimated Use Pattern of Caustic Soda
in the USSR a/
1954

<u>Industry</u>	<u>Thousand Metric Tons</u>	<u>Percent of Total</u>
Rayon	83	15
Textiles	60	11
Soap	42	8
Benzol, toluol, and phenol	37	7
Petroleum refining	31	6
Vegetable oils	18	3
Pulp and paper	15	3
Reclaimed rubber	7	1
Miscellaneous (chemicals, lye, cleansers, medicines, and others)	245	46
Total	<u>538</u>	<u>100</u>

a. For methodology, see Appendix B.

* Table 9 follows on p. 16.

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Table 9

Estimated Use Pattern of Chlorine
in the USSR a/
1954

<u>Industry</u>	<u>Thousand Metric Tons</u>	<u>Percent of Total</u>
Organic chemicals	148	50
Textiles	29	10
Pulp and paper	27	9
Sovprene synthetic rubber	16	5
Miscellaneous (exports, synthetic hydrochloric acid, aluminum chloride, bromine, sanitation, and others)	76	26
Total	<u>296</u>	<u>100</u>

a. For methodology, see Appendix B.

B. Current Requirements.

1. Caustic Soda.

Essential requirements for caustic soda in the USSR in 1954 were met by the available supply of 538,000 tons. Nonessential requirements, for such items as soaps and cleansers, may not have been met; caustic soda is believed to have been in short supply since the 1930's. The following Soviet statements, indicating efforts to reduce consumption of caustic soda, suggest a continuing shortage:

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"The norms for consumption of caustic soda in the USSR for 1952 were decreased in comparison with those for 1949." 17/

"In 1953 it is planned to reduce the consumption of caustic soda by several thousand tons as a result of the installation of new equipment." 18/

"Further reduction in the consumption of caustic soda in the production of synthetic fibers can be achieved by the installation of corresponding continuously operating equipment which will allow the savings of several thousand tons of caustic soda." 19/

Imports of caustic soda from Communist China and the 1954 trade agreement providing for imports from Yugoslavia also point to a continuing shortage.

2. Chlorine.

The estimated supply of chlorine in the USSR of 296,000 tons in 1954 apparently exceeded existing requirements. The following statements from Soviet sources are evidence of this:

"... in view of the fact that the amount of chlorine produced greatly exceeds the demand." 20/

"The starting materials for making hexachlorane are benzene and chlorine, both of which are plentiful." 21/

"The electrolytic method for caustic soda production requires cheap electric power and is justified economically only when there are consumers for the chlorine obtained as a byproduct." 22/

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C. Wartime Requirements.

1. Caustic Soda.

There are no direct military requirements of any significance for caustic soda. The indirect requirements, however, are many and large. Caustic soda is important in the manufacture of petroleum and rubber products and of chemical intermediates used in the production of plastics and explosives.

The outbreak of war would probably not result in any sudden surge of requirements for caustic soda. This conclusion is based on the assumption that the facilities for production of items of indirect military use are already operating at capacity and thus would not be able to increase production at once. There would be small increased requirements for caustic soda for the purification of cotton linters used in the manufacture of smokeless powder and perhaps for use as a sodium hypochlorite decontaminating agent for toxic gases, but the situation probably would not be critical. Initial wartime needs would be met by reallocation from civilian uses.

The current shortage of caustic soda for such consumer goods as vegetable oils, soap, and rayon, of course, would be aggravated by such reallocation to the military sector. At least in the initial stages of war, there would also be a great shortage of dyes, rayon, plastic products, and other products that require caustic soda.

Total requirements for caustic soda would not increase appreciably until such time as the capacity of the consuming industries had been increased.

2. Chlorine.

Like caustic soda, chlorine has many indirect military uses in wartime -- in the manufacture of chemicals for such products as synthetic rubber, aviation gasoline, explosives, lubricants, and antifreeze. If it is assumed that these chemicals are being produced at full capacity, the outbreak of war would bring no immediate increase of chlorine requirements for these uses. As in the case of caustic

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soda, military requirements for the end products would be satisfied, at least initially, by reallocation from the civilian sector.

Unlike caustic soda, chlorine has direct military uses -- in the manufacture of toxic chemical agents and screening smokes. Facilities very likely exist in the USSR for the manufacture of most of the standard toxic agents, such as mustard, Lewisite, phosgene, and hydrogen cyanide. In addition, it is assumed that the USSR is capable of producing annually at least 12,000 tons of Tabun (GA) and 600 tons of Sarin (GB). These tonnages are the capacities of the nerve gas installations removed from Germany to the USSR after World War II. ^{23/} It has been further assumed that the toxic agents chosen by the USSR would be Tabun and mustard, two effective agents for which the expenditure of chlorine would be relatively low. ^{24/} It is conceded that smaller quantities of other agents, such as Sarin, phosgene oxime, hydrogen cyanide, and Lewisite, might be produced. In the absence of indications of Soviet plans for the wartime production of these agents, it is assumed that production of toxic agents will be determined by the amount of chlorine which can be made available for this purpose.

The requirements for chlorine during the initial stages of war -- barring the large-scale use of poison gas -- would increase by only about 10 percent. By reallocation of chlorine from less essential civilian uses to the manufacture of toxic chemical agents, ^{25/} this increased demand could be met.* As the war progressed, requirements would rise or fall, corresponding with the rise or fall of the production of products consuming chlorine.

* Accordingly, in the event of war in 1957, the USSR would be able to allocate about 38,500 tons of chlorine to the manufacture of toxic agents, which is to be compared with 38,000 tons used by the US for this purpose in 1944. ^{26/} No estimate of chlorine requirements for the manufacture of screening smokes is included. During World War II the USSR made considerable use in tactical operations of smokes employing white phosphorus, chlorosulfonic acid, ammonium chloride, potassium chlorate, hexachlorethane, coal tar and petroleum derivatives, and other chemicals. ^{27/} Among these chemicals, hexachlorethane alone requires chlorine. Since there are a number of other adequate smoke-producing chemicals, and since hexachlorethane is a large consumer of chlorine (2.135 tons of chlorine per ton of hexachlorethane), it is not likely that this chemical would be used on an extensive scale as a military screening smoke.

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IV. Comparison of Prices.

A comparison of prices of caustic soda and chlorine in the USSR and in the US in 1950 is shown in Table 10. The indicated ruble-dollar ratios have probably declined since 1950 because of the increase in US prices and a probable decrease in Soviet prices. The large difference in the ruble-dollar ratios for caustic soda and chlorine may be explained by the shortage of caustic soda and the plentiful supply of chlorine.

Table 10

Comparison of Prices of Caustic Soda and Chlorine
in the USSR and in the US
1950

Product	Soviet Price (Rubles per Metric Ton) <u>a/</u>	US Price (Dollars per Metric Ton) <u>b/</u>	Ruble-Dollar Ratio
Caustic soda, solid	1,955	74	26.4
Caustic soda, liquid	1,490	56	26.6
Chlorine, liquid	338	59 <u>c/</u>	5.7

a. 28/

b. 29/

c. The price of chlorine varies greatly in the US, depending on the type of container used and the amount of chlorine ordered. In October 1950 the price varied from \$59 per ton in single-unit tank cars to \$220 per ton in cylinders. The price used here for comparison is the price of liquid chlorine when purchased in single-unit tank cars.

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V. Raw Materials.

A. Consumption.

1. Electrolytic Caustic Soda and Chlorine.

The estimated consumption of raw materials used in the manufacture of electrolytic caustic soda (329,000 tons) and chlorine (296,000 tons) in the USSR in 1954 is shown in Table 11.

Table 11

Estimated Consumption of Raw Materials
Used in the Manufacture of Electrolytic
Caustic Soda and Chlorine
in the USSR a/
1954

<u>Material</u>	<u>Metric Tons</u>	<u>Million Kilowatt-Hours</u>
Salt	519,000	
Graphite electrodes	2,300	
Asbestos diaphragms	584	
Soda ash	4,900	
Sulfuric acid (66° Bé) b/	33,000	
Water	1,320,000	
Steam	256,000	
Electricity		843

a. For methodology, see Appendix B.

b. Bé is the standard abbreviation for Baumé acid, a measure of specific gravity used to determine concentration.

2. Chemical Caustic Soda.

The estimated consumption of raw materials used in the manufacture of chemical caustic soda (204,000 tons) in the USSR in 1954 is shown in Table 12.*

* Table 12 follows on p. 22.

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Table 12

Estimated Consumption of Raw Materials
Used in the Manufacture of Chemical Caustic Soda
in the USSR a/
1954

<u>Material</u>	<u>Metric Tons</u>	<u>Million Kilowatt-Hours</u>
Soda ash	286,000	
Limestone	126,000	
Ferric oxide	2,400	
Steam	670,000	
Bituminous coal	39,000	
Mazut	46,000	
Water	64,500,000	
Electricity		15.1

a. For methodology, see Appendix B.

B. Location and Character of Principal Salt Deposits.

Common salt, consisting of 23 parts sodium and 35 parts chlorine, is the principal raw material used in the production of caustic soda and chlorine in the USSR. An estimated 519,000 tons of salt were required in 1954 for the production of electrolytic caustic soda and chlorine. An additional 510,000 tons of salt were required for the production of the 255,000 tons of soda ash used to manufacture chemical caustic soda. This supply of salt was obtained as lake salt, rock salt, evaporated salt, and sea salt. 30/

1. Lake Salt.

About 50 percent of the total salt extracted in the USSR comes from salt lakes which are scattered throughout the country. The most important of these lakes is Lake Baskunchak, located in the

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lower Volga region, north of Astrakhan (Region VI*). Other important salt lakes are the following: Saks koye and Sasyk-Sivash, located in Region III; Masazyrskoye, located in Region V; El'ton, located in Region VI; and Pavlodarskoye, Koryakovskoye, and Bol'shoye Tavolzhanskoye, located in Region X.

2. Rock Salt.

Deposits of rock salt are numerous in the USSR, and deep-shaft mining is used for extraction. The most important deposits are in the Ukraine, at Bryantsevka and Slavyansk, and in the Urals, at Sol'-Iletsk and Solikamsk. Other deposits are found in the Caucasus, Turkmen SSR, Tadzhik SSR, and East Siberia.

3. Evaporated Salt.

Ground waters sometimes dissolve salt deposits and form salt springs and underground lakes of brine. The underground brines are tapped and pumped to the surface at Slavyansk, in Region III, and at Berezniki, in Region VIII. In the Artemovsk deposit in the Ukraine, water is pumped into the ground to dissolve the salt deposits.

4. Sea Salt.

Sea water, an unlimited source of salt, generally contains 27 grams of salt per liter. Salt is extracted from the Black and Azov Seas by solar evaporation.

The production of salt in the USSR in 1935 was reported as 4.5 million tons. Figures for production in later years are not available. The Soviet supply of salt is assumed to be ample to support large increases in the production of caustic soda and chlorine.

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

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The chemical caustic soda plants at Berezniki, Slavyansk, Sterlitamak, and Lisichansk are located in the midst of salt deposits. Several of the electrolytic plants are located at a distance from the salt deposits, which necessitates transportation of salt to the producing plants. Salt from the lower Volga region is transported by barge up the Volga River in summer to supply the annual requirements of the electrolytic plants located at Dzerzhinsk.

VI. Capabilities, Vulnerabilities, and Intentions.

A. Capabilities.

1. Caustic Soda.

The estimated 538,000 tons of caustic soda which were available to the USSR in 1954 were sufficient to fulfill the more essential requirements but may have been inadequate to satisfy some of the less essential requirements.

There are no direct military requirements of any significance for caustic soda, and it is estimated that the supply would be adequate to support a war effort, provided that the indirect requirements for end products needed by the armed forces were met by reallocation of these products from civilian to military use.

2. Chlorine.

The estimated chlorine supply of 296,000 tons which was available to the USSR in 1954 apparently was more than adequate to meet all requirements.

Unless gas warfare were initiated on a large scale, the supply of chlorine would be adequate to support a war effort. The direct military requirements for the manufacture of toxic chemical agents could be satisfied by reallocating about 10 percent of the supply from less essential uses. The indirect military requirements for end products needed by the armed forces could be met by reallocation of these products from civilian to military use. The hardship imposed on the civilian population by these measures would be considerable but not unbearable.

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B. Vulnerabilities.

The caustic soda and chlorine industries of the USSR are not vulnerable to external restrictions such as commodity trade controls or blockade. Soviet foreign trade in these commodities is insignificant, and all the raw materials necessary for their production are available in sufficient quantities within the USSR.

C. Intentions.

Soviet preparations for war probably would not result in sudden increases in the production of chlorine or caustic soda. There would be a reallocation of chlorine to the manufacture of chemical warfare agents, and the installations producing these agents would be activated; but these changes would not be immediately apparent. The shortage of caustic soda would be aggravated but probably not to any discernible extent.

Soviet preparations for war might be revealed by trade in chlorine. There is a slight possibility that the increased requirements for chlorine which would result from war preparations would be filled at least in part by imports of chlorine from East Germany or, perhaps, from Czechoslovakia. In view of the plentiful supply of chlorine now available in the USSR, Soviet imports in any quantity might well be significant.

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APPENDIX A

LOCATION AND ESTIMATED PRODUCTION
OF CAUSTIC SODA AND CHLORINE PLANTS IN THE USSR
1949

Table 13 a/*

<u>Economic Region and City</u>	<u>Plant Name</u>	<u>Metric Tons</u>	
		<u>Chlorine</u>	<u>Caustic Soda</u>
Northwest (Ia)			
Enso (Svetogorsk)	Paper and Cellulose Plant	3,500	4,000
Leningrad	Okhtenskiy Chemical Plant	5,500	6,200
Pitkyaranta	Cellulose Plant	2,500	2,800
North (Ib)			
Kotlas	Cellulose Plant	N.A.	N.A.
South (III)			
Slavyansk	Krasnyy Khimik Plant No. 23	5,000	19,700
Slavyansk	New Slavyansk Soda Plant		18,000
Lisichansk (Verkhniy)	Donsoda		26,000
Transcaucasus (V)			
Sungait	Chemical Plant No. 142	N.A.	N.A.
Yerevan	Kirov Synthetic Rubber Plant	9,600	10,800

* Footnotes for Table 13 follow on p. 29.

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Table 13 a/*
(Continued)

<u>Economic Region and City</u>	<u>Plant Name</u>	<u>Metric Tons</u>	
		<u>Chlorine</u>	<u>Caustic Soda</u>
<u>Volga (VI)</u>			
Chapayevsk	Chemical Plant No. 102	4,900	5,500
Beketovka	Chemical Plant No. 91	15,500	17,500
<u>Central (VII)</u>			
Dzerzhinsk	Chemical Plant No. 96	11,270	8,200
Dzerzhinsk	Kalinin Chemical Plant	5,400	6,100
Moscow	Ugreshskiy Chemical Plant No. 93	5,400	6,100
Shchelkovo	Voroshilov Chemical Plant No. 755	N.A.	N.A.
Stalinogorsk	Stalin Chemical Combine	6,000	6,700
Tambov	Krasnyy Bol'shevik No. 204	9,000	10,000
<u>Urals (VIII)</u>			
Berezniki	Nitrogen Fertilizer Plant	22,000	25,000
Berezniki	Berezniki Soda Plant		45,000
<u>West Siberia (IX)</u>			
Kemerovo	Chemical Plant No. 510	20,000	22,000
Novosibirsk	Novosibirsk Recovery Plant	100	110
Tomsk	Tomsk Chemical Pharmaceu- tical Plant	1,200	1,350

* Footnotes for Table 13 follow on p. 29.

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Table 13 a/
(Continued)

<u>Economic Region and City</u>	<u>Plant Name</u>	<u>Metric Tons</u>	
		<u>Chlorine</u>	<u>Caustic Soda</u>
Central Asia (Xb)			
Chirchik	Stalin Electrochemical Combine	N.A.	N.A.
East Siberia (XI)			
Usol'ye-Sibirskoye	Chemical Plant No. 97	2,700	3,000
Total b/		<u>129,570</u>	<u>244,060</u>

a. The methodology for the derivation of these estimates is available in CIA files. The dearth of information on plants since 1949 has precluded estimates of plant production for any later year.

b. These totals are lower than the derived estimates of 303,000 tons of caustic soda and 182,000 tons of chlorine shown in Tables 3 and 5, pp. 8 and 11, respectively, above. Part, but probably not all, of the difference can be accounted for by the fact that no production estimates could be made for four of the plants. It is concluded that the estimates for certain plants may be low or that there may be other plants on which no information is available.

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APPENDIX B

METHODOLOGY

1. Calculation of Production of Caustic Soda and Chlorine in 1940.

On the basis of a statement in a Soviet periodical which said that production in 1940 was 4 times that of 1913, 31/ production of caustic soda in the USSR in 1940 is estimated at about 200,000 tons. Production in 1913 had been reported as 50,000 tons. 32/ The relative accuracy of this estimate is confirmed by another Soviet source, which stated that the goal for caustic soda of 390,000 tons in 1950 was twice the production in 1940. 33/

Of this production of 200,000 tons in 1940, an estimated 100,000 tons were produced by the chemical process in the 3 soda ash plants, 34/ and the remaining 100,000 tons were produced by the electrolytic process.

In producing 100,000 tons of electrolytic caustic soda, 89,000 tons of chlorine would be produced. Assuming that in 1940 a negligible amount of byproduct chlorine was produced in the manufacture of sodium metal, total production of chlorine in the USSR in 1940 is estimated at 89,000 tons.

A check on this estimate of the production of chlorine in 1940 was provided by a source who believes that he can account for practically all of the graphite anodes used by the USSR in the production of chlorine and caustic soda during this period. His estimate of annual chlorine production in the USSR from 1937 to 1940 was 94,000 tons,* 35/ which is close to the 1940 estimate of 89,000 tons.

* The estimate provided by the manufacturer of anodes was 104,000 tons (presumably short tons), which is equivalent to about 94,000 metric tons.

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2. Calculation of Total Production of Caustic Soda.

The estimates of increases in production of caustic soda in the USSR during 1946-54 were based on reported percentage increases. Reported production of caustic soda in the USSR, as a percentage of production in the preceding year, in 1946-54 is shown in Table 14.

Table 14

Reported Production of Caustic Soda in the USSR
as Percentage of Production in Preceding Year a/
1946-54

<u>Year</u>	<u>Percent of Preceding Year</u>
1946	109
1947	125 <u>b/</u>
1948	125
1949	127
1950	115
1951	108
1952	111
1953	115
1954	111

a. 36/

b. In 1947, no annual increase over production in 1946 was reported for caustic soda. There were, however, the following 3 quarterly production figures reported in terms of percent of the corresponding quarter in the preceding year: 121, 123, and 126. 37/ The goal for 1947 was 136 percent of production in 1946, 38/ but this goal was probably not reached. It is assumed that production in 1947 was 125 percent of production in 1946.

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3. Calculation of Production of Chemical Caustic Soda.

Production of chemical caustic soda in the USSR from 1945 to 1950 was estimated in another report, 39/ and the estimate of 1950 production was based on plant studies. For the 1951-54 period it has been assumed that production of chemical caustic soda has increased in direct proportion to the production of soda ash, the principal starting material used in the production of chemical caustic soda. Production during the 1955-58 period has been estimated by assuming an annual increase of 15 percent, which is the average annual increase reported for the production of soda ash in 1950-54. Reported production of soda ash in the USSR, as a percentage of production in the preceding year, in 1951-54 is shown in Table 15.

Table 15

Reported Production of Soda Ash in the USSR
as Percentage of Production in Preceding Year a/
1951-54

<u>Year</u>	<u>Percent of Preceding Year</u>
1951	109
1952	121
1953	119
1954	110
a. <u>40/</u>	

4. Calculation of the Use Pattern for Caustic Soda in 1954.

a. Rayon. 41/

Soviet production of rayon in 1953 was estimated at 145 million pounds, and, based on previous annual increases (estimated at about 27 percent during 1949-53), production in 1954 has been estimated at 184 million pounds. To produce this amount of rayon would require about 83,000 tons of caustic soda.

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b. Textiles.

Cotton textiles constitute the largest segment of the textile industry in the USSR as well as in the US. Caustic soda is used primarily in the mercerization of cotton, which increases the fiber strength and improves the dyeing properties. Because Soviet requirements for this purpose are not known, US practice has been used to estimate caustic soda requirements for the textile industry.

In 1948 the US textile industry produced 8.8 billion meters of cotton textiles ^{42/} and consumed 95,000 tons of caustic soda. ^{43/} In 1954 the USSR produced an estimated 5.6 billion meters of cotton textiles. ^{44/} On the basis of US practice, this amount would have consumed about 60,000 tons of caustic soda.

c. Soap.

It is estimated that Soviet production of soap in 1954 amounted to 756,000 tons ^{45/} and, on the basis of US practice, would have required about 42,000 tons of caustic soda. ^{46/}

d. Benzol, Toluol, and Phenol.

Caustic soda requirements for the manufacture of benzol, toluol, and phenol in the USSR have been estimated at 37,000 tons in 1954. ^{47/}

e. Petroleum Refining.

Soviet production of distillates and lubricating oils in 1954 has been estimated at 35 million tons. ^{48/} This production is equal to about 20 percent of US production in 1948, when the US consumed 154,000 tons of caustic soda for petroleum refining. ^{49/} Assuming that the USSR followed similar practices, Soviet consumption of caustic soda for this purpose in 1954 would also have been 20 percent of the US figure for 1948. In that event, the USSR consumed about 31,000 tons of caustic soda in refining petroleum during 1954.

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f. Vegetable Oils.

Soviet production of vegetable oils in 1954 is estimated at 1,380,000 tons. 50/ On the basis of US practice, this would require 18,000 tons of caustic soda. 51/

g. Pulp and Paper.

Soviet production of paper and paper board in 1954 has been estimated at 12 percent of US production in 1948. 52/ In 1948 the US pulp and paper industry used an estimated 127,000 tons of caustic soda. 53/ On the basis of US practice, the caustic soda requirements of the Soviet pulp and paper industry in 1954 amounted to approximately 15,000 tons.

h. Reclaimed Rubber.

In 1954 the USSR produced an estimated 66,000 tons of reclaimed rubber, which would require about 7,000 tons of caustic soda.

i. Miscellaneous.

The Soviet chemical industry probably is the largest consumer of the residual amount of caustic soda. Caustic soda enters into the manufacture of such a great number of chemical products that it is impossible to estimate requirements. In the US about 22 percent of the caustic soda produced in 1948 was consumed by the chemical industry. Some caustic soda was used in the manufacture of cleansers, drugs, and dyes and in the treatment of metals.

5. Calculation of the Use Pattern for Chlorine in 1954.

a. Organic Chemicals.

The organic chemical industry is the largest consumer of chlorine in the USSR. The principal organic chemicals derived from chlorine are the following: (1) ethylene glycol, used as an anti-freeze for motor cooling systems and also in the manufacture of low-freezing dynamites; (2) carbon tetrachloride, used as a solvent and as a raw material for DDT; (3) chlorinated benzenes, used as intermediates for dyes, synthetic phenol, medicinals, lubricants,

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and the like; (4) chlorinated ethanes, used as solvents for metal degreasing; (5) vinyl chloride and vinylidene chloride monomers, used for the manufacture of plastics and synthetic rubber; and (6) ethyl chloride, used in the manufacture of tetraethyl lead.

During the Fourth Five Year Plan the organic synthesis industry consumed an estimated 40 to 50 percent of total Soviet production of chlorine. 54/ Assuming that 50 percent of the chlorine produced in 1954 was consumed by the organic chemical industry, approximately 148,000 tons were required.

b. Textiles.

Soviet production of cotton textiles in 1954 has been estimated at about 64 percent of US production in 1948.* In 1948 the US textile industry consumed an estimated 45,000 tons of chlorine. 55/ On the basis of US practice, the Soviet textile industry would have required about 29,000 tons of chlorine in 1954.

c. Pulp and Paper.

Soviet production of paper and paper board in 1954 is estimated at approximately 11 percent of US production in 1950. 56/ The chlorine consumed by the pulp and paper industry in the US in 1950 was about 248,000 tons. 57/ Assuming the same rate of consumption by the Soviet pulp and paper industry, an estimated 27,000 tons of chlorine were consumed in 1954.

d. Sovprene.**

Soviet production of sovprene in 1954 is assumed to be the same as in 1953, which was estimated at 35,000 tons. 58/ Approximately 16,000 tons of chlorine would be required for this purpose on the basis of reported US practice.

* See p. 34, above.

** It is possible that the chlorine requirement for production of sovprene is included as a part of the chlorine required for the production of organic chemicals. If so, an additional 16,000 tons should be added to the miscellaneous category.

S-E-C-R-E-Te. Miscellaneous.

The 76,000 tons of chlorine remaining in the USSR in 1954 were used for chlorination of ores, preparation of aluminum chloride for petroleum catalyst, manufacture of bleaching powders, production of synthetic hydrochloric acid and bromine, treatment of water and sewage, and -- in small amounts -- for export.

6. Calculation of Input Requirements.

The input factors for the production of 1 ton of dry chlorine gas by the electrolytic method, using a diaphragm-type cell, have been estimated in a Soviet text as follows 59/:

Salt	1.7 to 1.8 tons
Electric power	2,700 to 2,800 kilowatt-hours
Graphite electrodes	8 kilograms
Asbestos diaphragm	2 kilograms
Water	4 to 5 cubic meters
Steam	0.75 to 1.0 ton

Using these factors, the raw materials required to produce 292,000 tons of chlorine and 329,000 tons of electrolytic caustic soda in 1954 were estimated as follows:

Salt	496,000 to 526,000 tons
Electric power	789 million to 818 million kilowatt-hours
Graphite electrodes	2,300 tons
Asbestos diaphragm	584 tons
Water	1.17 million to 1.46 million cubic meters
Steam	219,000 to 292,000 tons

In addition, sodium carbonate is generally used for the purification of brine, and sulfuric acid is used for drying the wet chlorine gas. On the basis of US practice, 60/ approximately 4,900 tons of sodium carbonate would be required for brine purification, and approximately 33,000 tons of sulfuric acid (66° Be) would be required for drying the wet chlorine gas. Refrigeration also would be required for liquefying the chlorine produced, but because the amount of chlorine to be liquefied is not known, this requirement has not been included.

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On the basis of US practice, production of approximately 4,000 tons* of chlorine from fused salt electrolysis would require an estimated 8,200 tons of sodium chloride and 39 million kilowatt-hours of electric power. 61/

Chemical caustic soda inputs for 1953 have been reported. 62/ Utilizing the same input factors, the raw materials required for the production of 204,000 tons of chemical caustic soda in 1954 are as follows:

	<u>Thousand Metric Tons</u>	<u>Thousand Kilowatt-Hours</u>
Soda ash	286	
Limestone	126	
Ferric oxide	2.4	
Steam	670	
Mazut	46	
Bituminous coal	39	
Water	64,500	
Electricity		15,100

7. Estimated Range of Error.

The range of error of the estimated production of caustic soda from 1945 to 1958 may be estimated on the basis of the following assumptions:

a. The planned increase of production of caustic soda from 1946 to 1950 was between 85 and 95 percent of the planned increase of capacity of 278,000 tons, or between 236,000 and 264,000 tons. By subtracting these estimates of planned increase of production from the planned 1950 production of caustic soda of 390,000 tons, the resulting production estimate for 1945 falls between 154,000 and 126,000 tons (140,000 tons plus or minus 10 percent).

b. The reported annual increases (Table 14**) for caustic soda have an implied range -- that is, if the production is reported as 109 percent of the production of the previous year, the implied range is from 108.5 to 109.5 percent.

* Based on plant studies.

** P. 32, above.

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By starting from the range of the base year 1945 of plus or minus 10 percent and applying the yearly increases reported for the production of caustic soda, the following ranges have been estimated: 1946-47, plus or minus 10 percent; 1948, plus or minus 11 percent; 1949-51, plus or minus 12 percent; 1952-53, plus or minus 13 percent; 1954, plus or minus 14 percent; 1955-56, plus or minus 15 percent; 1957-58, plus or minus 16 percent. These ranges have been combined to give the approximate range of error of plus or minus 10 percent from 1945 to 1951 and plus or minus 15 percent from 1952 to 1958.

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APPENDIX C

GAPS IN INTELLIGENCE

The scarcity of information on Soviet chemical plants since 1949 has made the task of estimating the production of many chemicals progressively more difficult. This is no problem in the case of caustic soda and a few other chemicals for which the USSR has published production indexes. It is a problem, however, in the case of chlorine and many other chemicals for which no production indexes have been published. All avenues of research which are likely to provide the basis for sound estimates have been explored, and -- if confidence in estimates of chemical production is to be raised or even maintained -- it appears that new approaches must be adopted or more effort must be applied to the collection of pertinent intelligence. Other outstanding gaps in intelligence concern the current use pattern and wartime requirements for chlorine.

1. The gaps in intelligence on the production of chlorine probably could be filled most easily by obtaining information on production of plants producing caustic soda by the chemical process and information on production of chlorine at Soviet magnesium plants.

a. Information is needed regarding current production of chemical caustic soda at the following plants:

- (1) Plant Name: Krasnyy Khimik No. 23
Location: Slavyansk, Stalino Oblast, Ukrainian SSR
- (2) Plant Name: New Slavyansk Soda Plant
Location: Slavyansk, Stalino Oblast, Ukrainian SSR
- (3) Plant Name: Donsoda
Location: Lisichansk, Voroshilovgrad Oblast,
Ukrainian SSR

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- (4) Plant Name: Berezniki Soda Plant*
Location: Berezniki, Molotov Oblast, Urals

- (5) Plant Name: Soda Plant
Location: Sterlitamak, Bashkir ASSR, Urals

b. Information is needed as to whether or not Soviet magnesium plants produce chlorine in excess of their requirements for the production of magnesium chloride. If so, the chlorine from the magnesium plants probably would be piped to nearby installations for the manufacture of chlorinated products, because the impurities in chlorine so produced prevent its liquefaction. In lieu of this information, detailed information on the process used by the magnesium plants in preparing magnesium chloride for electrolysis would suffice. The magnesium plants are located as follows: Berezniki, Molotov Oblast, Urals; Solikamsk, Molotov Oblast, Urals; and Zaporozh'ye, Zaporozh'ye Oblast, Ukrainian SSR.

2. The gap in intelligence on the wartime requirements for chlorine would be practically impossible to fill directly, but the formulation of estimates would be facilitated by information regarding the installed capacity to produce the following chemical warfare materials:

- a. Nerve gases, Tabun (GA), Sarin (GB), or other.
- b. Mustard.
- c. Phosgene oxime.
- d. Lewisite.
- e. Screening smokes, hexachlorethane, titanium tetrachloride.

3. The gap in intelligence on the current use pattern of chlorine could be filled by obtaining information on the amounts of chlorine consumed in the manufacture of chemicals, in the bleaching of textiles and pulp paper, and in the sterilization of water supplies and sewage wastes.

* A new soda plant has been reported as under construction at Berezniki. Information regarding the status of construction or production is needed.

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APPENDIX D

SOURCE REFERENCES

The principal sources used in the preparation of this report are the following:

1. Soviet Sources.

These sources include Soviet books, periodicals, press and radio statements, and reports of Plans and plan fulfillment. They are considered reliable and were useful in the preparation of nearly every section of this report.

2. German Intelligence.

Although these reports are more than 10 years old, they were useful in estimating plant production and are considered fairly reliable.

3. Prisoner-of-War Reports.

The prisoner-of-war reports as a group are considered reliable and were useful for information on certain postwar plants.

4. Reports Received through CIA Channels.

These reports were used to determine plant production and are considered reliable. One CIA report on the chemical caustic soda and soda ash industry was used for information on plants producing chemical caustic soda.

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

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


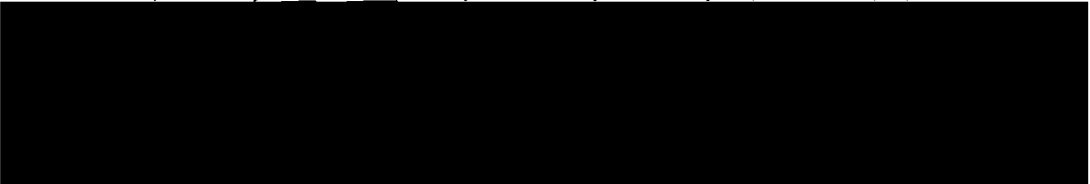

"Documentary" refers to original documents of foreign governments and organizations; copies or translations of such documents by a staff officer; or information extracted from such documents by a staff officer, all of which may carry the field evaluation "Documentary."

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

1. CIA. CIA/RR 29, The Soda Ash and Chemical Caustic Soda Industry in the USSR, 20 Jan 54, p. 3, S/US ONLY.
2. Doklady Akademii Nauk SSSR, novaya seriya (Reports of the Academy of Sciences, USSR, New Series), vol 94, no 4, 1 Feb 54, p. 733-35, U. Eval. RR 2.
3. 
4. 
5. Ibid.

25X1A

S-E-C-R-E-T

6. Tyshkovsky, Ya. D. Zhurnal khimicheskoy promyshlennosti (Journal of the Chemical Industry), no 1, 1931, p. 57-58, U. Eval. RR 2.
7. State Planning Commission of the USSR. The Second Five Year Plan for the Development of the National Economy of the USSR, part 2, Moscow, Cooperative Publishing Society of Foreign Workers in the USSR, 1936, p. 549, U. Eval. Doc.
8. Ibid.
9. Soviet Embassy, Washington. "The Stalin Five Year Plan for the Restoration and Development of the National Economy of the USSR for 1946-50," Information Bulletin, Jun 46, p. 5, 9, U. Eval. Doc.
10. New York Times, 23 Aug 52, U. Eval. RR 2. (citing Pravda, 20 Aug 52)
11. National Production Authority, Chemical Division. Survey on Caustic Soda, Feb 51, p. 49, R. (hereafter referred to as Survey on Caustic Soda)
UN. Statistical Yearbook, 1954, p. 211, U.
Industrial and Engineering Chemistry, vol 46, no 6, Jun 54, p. 1121, U.
Commerce. Chemical and Rubber Industry Report, vol 2, no 4, Apr 55, p. 7, U.
12. National Production Authority, Chemical Division. Survey on Chlorine, Jan 51, R. (hereafter referred to as Survey on Chlorine)
Industrial and Engineering Chemistry, vol 46, no 6, Jun 54, p. 1121, U.
Commerce. Chemical and Rubber Industry Report, vol 2, no 4, Apr 55, p. 6, U.
13. 
Commerce, OIT. Tabulation of Official French Statistics on Trade with the Soviet Bloc for 1952, U. Eval. Doc.
14. CIA. FDD, Summary, no 294, 29 Nov 54, C. Eval. RR 2. (tr of Ekonomska politika, Belgrade, 7 Oct 54)
15. CIA. CIA/RR 29, op. cit. (1, above), p. 22, S/US ONLY.
16. 
17. 
18. Ibid.

25X1A

25X1A

S-E-C-R-E-T

19. Za ekonomiyu materialov (Conserving Materials), no 5, Dec 52, p. 8, U. Eval. RR 2.
20. Sergienko, S.R. Khimicheskoye ispol'zovaniye prirodnykh i promyshlennykh gazov, Academy of Sciences of the Ukraine SSR, Kiev, 1951, U. Eval. RR 2.
- 25X1A2g
21. [REDACTED]
22. Doklady Akademii Nauk SSSR, novaya seriya, op. cit. (2, above).
23. [REDACTED]
24. Ibid., p. 15, S. 25X1A
25. Ibid., p. 14, S.
26. Survey on Chlorine, op. cit. (12, above), p. 94, R.
27. [REDACTED] 25X1A
28. Spravochnik tsennik (Price Handbook), Baku, 1950, vol 2, part 1, p. 187-88 and 199, U. Eval. Doc.
29. Chemical and Engineering News, vol 28, no 41, 9 Oct 50, p. 3547, U. Eval. RR 2.
- Ibid., no 43, 23 Oct 50, p. 3734, U. Eval. RR 2.
30. Khomyakov, V.G., Mashovets, V.P., and Kuz'min, L.L. Tekhnologiya elektrokhimicheskikh proizvodstv, Moscow, Goskhimizdat, 1949, p. 257-58, CIA N/5 741.96.K4, U. Eval. RR 2.
31. Planovoye khozyaystvo (Planned Economy), no 4, Apr. 53, U. Eval. RR 2.
32. Tyshkovsky, op. cit. (6, above), U. Eval. RR 2.
33. Planovoye khozyaystvo, no 3, 1946, U. Eval. RR 2.
34. CIA. CIA/RR 29, op. cit. (1, above), S/US ONLY. 25X1A2g
35. [REDACTED]
36. [REDACTED]
- Current Digest of the Soviet Press, vol 1, no 4, 2 Feb 49, U. Eval. RR 2. STATSPEC
- Ibid., vol 2, no 4, 13 Mar 50, U. Eval. RR 2.
- Ibid., vol 3, no 3, 3 Mar 51, U. Eval. RR 2.
- [REDACTED]
- Ibid., no 23, sec B, 23 Jan 53, U. Eval. RR 2. 25X1A

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S-E-C-R-E-T

STATSPEC

25X1A

Ibid., no 35, sec B, 4 Feb 54, U. Eval. RR 2.

STATSPEC

37.
38.
39.
40.

CIA. CIA/RR 29, op. cit. (1, above)

25X1A

41. Cotton Yearbook, 1953, 48th ed, London, Jun 53, p. 679-80 and 686, CIA 729.11.C8, U.
42. UN. Statistical Yearbook, 1949-1950, Table 80, p. 212, U. Eval. Doc.
43. Survey on Caustic Soda (11, above), p. 51, R.
44. CIA. CIA/RR IP-385, ORR Contribution to NIE 11-3-55, Soviet Capabilities and Probable Course of Action, 1954-1960, 7 Mar 55, S.
45. Ibid.
46. Shreve, R.N. The Chemical Process Industries, New York, 1945, p. 606, U.
47. CIA. CIA/RR 60, Major Aromatic Chemicals in the USSR, 27 Jun 55, S/NOFORN.
48. CIA. ORR Project 25.471, Petroleum Products in the USSR (to be published), S/NOFORN.
49. Survey on Caustic Soda (11, above), p. 51, R.
50. CIA. CIA/RR IP-385, op. cit. (44, above).
51. Shreve, op. cit. (46, above), p. 584.
52. UN. World Pulp and Paper Resources and Prospects, New York, 1954, U. Eval. RR 3.
53. Survey on Caustic Soda (11, above), p. 51, R.
54. Khimicheskaya promyshlennost' (Chemical Industry), no 12, Moscow, Dec 46, p. 1-4, U. Eval. RR 3.
55. Survey on Chlorine (12, above), p. 77, R.
56. UN. World Pulp and Paper Resources and Prospects, New York, 1954, U. Eval. RR 3.
57. Survey on Chlorine (12, above), p. 79, R.
58. CIA. CIA/RR 19, The Rubber Position of the Soviet Bloc, 19 Jan 53, S.

- 47 -

S-E-C-R-E-T

~~SECRET~~

59. Vol'fkovich, S.I., Yegorov, A.P., and Epshtein, D.A. Obshchaya khimicheskaya tekhnologiya (General Chemical Technology), Moscow, 1953, vol 1, p. 584-87, U. Eval. RR 2.
60. Faith, W.L., Keyes, D.B., and Clark, R. Industrial Chemicals, New York, 1950, p. 216, U.
61. Ibid., p. 530.
62. CIA. CIA/RR 29, op. cit. (1, above), p. 24, S/US ONLY.

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