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ECONOMIC INTELLIGENCE REPORT

THE NITRIC ACID INDUSTRY IN THE USSR

CIA/RR 24

4 June 1953

CENTRAL INTELLIGENCE AGENCY

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S-E-C-R-E-T

SECURITY INFORMATION

ECONOMIC INTELLIGENCE REPORT

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CIA/RR 24

(ORR Project 22.1.2)

CENTRAL INTELLIGENCE AGENCY

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S-E-C-R-E-T

CONTENTS

Appendixes

50X1

Tables

Chart

CIA/RR 24
(ORR Project 22.1.2)

S-E-C-R-E-T

SECURITY INFORMATION

THE NITRIC ACID INDUSTRY IN THE USSR*

Summary

Nitric acid is perhaps the most important military chemical and an indispensable industrial chemical. As a military chemical, it is essential to the manufacture of all nonatomic high explosives and propellants and is assuming increasing importance as a fuel oxidizer in rocket-propelled guided missiles. As an industrial chemical, it is used principally for the manufacture of nitrogenous fertilizers, industrial explosives, and organic dyestuffs.

The only process of commercial significance for the manufacture of nitric acid in the USSR is the ammonia oxidation process. Soviet technology regarding this process is comparable with corresponding technology in the US, Germany, the UK, and other industrial nations. The USSR has placed great emphasis on the development of the nitric acid industry and its parent industry, the synthetic ammonia industry. The output of the nitric acid, synthetic ammonia, and nitrogen fertilizer industries (which are called, collectively, the nitrogen industry) is greater, relative to US production, than the output of any other allied groups of Soviet chemical industries. The Soviet intention here is quite clear. During peacetime, practically unlimited supplies of ammonia and nitric acid, in the form of ammonium nitrate, can be applied to the soil as fertilizer. In the event of war, these chemicals can be diverted quickly and easily to the manufacture of military explosives. The continued emphasis placed on the expansion of this industry by the USSR indicates an acute awareness of the necessity for having a large explosives production potential as soon as possible.

Nitric acid** has been a product of the Soviet chemical industry since before World War I, and production increased from a reported 2,872 tons*** in 1913 to an estimated 400,000 tons in 1940. The

* This report contains information available as of 1 April 1953.
** Unless otherwise specified, all figures for the production and consumption of nitric acid in this report are on the basis of 100 percent nitric acid.
*** Tonnages are given in metric tons throughout this report.

penetration of the German armies in 1941 and 1942 resulted in the loss of about half of the productive capacity of the industry, but intensification of production in the plants remaining under Soviet control, combined with the output of new installations in the eastern areas, enabled the USSR to reattain by 1943 the 1940 production level of about 400,000 tons and to increase output by 1945 to an estimated 500,000 tons. In spite of the apparent success achieved by the USSR in the manufacture of nitric acid during World War II, a critical shortage of this chemical probably would have been experienced had it not been for the aid furnished to the USSR under Lend-Lease.

The output of nitric acid in the USSR from 1946 through 1949 is obscure because many of the plants were undergoing extensive rehabilitation and expansion during this period. By 1950, however, the restoration of the industry was almost completed, and production from installed facilities probably was approaching a peak. A survey of plant information indicates that the output of nitric acid in the USSR was about 1,035,000 tons in 1950, increasing by 1953 to an estimated 1,195,000 tons, equivalent to about 44 percent of US production of nitric acid in 1951. This supply of nitric acid should be ample to meet Soviet demands for explosives; to fill all industrial requirements; and, in addition, to make hundreds of thousands of tons of nitrogenous fertilizers.

In the event of a general war in the near future, much of that nitric acid which is allocated for the manufacture of ammonium nitrate would be concentrated and reallocated to the manufacture of high explosives and smokeless powder and for use as rocket fuel oxidizer, although this latter requirement would be small relative to the total military requirements. In addition, practically all of the remaining production of ammonium nitrate, previously allocated to agriculture for use as fertilizer, would be reallocated to the explosives industry for use as a component of military and industrial high explosives. When it is considered that the peak annual output of nitric acid in the USSR during World War II was only about one-third as large as the estimated 1953 output, it appears, if the effects of possible wartime destruction are ignored, that the present output is sufficient to sustain a prolonged military effort of major proportions.

The primary input requirements for the manufacture of an estimated 1,195,000 tons of nitric acid in the USSR in 1953 are estimated

at about 346,000 to 358,000 tons of ammonia, 120 to 155 kilograms of platinum catalyst, and 250 to 360 million kilowatt-hours of electricity.

The requirements for nitric acid in the USSR in 1953 cannot be estimated, because of insufficient information, but, based partly on the estimated production, the consumption is estimated as follows by broad category of use: 700,000 tons, or 58.5 percent, for the manufacture of nitrogenous fertilizers; 400,000 tons, or 33.5 percent, for the manufacture of military and industrial explosives; and 95,000 tons, or 8 percent, for chemical manufacture and all other uses.

Although information is lacking, it can be stated with near certainty that nitric acid is not stockpiled in the USSR. Rather than stockpiling the highly corrosive nitric acid, which would require prohibitive amounts of stainless steel or aluminum alloy tankage, it is believed that the Russians are stockpiling the finished and semifinished products such as filled munitions, high explosives, and ammonium nitrate.

The Soviet nitric acid industry is entirely self-sufficient and is, therefore, not vulnerable to economic warfare. The plants producing nitric acid are well dispersed throughout the USSR, the principal economic regions* of production being the Ukraine, Central European USSR, the Urals, and Central Asia, which account for about 85 percent of the total Soviet output.

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The nitrogen industry is a potentially good indicator of Soviet intentions with respect to the immediate future. Preparatory to initiating large-scale war, Soviet production of military high

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explosives probably would be greatly increased. Such an increase necessarily would be accompanied by increased production of concentrated nitric acid and by reduced production of ammonium nitrate. In addition, large quantities of ammonium nitrate probably would be diverted from agriculture to the explosives industry. Thus a sudden large increase in the production of military explosives, which presumably would not take place unless the USSR was planning or expecting a large-scale war in the immediate future, might be revealed by a significant reduction of deliveries of ammonium nitrate to agriculture.

I. Introduction.

Nitric acid (HNO_3) is one of the most valuable products of the chemical industry. It is a heavy, fuming liquid with a sharp choking odor and is colorless when pure but ordinarily yellow in color. The coloration is caused by the presence of oxides of nitrogen resulting from the decomposition of the acid. It is extremely corrosive to metals. The processing equipment in modern plants, therefore, is constructed principally of stainless steel and high-silicon iron. Tank cars and drums used for shipping nitric acid usually are constructed of stainless steel or aluminum alloy. Mixed acids -- that is, mixtures of concentrated nitric acid and sulfuric acid used for nitration purposes -- may be shipped in iron drums or tank cars.

A consideration of the use pattern of nitric acid immediately establishes it as perhaps the most important military chemical and as an indispensable industrial chemical. As a military chemical, nitric acid is essential to the production of all nonatomic high explosives and propellants, such as trinitrotoluene (TNT), picric acid, hexogen, tetryl, pentaerythritol tetranitrate (PETN*), mercury fulminate, nitrocellulose, and nitroglycerine. In addition, nitric acid is assuming increasing importance as a fuel oxidizer in rocket-propelled guided missiles.

As an industrial chemical, nitric acid is used for the production of the nitroderivatives of benzol, naphthalene, anthracene, and other

* Designated TEN in the USSR.

aromatic compounds which in turn are used as intermediates in the manufacture of various organic chemicals and dyestuffs. The principal industrial use for nitric acid, however, is in the manufacture of inorganic salts, such as ammonium, sodium, and calcium nitrates, which are used primarily as soil fertilizers. Ammonium nitrate, in addition to being the most widely used nitrogen fertilizer, also is employed in large quantities in the USSR as a component of military and industrial high explosives. Smaller amounts of nitric acid are consumed by industry in the manufacture of copper and silver nitrates, in the pickling of brass, in photoengraving, and in other miscellaneous applications.

In the nitration of organic compounds for the manufacture of explosives, dye intermediates, and other similar products, concentrated, or white fuming, nitric acid, having a concentration of about 96 to 99 percent HNO_3 by weight, is required. Weak nitric acid, having a concentration of about 49 to 65 percent HNO_3 by weight, is used in the manufacture of ammonium nitrate and other inorganic nitrates and in most of the miscellaneous industrial applications.

II. Technology.

At present, only one process of commercial significance for the production of nitric acid is in use in the USSR. This process is known as the ammonia oxidation process. Other methods of production of nitric acid, such as the arc method and the sodium nitrate method, have only an historical significance in the USSR and are not treated in this report. The ammonia oxidation process has many modifications with respect to the size and design of equipment, to operating pressures and temperatures, and to other variable conditions but consists essentially in the following unit processes:

1. Ammonia is oxidized to nitric oxide by passing a mixture of ammonia gas and air, or ammonia gas and air enriched with oxygen, through a converter equipped with a platinum-rhodium gauze catalyst heated to about 750°C.

2. The resulting nitric oxide gas is passed through heat exchangers, cooled, and then passed into cooled absorption columns, where the nitric oxide gas is further oxidized to nitrogen dioxide gas. The nitrogen dioxide gas is then absorbed in dilute nitric acid to produce a water solution of weak nitric acid having a concentration of about 49 to 65 percent HNO_3 by weight.

This process may be carried out at atmospheric pressure or at pressures up to about 100 pounds per square inch. Oxidation and absorption at atmospheric pressure furnish a nitric acid containing about 49 to 55 percent HNO_3 by weight, whereas an acid containing about 60 to 65 percent HNO_3 by weight is obtained when the process is carried out under pressures above atmospheric.

The concentrated nitric acid (96 to 99 percent HNO_3) required particularly for the nitration of organic compounds in the production of explosives, dye intermediates, and similar products is usually obtained by mixing the weak nitric acid (49 to 65 percent HNO_3) from the absorption columns with strong sulfuric acid and distilling in either a pot still or a continuous pipe still. The distillate in the form of nitric acid vapors is condensed, thus producing strong nitric acid having a concentration of about 96 to 99 percent HNO_3 by weight. Concentrated nitric acid also may be produced directly from the nitric oxide gas leaving the converter by further oxidation to nitrogen tetroxide and subsequent polymerization with weak nitric acid and oxygen. This process produces concentrated nitric acid in one step, thus avoiding the concentration of weak acid by means of the sulfuric acid distillation. In the USSR, the former process is of far greater commercial significance than the latter.

Soviet technology in the field of nitric acid production is comparable with technology in the US, Germany, the UK, and other industrial nations. Sufficient evidence is available in Soviet technical literature to show that much research work has been done by the Russians on the many details associated with each of the unit processes and operations involved in the production of nitric acid. 1/*

Soviet specifications regarding the quality of nitric acid are as follows 2/:

1. Weak Nitric Acid (OST** 15374-39).

	Grade A	Grade B
Content of HNO_3 in percent by weight, not less than	49	60
Solid residue, calcined, in percent by weight, not more than	0.07	0.05

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** OST is the Russian abbreviation for Obshchesoyuznyy standart (All-Union Standard).

Although it is not so stated in the Soviet literature, Grade A weak nitric acid is undoubtedly that acid produced by plants operating at atmospheric pressure, whereas Grade B is that produced by the elevated pressure process plants.

2. Concentrated Nitric Acid (GOST* 701-41).

	1st Grade	2d Grade
Content of HNO_3 in percent by weight, not less than	98	96
Content of nitric oxides calculated as N_2O_4 in percent by weight, not more than	0.3	0.4
Solid residue in percent by weight, not more than	0.05	0.07
Content of sulfuric acid in percent by weight, not more than	0.1	0.2

III. Supplies.

1. Production.

a. 1913-28.

Before World War I the manufacture of nitric acid in Russia depended entirely on imported Chilean sodium nitrate, and production in 1913 was reported to have been 2,872 tons. During World War I the supply of sodium nitrate from Chile was cut off, and the Russian explosives industry was placed in a precarious position. Attempts were made to exploit the saltpeter ore in Dagestan and Turkestan,** but the deposits were found to be too small, and the plan proved a failure. In order, therefore, to keep their explosives plants operating, the Russians were forced to devise another means of producing nitric acid. Since no facilities were available for the production of synthetic ammonia, a method was worked out whereby nitric acid was produced by oxidation of the ammonia solution derived from the coking of coal.

* GOST is the Russian abbreviation for Gosudarstvennyy obshchesoyuznyy standart (State All-Union Standard). Both OST and GOST refer to Soviet standard specifications regarding the quality of products.

** Turkestan is the former name for those areas of the USSR now included in the economic regions Kazakhstan SSR and Central Asia.

Pilot work on this process was done at the Makeyevka coal tar chemical plant, and in 1916 the construction of a commercial-scale synthetic nitric acid plant was begun at Stalino (Yuzovka). 3/ The original capacity of this plant was reported as 10,000 tons per year of ammonium nitrate, equivalent to a nitric acid capacity of about 7,900 tons. 4/ The total production of nitric acid in Russia in 1916 was reported to have been 11,727 tons. 5/

As a result of the October Revolution in 1917 and the civil war which ensued, most of the chemical plants and other industrial plants ceased operating, and, although statistics are lacking, it is fairly certain that the annual output of nitric acid in the USSR before 1926 was lower than it had been in 1916. An effective program for the restoration of the chemical industry was begun in 1926, and by the end of 1927 it is probable that the output of nitric acid had reached the prerevolutionary level.

b. First Five Year Plan (1928-32).

According to information published by the USSR, the first plant in the USSR producing nitric acid from synthetic ammonia was put into operation in 1928. 6/ Although it is not so stated in the published information, it is believed that the plant referred to was the Fauser ammonia oxidation installation at the Chernorech'ye Chemical Combine imeni Kalinin near Dzerzhinsk. By the end of 1932, three more plants producing nitric acid by the oxidation of ammonia are known to have been put into operation. Two of these plants were installed by a US company: one at the Chernorech'ye Chemical Combine imeni Kalinin near Dzerzhinsk, with an annual nitric acid capacity of about 16,500 tons, and another at Shostka, with an annual capacity of about 8,250 tons. Aided by foreign technologists and equipment, a third, with an annual capacity of about 18,000 tons, was put into operation at the Berezniki plant in April 1932. In addition, an installation producing about 3,000 tons per year of nitric acid, probably by the sodium nitrate process, is believed to have been operating in 1932 at the Okhtenskiy plant in Leningrad. Other plants producing small quantities of nitric acid may have been in operation during the period 1928-32, but further information is lacking. The total annual capacity of the nitric acid plants in operation at the end of 1932 probably was about 55,000 to 65,000 tons. The actual production of nitric acid in 1932, however, probably was only about 20,000 to 30,000 tons because the three largest plants, representing about 70 percent of the capacity, were not put into operation until sometime during that year.

c. Second Five Year Plan (1933-37).

During the period of the Second Five Year Plan (1933-37), the substantial investment made by the USSR in its synthetic nitrogen industry began to show results. Projects initiated during the period of the First Five Year Plan (1928-32) were brought to completion, mainly with the help of foreign technology and equipment, and large nitric acid plants were put into operation at Stalinogorsk, Gorlovka, and Dneprodzerzhinsk. In addition, the capacities of the existing plants at Dzerzhinsk and Berezniki were increased considerably by the installation of additional production equipment. A number of smaller units for the production of nitric acid undoubtedly were installed during this period at plants producing explosives and dyes, but information concerning the dates of installation of these smaller units is almost entirely lacking. The total annual capacity of the Soviet nitric acid plants operating at the end of 1937 is estimated at about 300,000 tons. The production of nitric acid in 1937 is not known, however, and cannot be estimated accurately, because of the lack of information concerning the operations of the new plants and the new units at the existing plants. In view of the large capacity centered in new plants which undoubtedly were still attempting to overcome production difficulties in 1937, it is doubted that production exceeded 50 percent of the total installed capacity.

d. Third Five Year Plan (1938-42).

With respect to nitric acid, the Third Five Year Plan (1938-42) stated only: " ... the production of nitric acid is to be increased considerably, and ... work will be carried out on the production of strong nitric acid, avoiding the use of sulfuric acid." With respect to the nitrogen industry as a whole, the Third Five Year Plan stated: "In the nitrogen industry, the disproportion existing between basic and processing departments will be eliminated; the construction of the first section of the Chirchik Nitrogen Fertilizer Plant and other plants carried over from the Second Five Year Plan will be completed. The construction of the Baku plant and of two or three new nitrogen fertilizer plants is progressing."*

* There is no indication that the plant at Baku was ever built.

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The first section of a plant for the production of synthetic ammonia, nitric acid, and nitrogen fertilizers was put into operation at Kemerovo in 1938. The annual nitric acid capacity of this first section is estimated to have been 40,000 to 45,000 tons. A smaller unit manufacturing nitric acid also is believed to have been put into operation at the Aleksin Chemical Combine No. 100 in 1938. The capacity of this unit is not known, but estimates of propellant and explosives production indicate that it probably did not exceed 10,000 tons of nitric acid per year. In late 1940, as envisioned in the Third Five Year Plan, the first section of the Chirchik Nitrogen Fertilizer Plant was put into operation. The nitric acid capacity of this first section is believed to have been about 500 to 600 tons per day of weak acid, equivalent to about 100,000 to 120,000 tons* per year of 100 percent nitric acid. Other smaller plants undoubtedly were put into operation in the period from 1938 to 1940, but further information is lacking.

A survey of the information concerning the nitric acid plants reported to be in operation in 1940,** the last full year of operation before the German invasion, indicates that the total Soviet nitric acid capacity in that year probably was about 460,000 tons. Based on this estimate of capacity, the production of nitric acid in the USSR in 1940 probably was about 400,000 tons. The production of concentrated nitric acid in the USSR in 1940 was [redacted] to have been 232,000 tons, 7/ or about 225,000 tons*** of 100 percent nitric acid. Based on a total 1940 estimated production of 400,000 tons of 100 percent nitric acid and a concentrated nitric acid production of 232,000 tons, the weak acid production in 1940 was about 318,000 tons, equivalent to about 175,000 tons of 100 percent nitric acid. Most of this weak acid probably was converted to ammonium nitrate for admixture with high explosives such as TNT and picric acid. The outbreak of the war with Germany in mid-1941 brought an abrupt end to Soviet plans for industrial expansion under the Third Five Year Plan.

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e. World War II (1941-45).

The penetration of the German armies in 1941 and 1942 caused the destruction or evacuation of the nitric acid plants at

* Based on an acid strength of 55 percent nitric acid by weight.
** Excluding the Chirchik plant, which was not put into operation until November 1940 and did not contribute significantly to the total 1940 output.
*** Based on an acid strength of 97 percent nitric acid by weight.

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to this hypothesis. All things considered, it is probable that the total production of nitric acid in the USSR in 1943 was about 400,000 tons of 100 percent acid.

In early 1944 the second section of the Chirchik plant, having an estimated capacity of about 60,000 tons of nitric acid per year, was put into operation. An additional section of the Chernorech'ye Chemical Combine imeni Kalinin near Dzerzhinsk, having an estimated yearly capacity of about 35,000 to 40,000 tons, also is believed to have been put into operation in 1944. It appears from these estimates that the production of nitric acid in the USSR probably reached about 500,000 tons in 1945 and that about 400,000 tons of this total probably was produced as concentrated nitric acid.

In spite of the strenuous efforts made by the USSR during World War II to increase the production of nitric acid, a critical shortage of this chemical probably would have been experienced had it not been for the aid furnished to the USSR under Lend-Lease. Under Lend-Lease, sometime during the period from 1941 to 1945, the USSR received a complete nitric-acid-manufacturing plant with a capacity of 30 tons per day of nitric acid. 12/ In addition, the USSR received large quantities of ammunition, smokeless powder, TNT, dynamite, and other high explosives; ammonium nitrate; colloxylin; aniline and chemicals derived from aniline; lacquers; and cellulose film base. 13/ The nitric acid equivalent contained in these products shipped to the USSR is estimated to have been about 250,000 to 300,000 tons, which was approximately equal to the entire production of nitric acid in the USSR in 1942.

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

The Fourth Five Year Plan (1946-50) gave no information concerning Soviet plans for the production of nitric acid. Furthermore, the yearly and quarterly reports concerning fulfillment of the plans during this period, as well as the report concerning fulfillment of the Fourth Five Year Plan, did not reveal anything with respect to Soviet production of this chemical.

Accurate estimates of the annual production of nitric acid in the USSR during the immediate postwar years cannot be made from studies of plant operations, because of insufficient information concerning the plants, many of which were undergoing extensive rehabilitation and expansion during this period. By 1950, however,

the restoration of the industry was almost completed, and production from installed facilities probably was approaching a peak. A survey of the plant information indicates that the output of nitric acid in the USSR in 1950 was about 1,035,000 tons, or in the range of 900,000 to 1,100,000 tons. Estimates of Soviet production of nitric acid for the years 1946 through 1949 have been established by means of interpolation and are presented in Table 1.*

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

The Fifth Five Year Plan (1951-55) did not give any direct information concerning Soviet plans for the expansion of the nitric acid industry.** By analyses of the plant information, however, the production of nitric acid in 1951 is estimated at 1,065,000 tons, an increase of about 30,000 tons over 1950 output. It is believed that this increased output was effected principally by putting new capacity into operation at the Dneprodzerzhinsk plant.

In 1952 an estimated additional production of 107,000 tons of nitric acid was realized by putting the new plants at Severo Donetsk and Kirovakan into operation and by improving the operating efficiency of the new unit at Dneprodzerzhinsk, thus raising the output in 1952 to an estimated 1,172,000 tons.

The output of nitric acid in the USSR in 1953 will amount to an estimated 1,195,000 tons, an increase of about 23,000 tons over

* Table 1 follows on p. 15.

** One provision of the Fifth Five Year Plan might be construed as indirect evidence of Soviet plans for the expansion of the nitric acid industry. The Plan provides "for an expansion in the production capacities of ammonia and mineral fertilizers." The Plan also states that the goal for the production of mineral fertilizers in 1955 is an 88-percent increase over 1950 output. If it is assumed from this statement that the production of nitrogen fertilizers, which represents about one-third of the production of mineral fertilizers, will follow a similar pattern and increase about 88 percent, then it can probably be assumed that about the same percentage increase is planned for the production of nitric acid. An 88-percent increase over the estimated 1950 production of nitric acid would amount to about 1,950,000 tons, or in the range from 1,690,000 to 2,070,000 tons, which might be tentatively regarded as the Soviet goal for production of nitric acid in 1955.

1952 production. Practically all of this increased output probably will be supplied by the new plants at Severo Donetsk and Kirovakan.

Production of nitric acid in 1954 and 1955 cannot be estimated with any certainty from the point of view of plant operations. Additional production may be realized from improved operations and increased capacity at the Severo Donetsk and Kirovakan plants. The plants reported as under construction at Rustavi and Rion in the Georgian SSR and at Gubakha in the Ural Mountains are also potential, but definitely uncertain, sources of new production. In view of these uncertainties regarding Soviet production of nitric acid for the years beyond 1953, estimates of output for 1954 and 1955 have been established by means of mathematical extrapolation. The extrapolation indicates that Soviet production of nitric acid in 1954 and 1955 will level off at about 1,211,000 tons.

The production of 1,211,000 tons, estimated for 1954 and 1955, is considered a fairly low estimate of production. If all or a substantial part of the potential sources of new nitric acid output should be put into operation in the period 1953-55, then it is probable that the 1955 estimate of 1,211,000 tons, which was derived by mathematical extrapolation, will be exceeded.

Summarizing the production data contained in the foregoing pages, the estimated output of nitric acid in the USSR in selected years from 1913 to 1955 is given in Table 1.

The growth of nitric acid production in the USSR from 1932 to 1955 is illustrated in the accompanying chart.*

2. Comparison of Soviet Production of Nitric Acid with US Production.

For the purpose of comparison, the production of nitric acid in the USSR and in the US in 1947-51 is given in Table 2.**

3. Regional Distribution of Production.

The estimated output of nitric acid in each of the economic regions of the USSR in 1953 is given in Table 3.***

* Following p. 16.
** Table 2 follows on p. 16.
*** Table 3 follows on p. 16.

Table 1

Estimated Production of Nitric Acid in the USSR
Selected Years, 1913-55

Tons

Year	Weak Nitric Acid [a]	Concentrated Nitric Acid [b]	Total Nitric Acid [c]	Probable Range of Estimate
1913	N.A.	N.A.	2,872	
1916	N.A.	N.A.	11,727	
1932	N.A.	N.A.	25,000	20,000 to 30,000
1937	N.A.	N.A.	150,000	100,000 to 200,000
1940	318,000	232,000	400,000	325,000 to 425,000
1942	102,000	252,000	300,000	250,000 to 350,000
1943	123,000	342,000	400,000	350,000 to 450,000
1945	N.A.	N.A.	500,000	400,000 to 525,000
1946	N.A.	N.A.	605,000	500,000 to 640,000
1947	N.A.	N.A.	710,000	600,000 to 755,000
1948	N.A.	N.A.	820,000	700,000 to 870,000
1949	N.A.	N.A.	930,000	800,000 to 990,000
1950	N.A.	N.A.	1,035,000	900,000 to 1,100,000
1951	N.A.	N.A.	1,065,000	930,000 to 1,130,000
1952	N.A.	N.A.	1,172,000	1,000,000 to 1,200,000
1953	N.A.	N.A.	1,195,000	1,025,000 to 1,225,000
1954	N.A.	N.A.	1,211,000	1,040,000 to 1,260,000
1955	N.A.	N.A.	1,211,000	1,040,000 to 1,300,000

a. The production figures in this column are based on an acid strength of 55 percent nitric acid by weight.
b. The production figures in this column are based on an acid strength of about 97 percent nitric acid by weight.
c. The production figures in this column are based on 100 percent nitric acid.

Table 2

Estimated Production of Nitric Acid in the USSR
As Compared with US Production a/
1947-51

Year	Soviet Production (Tons)
1947	710,000
1948	820,000
1949	930,000
1950	1,035,000
1951	1,065,000

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Table 3

Estimated Production of Nitric Acid in the USSR by Economic Regions
1953

Economic Region	Amount (Tons)	Percent of Total
Northwest	3,000	0.2
Ukraine	328,000	27.5
Transcaucasus	50,000	4.2
Volga	30,000	2.5
Central European USSR	289,100	24.2
Urals	160,000	13.4
West Siberia	85,000	7.1
Central Asia	245,000	20.5
Far East	5,000	0.4
Total	1,195,100	100.0

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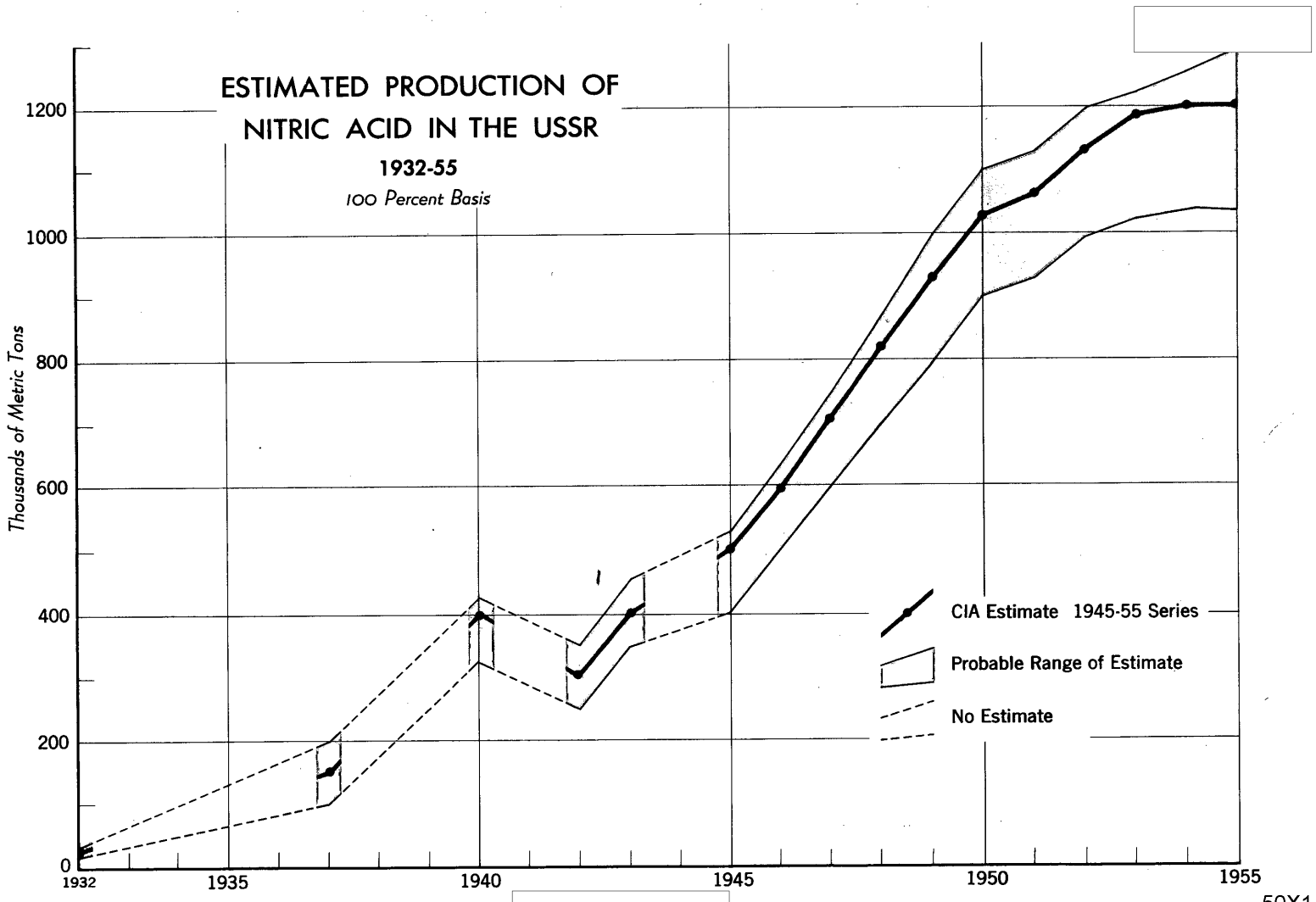

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4. Location and Estimated Production of Plants.

The location and estimated production of nitric acid plants in the USSR are given in Table 4. Studies of each of these installations, outlining the information and methods used in arriving at the estimates of output, are attached to this report in Appendix A.

Table 4

Location and Estimated Production of Nitric Acid Plants in the USSR a/*
1952-53

Tons

Economic Region and City	Plant	Production 1952	Production 1953
Northwest			
Leningrad	Okhtenskiy Chemical Combine	3,000	3,000
Leningrad	Krasnyy Khimik Chemical Plant	N.A.	N.A.
Ukraine			
Gorlovka	Sergo Ordzhonikidze Nitrogen Fertilizer Plant	77,000	77,000
Dneprodzerzhinsk	Nitrogen Fertilizer Plant	180,000	180,000
Petrovenka	Petrovskiy Explosives Plant	6,000	6,000
Severo Donetsk	N.A.	39,000	50,000
Shostka	Powder Plant	7,500	7,500
Stalino	Karpov Nitrating Plant	7,500	7,500
Transcaucasus			
Kirovakan	Electrochemical Plant	38,000	50,000

* Footnote for Table 4 follows on p. 19.

Table 4

Location and Estimated Production of Nitric Acid Plants in the USSR a/ 1952-53 (Continued)

Tons

Economic Region and City	Plant	Production 1952	Production 1953	
Volga				
Bondyuzhskiy	Karpov Chemical Plant	N.A.	N.A.	
Kazan'	Lenin Powder Plant	30,000	30,000	
Central European USSR				
Aleksin	Chemical Combine [redacted]	10,000	10,000	50X1
Dzerzhinsk	Chernorech'ye Chemical Combine imeni Kalinin	65,000	65,000	
Kineshma	Frunze Chemical Plant [redacted]	13,000	13,000	50X1
Moscow	Ugreshskiy Chemical Plant	2,500	2,500	
Moscow	Dorogomilov-Frunze Chemical Plant	3,400	3,400	
Moscow	Voykov Chemical Plant	1,700	1,700	
Roshal'	Kosyakov Powder Plant [redacted]	10,500	10,500	50X1
Shchelkovo	Shchelkovo Chemical Plant	18,000	18,000	
Stalinogorsk	Stalin Chemical Combine	150,000	150,000	
Tambov	Krasnyy Bolshevik Powder Plant [redacted]	15,000	15,000	50X1
Urals				
Berezniki	Voroshilov Chemical Combine	160,000	160,000	
Zakamsk	Chemical Plant	N.A.	N.A.	
West Siberia				
Kemerovo	Nitrogen Fertilizer Combine	85,000	85,000	

Table 4

Location and Estimated Production of Nitric Acid Plants in the USSR a/
1952-53
(Continued)

Tons

Economic Region and City	Plant	Production 1952	Production 1953
Central Asia			
Chirchik	Stalin Electrochemical Combine	245,000	245,000
Far East			
Kuybyshevka-Vostochnaya	Powder Plant	5,000	5,000
Total		1,172,100	1,195,100

a. Nitric acid plants have been reported at the following locations as under construction, as planned, or as in operation, but production at these plants has not been confirmed: Rubezhnoye in the Ukraine; Derbent and Kamensk in the Lower Don-North Caucasus; Rion and Rustavi in the Transcaucasus; Dzerzhinsk and Voskresensk in Central European USSR; Chelyabinsk, Gubakha, Kyshtym, Magnitogorsk, Neyvo-Rudyanka, Nizhniy Tagil, Shaytanka, and Zlatoust in the Urals; Shorsu in Central Asia; and Vladivostok in the Far East.

5. Stockpiling.

Although information on Soviet practice is lacking, it can be stated with near certainty that nitric acid is not stockpiled in the USSR. Such large quantities of nitric acid are used in wartime that prohibitive amounts of stainless steel or aluminum alloy tankage would be required for the stockpiling of a significant quantity of this corrosive acid. The more convenient practice, and the one undoubtedly followed in the USSR, is that of stockpiling the finished and semi-finished products such as filled munitions, high explosives, and ammonium nitrate.

6. Trade.

No information is available concerning Soviet trade in nitric acid either with other Soviet Bloc or with non-Bloc countries. Although information is lacking, trade in nitric acid on a small scale between the USSR and other Bloc countries is possible, but the quantity of nitric acid involved in any such trade would be insignificant relative to Soviet production.

7. Total Supply.

In view of the probable nonexistence of a stockpile of nitric acid in the USSR as well as the absence of significant trade, the total supply of nitric acid available to the USSR in 1953 will be about equal to the estimated production: that is, 1,195,000 tons.

IV. Input Requirements.

According to a recent Soviet publication, the raw materials and electric power required for the manufacture of 1 ton of nitric acid by the atmospheric pressure process and by the elevated pressure process are as follows 15/:

1. Atmospheric Pressure Process.

	Amount
Ammonia	290 to 300 kilograms
Platinum Catalyst	0.05 to 0.06 grams
Cooling Water	70 to 120 cubic meters
Steam	100 to 120 kilograms
Electrical Energy	80 to 100 kilowatt-hours

2. Elevated Pressure Process.

	Amount
Ammonia	290 to 300 kilograms
Platinum Catalyst	0.15 to 0.20 grams
Cooling Water	90 to 170 cubic meters
Steam	190 to 600 kilograms
Electrical Energy	340 to 500 kilowatt-hours

Soviet production of nitric acid in 1953 is estimated at about 1,195,000 tons, but the proportionate production by the atmospheric and elevated pressure processes is not known. Therefore, in order to calculate the raw material requirements from the consumption coefficient data given above, it is necessary to use consumption coefficients which represent averages of the values given for each process. Based on the data given, the average consumption coefficients for the manufacture of 1 ton of nitric acid in the USSR are as follows:

	Amount
Ammonia	290 to 300 kilograms
Platinum Catalyst	0.10 to 0.13 grams
Cooling Water	80 to 145 cubic meters
Steam	145 to 360 kilograms
Electrical Energy	210 to 300 kilowatt-hours

These average raw material consumption coefficients have been used in computing the raw material requirements for the manufacture of an estimated 1,195,000 tons of nitric acid in the USSR in 1953. The results are given in Table 5.

Table 5

Raw Material Requirements for the Manufacture of Nitric Acid in the USSR 1953

Raw Material	Amount
Ammonia	346,000 to 358,000 tons
Platinum Catalyst	120 to 155 kilograms
Cooling Water	96 to 173 million cubic meters
Steam	173,000 to 430,000 tons
Electrical Energy	250 to 360 million kilowatt-hours

V. Consumption.

Soviet requirements for nitric acid in 1953 cannot be estimated, because of the complete lack of information regarding the magnitude of explosives production, because estimates of Soviet nitrogenous fertilizer production are somewhat controversial, and because the available information does not permit calculation of the nitric acid requirements for the manufacture of chemicals and for many miscellaneous uses. In lieu of requirements, Table 6 gives the probable consumption of nitric acid, by broad category of use, in the USSR in 1953.

Table 6

Estimated Consumption of Nitric Acid in the USSR a/
1953

Use	Amount (Tons)	Percent of Total
Nitrogenous Fertilizers	700,000	58.5
Explosives (Industrial and Military)	400,000	33.5
Other	95,000	8.0
Total	1,195,000	100.0

a. The methods used in arriving at these estimates are presented in Appendix B.

VI. Capabilities, Vulnerabilities, and Intentions.

1. Capabilities.

The supply of nitric acid available to the USSR in 1953 is estimated at 1,195,000 tons (probable range: 1,025,000 to 1,225,000 tons), equivalent to about 44 percent of US 1951 production. Although Soviet requirements for nitric acid in 1953 are not known, this amount should be ample to meet the requirements for explosives, to fill all industrial demands, and, in addition, to make hundreds of thousands of tons of nitrogenous fertilizers. In the event of a general war in the near future, much of that nitric acid which

is allocated for the production of ammonium nitrate would be concentrated and reallocated for the manufacture of high explosives and smokeless powder and for use as rocket fuel oxidizer, although this latter requirement would be small relative to the total military requirement. In addition, practically all of the remaining production of ammonium nitrate delivered to agriculture for use as fertilizer would be reallocated to the explosives industry for admixture with TNT, picric acid, hexogen, and other high explosives. If the effects of wartime destruction are ignored, the output of nitric acid in the USSR is sufficient to sustain a prolonged military effort of major proportions. This conclusion appears to be justified when it is considered that the peak annual production of nitric acid in the USSR during World War II was only about one-third as large as the estimated 1953 output.

50X1

3. Intentions.

Since 1928 the USSR has placed great emphasis on the development of the nitrogen industry, and the output of this industry in 1953, relative to US production, is greater than the output of any other branch of the Soviet chemical industry. The Soviet intention here is quite clear. During peacetime, practically unlimited supplies of ammonia and nitric acid, in the form of ammonium nitrate, can be applied to the soil as fertilizer. In the event of war, these

supplies can be diverted quickly and easily to the manufacture of military explosives. The continued emphasis placed on the expansion of the industry by the USSR indicates an acute awareness of the necessity for having a large explosives production potential as soon as possible.

50X1

APPENDIX A

NITRIC ACID PLANTS IN THE USSR

I. Plants on Which There Is Reliable Information.

1. Okhtenskiy Chemical Combine. 16/

a. Location. Leningrad, Leningrad Oblast (Northwest, Ia).
b. Coordinates. [redacted] 50X1
c. Estimated Annual Production of Nitric Acid. 3,000 tons per year for 1952-53.
d. Comment. [redacted] listed nitric 50X1 acid as one of the products of this plant and stated that the 1932 plan for production was 3,000 tons. This plant probably was destroyed during World War II. Although no postwar information is available, reconstruction to prewar status is assumed.

2. Krasnyy Khimik (Red Chemist) Chemical Plant. 17/

a. Location. Leningrad, Leningrad Oblast (Northwest, Ia).
b. Coordinates. [redacted] 50X1
c. Estimated Annual Production of Nitric Acid. Not available.
d. Comment. [redacted] production 50X1 of nitric acid at this plant. Postwar production of nitric acid [redacted] 50X1 [redacted] Quantitatively, the production 50X1 is not known but is believed to be small, since this plant is not a producer of synthetic ammonia.

3. Sergo Ordzhonikidze Nitrogen Fertilizer Plant. 18/

a. Location. Gorlovka, Stalino Oblast (Ukraine, III).
b. Coordinates. [redacted] 50X1
c. Estimated Annual Production of Nitric Acid. 77,000 tons per year for 1952-53.
d. Comment. [redacted] 50X1 [redacted] the existence of four towers which are probably nitric acid 50X1 absorption columns. [redacted] estimate the diameter of these 50X1 columns at 8 meters and the height at 15 to 16 meters. The estimates are probably in error because a tower of these dimensions would be

too wide for its height. Assuming, however, that the dimensions given are approximately correct, the cubic capacity of each absorption column is about 26,500 cubic feet, and the total volume of the absorption system is about 26,500 x 4, or 106,000 cubic feet. If it is further assumed that the absorption is carried out under slight pressure, then about 397 cubic feet of absorption volume would be required for the production of 1 ton of nitric acid per day, and the total capacity of the plant for the manufacture of nitric acid would amount to $\frac{106,000}{397}$, or about 267 tons per day.

[redacted] 50X1

an installation described as follows:

> "8 or 10 heated catalyzer vessels, each of about 1.5 meters in diameter and about 3 meters high, the catalyzers being on wire mesh."

The reference here is obviously to nitric acid converters. With respect to nitric acid converters, a book recently published in the USSR concerning the technology of nitric acid states the following:

> "The most widely used apparatuses (converters) have a diameter of 1.1 and 2 meters, more rarely 2.8 meters ... . The productive capacity of apparatuses (converters) with a diameter of 1.1 meters amounts to 2.5 to 3 tons of ammonia oxidized per 24 hours, and at a diameter of 2 meters amounts to 6 to 10 tons per 24 hours."

If it is assumed that the 8 or 10 converters are actually 2 meters in diameter instead of the 1.5 meters reported, that each of these converters is operated at atmospheric pressure, and that each has the capacity for oxidizing an average of 8 tons of ammonia per 24 hours, then the capacity of this plant amounts to 64 to 80 tons of ammonia oxidized per 24 hours, which is equivalent to a nitric acid capacity of about 192 to 240 tons per day.

It appears, therefore, based on the information concerning the oxidation and absorption systems of this plant, that the nitric

acid capacity amounts to about 240 to 267 tons per day, or to about 90,000 tons per year. Assuming that 1952 production was about 35 percent of installed capacity, the output of nitric acid at this plant in 1952 amounted to an estimated 77,000 tons. No increase of production is estimated for 1953.

4. Nitrogen Fertilizer Plant. 19/

a. Location. Dneprodzerzhinsk, Dnepropetrovsk Oblast (Ukraine, III).

b. Coordinates. [redacted] 50X1

c. Estimated Annual Production of Nitric Acid. 180,000 tons per year for 1952-53.

d. Comment. The existence of a considerable amount of conflicting information regarding both the nitric-acid-processing equipment and the production of ammonium nitrate at this plant complicates any attempt at an accurate estimate of nitric acid production. For example, [redacted] that the ammonia oxidation equipment in 1949 consisted of 20 converters, each 2.5 meters in diameter, whereas [redacted] the existence of 10 converters, each about 3 meters in diameter. Regarding the absorption system, [redacted] 9 absorption columns were installed and that only 6 were operating during the period of observation in 1948 and 1949. [redacted] estimate the height of the columns at 25 to 30 meters and the diameter at 6 to 8 meters. Although the differences in these estimates are apparently small, they result in a considerable variation in the estimates of nitric acid capacity based on the calculation of oxidation and absorption volumes. 50X1 50X1 50X1 50X1 50X1

Therefore, in order to arrive at an estimate of nitric acid production, it is necessary to make certain assumptions which appear to be in conformity with the operations of this plant [redacted] 50X1

If it is assumed that the ammonia oxidation system consists of 20 converters, each with an interior diameter of 2 meters, then the capacity of each converter would be about 30 tons per day of nitric acid. The capacity of the plant, therefore, would be about 20 x 30, or 600 tons per day of nitric acid, which corresponds to a yearly capacity of about 219,000 tons. If it is further assumed that each of the 9 absorption columns is 6 meters in diameter and 25 meters high and that the absorption is carried out under slight pressure, then about 397 cubic feet of absorption volume would be required per daily ton of nitric acid, and the

capacity of the plant would be about 567 tons of nitric acid per day, which corresponds to a yearly capacity of about 207,000 tons. Assuming that 1952 production was about 85 percent of capacity, the production of nitric acid at this plant in 1952 probably was about 175,000 to 185,000 tons.

This estimate is substantiated to some extent by [redacted] 50X1
[redacted] estimates of ammonium nitrate production during 1948 50X1
and 1949. Although these estimates vary from 125 tons to 1,000 tons per day, most of the estimates place the production of ammonium nitrate during 1948 and 1949 in the range of 300 to 400 tons per day. There also is substantial agreement [redacted] 50X1
[redacted] that only 6 of the 9 installed nitric acid absorption 50X1
columns were operating at this time. A production of 300 to 400 tons per day of ammonium nitrate would necessitate a nitric acid production of about 83,000 to 110,000 tons per year solely for the manufacture of ammonium nitrate. [redacted] 50X1
report the shipment of nitric acid from this plant. If it is assumed that about 10,000 tons of nitric acid were being shipped out of this plant annually during 1948 and 1949, then the total annual production of nitric acid during this period probably was in the range from 93,000 to 120,000 tons. Therefore, a 50-percent increase in nitric acid production, effected by putting the remaining 3 absorption columns into operation, should have raised the production of nitric acid in 1952 to about 140,000 to 180,000 tons, which agrees fairly well with the 175,000- to 185,000-ton production figure calculated from the information concerning the installed oxidation and absorption equipment.

5. Plant Name Not Available. 20/

a. Location. Severo Donetsk, Voroshilovgrad Oblast (Ukraine, III).
b. Coordinates. [redacted] 50X1
c. Estimated Annual Production of Nitric Acid. 39,000 tons in 1952; 50,000 tons in 1953.
d. Comment. A nitric acid plant was put into operation at Severo Donetsk in January 1951. However, the synthetic ammonia plant under construction in Severo Donetsk was not completed at that time, and the ammonia for oxidation was being supplied by the Gorlovka nitrogen fertilizer plant [redacted] two large nitric acid 50X1
absorption columns [redacted] Assuming that each 50X1
of these columns has a cubic capacity of 25,000 cubic feet and that

the absorption is carried out under slight pressure, then about 397 cubic feet of absorption volume would be required for the production of 1 ton of nitric acid per day and the daily capacity of the plant for the manufacture of nitric acid would amount to $\frac{50,000}{397}$, or 126 tons, corresponding to an annual capacity of about 46,000 tons. The production in 1951 undoubtedly was much lower than the capacity, owing to the normal difficulties encountered in the starting of a new plant. It is possible that this nitric acid plant was operated only on a test basis in 1951 and that it will not be put into full-scale production until the ammonia synthesis section of the plant is completed. Although information regarding completion of the ammonia synthesis section is lacking, it is assumed, nevertheless, that in 1952 the nitric acid section of this plant operated continuously on a production basis, producing nitric acid from ammonia which was either produced by this plant or shipped in from Gorlovka or from one of the other ammonia synthesis plants. If it is assumed that production in 1952 amounted to 85 percent of capacity, then the output of nitric acid at this plant in 1952 probably was about 39,000 tons.

It is probable that the USSR intends to expand the nitric acid capacity of this plant beyond 46,000 tons. If previous Soviet practice in the construction of ammonia plants is used as an indicator, the first section probably will have an annual capacity of about 50,000 tons of nitrogen. Furthermore, in view of the military importance of both nitric acid and ammonium nitrate, it is logical to expect that the USSR will install sufficient equipment for the conversion of the entire nitrogen production to these two products. If these assumptions are valid, then, after completion of the first section of the plant, the annual capacity for the production of nitric acid and ammonium nitrate probably will be about 112,500 tons and 143,000 tons, respectively. Assuming that the expansion of this plant will continue, it is estimated that the production of nitric acid in 1953 will be about 50,000 tons.

6. Powder Plant. 21/

a. Location. Shostka, Sumy Oblast (Ukraine, III).
b. Coordinates. [redacted] 50X1
c. Estimated Annual Production of Nitric Acid. 7,500 tons per year for 1952-53.

d. Comment. During the period from 1930 to 1932 a US company installed a plant at Shostka for the production of nitric acid. This plant consisted of 2 units for the manufacture of 60 percent nitric acid by the oxidation of ammonia. Each unit consisted of 2 absorption towers and 1 converter. Each of these units had a designed capacity of 11.3 tons of 100 percent nitric acid per day. Thus the total capacity of the plant was 22.6 tons per day, or about 8,250 tons per year of 100 percent nitric acid. All of the 60 percent acid produced was concentrated and used for the manufacture of explosives. At the time this plant was put into operation in 1932, the ammonia used for oxidation was supplied by the Berezniki plant. The Shostka nitric acid and powder plant was in the area occupied by the German armies in World War II and undoubtedly was destroyed. Although postwar information is lacking, it is assumed that this plant has been restored to its former capacity and that it produced about 7,500 tons of nitric acid in 1952. No change of production is estimated for 1953.

7. Petrovskiy Explosives Plant. 22/

a. Location. Petrovenka, Voroshilovgrad Oblast (Ukraine, III).
b. Coordinates. [redacted] 50X1
c. Estimated Annual Production of Nitric Acid. 6,000 tons per year for 1952-53.
d. Comment. [redacted] 50X1 the production of nitric acid at this plant. This installation was destroyed during World War II and restored in 1946. Postwar information reports the production of gunpowder in 1947 at 9 tons per day and explosive bars in 1948 at 20 to 24 tons per day. Based on this information, the production of nitric acid in 1947 and 1948 probably was about 6,000 tons per year. It is assumed that this plant operated in 1952 and produced about 6,000 tons of nitric acid. No change of production is estimated for 1953.

8. Karpov Nitrating Plant. 23/

a. Location. Stalino, Stalino Oblast (Ukraine, III).
b. Coordinates. [redacted] 50X1
c. Estimated Annual Production of Nitric Acid. 7,500 tons per year for 1952-53.

d. Comment. Information published by the USSR states that this plant had the following features:

> "According to the method of I.I. Andreev, at the end of 1916 in Yuzokva (Stalino), the first factory producing nitric acid from ammonia was constructed. Ammonia, obtained from the ammonia water of the coke-benzol plants, served as the raw material for the production of nitric acid. The ammonia was oxidized on platinum gauze under atmospheric pressure in small cast iron contact apparatuses of cylindrical shape (diameter 300 millimeters). The apparatuses had a small productive capacity and gave a low yield of nitric oxide. The nitrose gases leaving the contact apparatuses were cooled in spray coolers made of ferrosilicon. The oxides of nitrogen were absorbed in water in small granite towers with a diameter of 3 meters and a height of 12 to 15 meters."

Other information published by the USSR concerning this plant states that it had a capacity of 10,000 tons per year of ammonium nitrate, which corresponds to a nitric acid capacity of about 7,900 tons per year. The installation was destroyed during World War II, but a chemical reagents price and procurement list published by the USSR indicated that it was again in operation in 1946. It is assumed that this plant was restored to its prewar capacity and that it produced about 7,500 tons of nitric acid in 1952. No change of production is estimated for 1953.

9. Electrochemical Plant. 24/

a. Location. Kirovakan, Armenian SSR (Transcaucasus, V).

b. Coordinates. [redacted] 50X1

c. Estimated Annual Production of Nitric Acid. 38,000 tons in 1952; 50,000 tons in 1953.

d. Comment. The construction of a synthetic ammonia, nitric acid, and ammonium nitrate plant was begun here after World War II, probably sometime during 1946. The construction of this plant lagged, [redacted] and the plant was not operating at the end of 1949. [redacted] it is estimated that this plant was put into operation about January 1952. 50X1 50X1

[redacted] an installation consisting of 50X1
18 pieces of apparatus which are undoubtedly electrolytic oxygen-hydrogen cells of the filter-press type produced by Bamag-Meguin Aktiengesellschaft, Berlin, Germany. [redacted] 50X1
[redacted] they are probably 50X1
Bamag C-500 cells, or Soviet copies of the Bamag cell, which produces about 500 cubic meters of hydrogen per hour. In 24 hours, the entire installation of 18 cells could produce about 216,000 cubic meters of hydrogen. Assuming a 10-percent loss of gas volume through leaks and through the loss of unconverted gases when purging the system of argon, about 2,340 cubic meters of hydrogen are required for each ton of ammonia manufactured. Therefore, from a production of 216,000 cubic meters of hydrogen per day, about 92 tons of ammonia can be manufactured per day. From these data, it appears that the Kirovakan plant has a capacity for the manufacture of about 92 tons of ammonia per day, or about 33,000 to 34,000 tons per year. Since 1952 was the first year of operation for this plant, the total production for the year probably did not exceed 60 percent of capacity, or about 20,000 tons of ammonia.

In view of the importance of both nitric acid and ammonium nitrate to the Soviet military and industrial economies, it is probable that this plant has the capacity to convert all of its ammonia production to these two products. If such is the case, this plant probably has a capacity for the production of about 60,000 to 65,000 tons of nitric acid and 75,000 to 80,000 tons of ammonium nitrate per year.

Another method of estimating the nitric acid capacity of this plant was [redacted] an installation 50X1
consisting of 7 columns fitted with Raschig rings. These columns are 50X1
probably nitric acid absorption columns. [redacted] 50X1
[redacted] 50X1
[redacted] Assuming that the absorption is carried out under slight 50X1
pressure, the absorption volume required per daily ton of nitric acid will amount to about 397 cubic feet. If each of these columns is 20 meters high by 3 meters in diameter, the total absorption volume of the system is 34,800 cubic feet, and the capacity of the plant is approximately 32,000 tons of nitric acid per year. If, however, these columns are each 18 meters high by 3.6 meters in diameter, the capacity of the plant is about 41,500 tons of nitric acid per year. Both of these estimates appear to be low in relation to the estimate of ammonia capacity derived from the information concerning the electrolytic oxygen-hydrogen cells. This is understandable when it is

realized that a small difference in the estimated size of the absorption columns results in a significant difference in the calculated capacity of the plant. For example, if the diameter of each column was actually 4 meters instead of the estimated 3.6 meters, and the height was 20 meters instead of 18 meters, the capacity of the plant would be about 56,500 tons instead of 41,500 tons. It appears, therefore, that the estimate of nitric acid capacity derived from the information concerning the hydrogen-producing equipment may be more reliable than the estimates derived from the absorption column information, and, until further information is received, the nitric acid capacity of this plant is estimated at about 60,000 tons per year. Based on an estimated ammonia production of 20,000 tons in 1952, and assuming that all of the ammonia was converted to ammonium nitrate, the 1952 production of nitric acid at this plant is estimated to have been about 38,000 tons. Production in 1953 is estimated at about 50,000 tons.

10. Karpov Chemical Plant. 25/

a. Location. Bondyuzhski, Tatar ASSR (Volga, VI).
b. Coordinates. [redacted] 50X1
c. Estimated Annual Production of Nitric Acid. Not available.
d. Comment. [redacted] production of ni- 50X1
tric acid at this plant during the early years of World War II. [redacted] 50X1
[redacted] nitric acid is 50X1
one of the products manufactured here. None of these reports, however, gives any clues to quantity of output, but the general tone of the reports indicates that the production of nitric acid is small.

11. Lenin Powder Plant. 26/

a. Location. Kazan', Tatar ASSR (Volga, VI).
b. Coordinates. [redacted] 50X1
c. Estimated Annual Production of Nitric Acid. 30,000 tons per year for 1952-53.
d. Comment. [redacted] estimated production of 50X1
nitric acid at this plant during the early years of World War II at 2,500 tons per month, equivalent to about 30,000 tons per year. Although postwar information concerning the production of nitric acid at this plant is entirely lacking, it is assumed that this plant is operating and that its output in 1952 was substantially the same as estimated [redacted] No change of production 50X1
is estimated for 1953.

12. Chemical Combine [redacted] 27/ 50X1

a. Location. Aleksin, Tula Oblast (Central European USSR, VII).
b. Coordinates. [redacted] 50X1
c. Estimated Annual Production of Nitric Acid. 10,000 tons per year for 1952-53.
d. Comment. [redacted] this 50X1
plant was put into operation in 1938. It sustained only slight war damage, but most of its important installations were evacuated to eastern areas of the USSR. The reconstruction of the plant reportedly began in 1943, and the premises were considerably expanded during the following years. This is primarily an explosives plant, and, [redacted] a new nitric acid plant was installed 50X1
after World War II. Based on very tentative estimates of explosives production, the output of nitric acid in 1952 and 1953 is estimated at about 10,000 tons per year.

13. Chernorech'ye Chemical Combine imeni Kalinin. 28/

a. Location. Dzerzhinsk, Gor'kiy Oblast (Central European USSR. VII).
b. Coordinates. [redacted] 50X1
c. Estimated Annual Production of Nitric Acid. 65,000 tons per year for 1952-53.
d. Comment. An ammonia oxidation plant producing nitric acid by the Fauser process from synthetic ammonia was erected in Dzerzhinsk in 1928. In 1932 a US company installed another nitric acid plant with a production of 50 tons per day. Subsequent to the US installation, another nitric acid plant was installed, probably by the Bamag-Meguin firm of Germany, and the obsolete Fauser unit is believed to have been dismantled. After the installation of the Bamag plant, the total monthly production is believed to have been about 600 tons of nitrogen, equivalent to 2,700 tons of nitric acid. It was reported that this plant was expanded during World War II and that the expansion probably amounted to a doubling of capacity, raising the production of nitric acid to about 5,400 tons per month, or 65,000 tons per year. [redacted] there 50X1
is no evidence of further expansion of this plant, so that production of nitric acid in 1952 and 1953 is estimated at 65,000 tons per year.

14. Frunze Chemical Plant [redacted] 29/ 50X1

a. Location. Kineshma, Ivanovo Oblast (Central European USSR, VII).
b. Coordinates. [redacted] 50X1
c. Estimated Annual Production of Nitric Acid. 13,000 tons per year for 1952-53.
d. Comment. [redacted] listed nitric acid 50X1 as one of the products of this plant and stated that the yearly capacity was reported as 15,000 tons. This plant probably suffered no significant war damage, and, since it is not a producer of synthetic ammonia, it is improbable that the nitric acid capacity has been expanded. The production of nitric acid in 1952 and 1953 is estimated at 85 percent of the reported capacity, or at about 13,000 tons.

15. Ugreshskiy Chemical Plant. 30/

a. Location. Moscow, Moscow Oblast (Central European USSR, VII).
b. Coordinates. [redacted] 50X1
c. Estimated Annual Production of Nitric Acid. 2,500 tons per year for 1952-53.
d. Comment. [redacted] 50X1 nitric acid was one of the products of this plant before World War II. [redacted] 50X1
[redacted] the capacity of this plant for production 50X1 of nitric acid in 1940 was 3,000 tons per year. No postwar information regarding this plant is available. Recognizing that it may have been destroyed during the war, it is assumed that, if destroyed, it has been restored to its prewar capacity and operated in 1952 and 1953, producing about 2,500 tons of nitric acid per year.

16. Dorogomilov-Frunze Chemical Plant. 31/

a. Location. Moscow, Moscow Oblast (Central European USSR, VII).
b. Coordinates. [redacted] 50X1
c. Estimated Annual Production of Nitric Acid. 3,400 tons per year for 1952-53.
d. Comment. [redacted] nitric 50X1 acid was one of the products of this plant before World War II. [redacted] 50X1
[redacted] 50X1

[redacted] the capacity of this plant for production of nitric acid was 4,000 tons in 1940. No further information is available, but, considering that this plant manufactured aniline, dyes, and possibly other products requiring nitric acid, it is probable that a small nitric acid plant was installed here. Recognizing that this plant may have been destroyed during World War II, it is assumed that, if destroyed, it has been restored to its prewar capacity of about 4,000 tons and operated in 1952 and 1953 at about 85 percent of capacity, producing an estimated 3,400 tons of nitric acid per year. 50X1

17. Voykov (formerly Deguninskiy) Chemical Plant. 32/

a. Location. Moscow, Moscow Oblast (Central European USSR, VII).
b. Coordinates. [redacted] 50X1
c. Estimated Annual Production of Nitric Acid. 1,700 tons per year for 1952-53.
d. Comment. [redacted] 50X1

production of nitrogenous fertilizers and technical nitrogenous products at the Degunino Nitric Acid Factory. It is believed that this reference is to the Deguninskiy plant in Moscow. [redacted] 50X1

[redacted] 50X1

[redacted] the Deguninskiy and Voykov plants probably are the same plant. [redacted] estimated that the annual nitric acid capacity of this plant in 1940 was 2,000 tons. It is probable that this plant suffered at least some damage during World War II. Although postwar information is lacking, it is assumed that, if destroyed, it has been reconstructed to its former capacity and operated in 1952 and 1953 at about 85 percent of capacity, producing an estimated 1,700 tons of nitric acid per year. 50X1 50X1

18. Kosyakov Powder Plant [redacted] 33/ 50X1

a. Location. Roshal', Moscow Oblast (Central European USSR, VII).
b. Coordinates. [redacted] 50X1
c. Estimated Annual Production of Nitric Acid. 10,500 tons per year for 1952-53.
d. Comment. [redacted] estimate 50X1

that the prewar production of nitric acid at this plant was about 10,500 tons. This plant may have been destroyed during World War II. Although postwar information is lacking, it is assumed that, if

destroyed, this plant has been restored to its former capacity and operated in 1952 and 1953, producing about 10,500 tons of nitric acid per year.

19. Shchelkovo Chemical Plant. 34/

a. Location. Shchelkovo, Moscow Oblast (Central European USSR, VII).
b. Coordinates. [redacted] 50X1
c. Estimated Annual Production of Nitric Acid. 18,000 tons per year for 1952-53.
d. Comment. [redacted] production of 50X1 nitric acid at this plant and stated that the planned production for 1941 was 18,000 tons. It is probable that this plant suffered at least some destruction during World War II. Although postwar information is lacking, it is assumed that this plant, if destroyed, has been restored to its former capacity and operated in 1952 and 1953, producing about 18,000 tons of nitric acid per year.

20. Stalin Chemical Combine. 35/

a. Location. Stalinogorsk, Moscow Oblast (Central European USSR, VII).
b. Coordinates. [redacted] 50X1
c. Estimated Annual Production of Nitric Acid. 150,000 tons per year for 1952-53.
d. Comment. This is one of the largest synthetic ammonia and nitric acid plants in the USSR. [redacted] 50X1 50X1 before World War II this plant had two sections for the production of nitric acid, each with a capacity of about 100 tons per day, equivalent to a total nitric acid capacity of about 73,000 tons per year. Information published by the USSR in 1934 indicated that three sections were originally intended for installation in this plant. During World War II, this plant was partially destroyed and dismantled but was able to resume operation in late 1945 or early 1946. Postwar information is lacking, but in view of the importance of nitric acid it is reasonable to assume that a third section for the production of nitric acid has been installed since the war. Considering the large capacity of this plant for the production of synthetic ammonia, estimated to be in excess of 100,000 tons per year, it is probable that the installed capacity for production of nitric acid now exceeds 150,000 tons per year.

The production of nitric acid at this plant in 1952 and 1953 is estimated at 150,000 tons annually.

21. Krasnyy Bolshevik Powder Plant [redacted] 36/ 50X1

a. Location. Tambov, Tambov Oblast (Central European USSR, VII).

b. Coordinates. [redacted] 50X1

c. Estimated Annual Production of Nitric Acid. 15,000 tons per year for 1952-53.

d. Comment. This plant is located about 6 miles SSW of Tambov and sometimes is referred to as the Kotovsk Krasnyy Bolshevik Powder Plant [redacted] estimated that this plant produced 7,000 tons of nitroglycerine and 8,000 tons of nitrocellulose per year during the early years of World War II, which would require a nitric acid production of about 15,000 tons per year. The production of explosive bricks also was reported, but these probably were a dynamite-type explosive based on nitroglycerine, requiring no additional nitric acid. Although this plant was beyond the line of advance of the German armies, it is possible that it may have been evacuated or may have suffered some bombing damage. Despite the lack of postwar information, it is assumed that this plant, if damaged or dismantled, has been restored to its former capacity and operated in 1952 and 1953, producing about 15,000 tons of nitric acid per year. 50X1

22. Voroshilov Chemical Combine. 37/

a. Location. Berezniki, Molotov Oblast (Urals, VIII).

b. Coordinates [redacted] 50X1

c. Estimated Annual Production of Nitric Acid. 160,000 tons per year for 1952-53.

d. Comment. The Soviet press reported that the production of ammonium nitrate at this plant was 112,000 tons in 1946 and 35,000 tons in the first quarter of 1947. The production of ammonium nitrate for the entire year of 1947 is estimated, therefore, at about 140,000 tons, which would require a nitric acid production of about 114,000 tons, solely for the manufacture of ammonium nitrate. This is ample evidence that the nitric acid capacity of this plant has been increased since 1935, because the equipment installed in 1932 and 1935 reportedly had a combined capacity of about 90,000 to 100,000 tons per year. In addition, this plant undoubtedly produced concentrated nitric acid and possibly other products derived from nitric acid, such as sodium nitrate, in 1947. Assuming that since

1935 the nitric acid capacity of this plant has been doubled, the capacity is now about 180,000 to 200,000 tons per year. Production in 1952 and 1953 is estimated at 85 percent of capacity, or about 160,000 tons per year.

The plant reportedly had a capacity in 1935 for the production of 200 tons per day of concentrated nitric acid. Assuming that the capacity of the concentrating facilities also has been doubled, the present capacity of this plant for production of concentrated nitric acid is about 400 tons per day, or 140,000 to 150,000 tons per year, which can be obtained at the expense of ammonium nitrate output.

23. Chemical Plant. 38/

a. Location. Zakamsk, Molotov Oblast (Urals, VIII).
b. Coordinates. [redacted] 50X1
c. Estimated Annual Production of Nitric Acid. Not available.
d. Comment. [redacted] production of nitric acid 50X1
at a chemical plant in the Zakamsk area. The chemical plant reportedly is located near a powder factory and supplies the powder factory with nitric acid and nitrate compounds. The available information concerning these two installations is not sufficient to make a quantitative estimate of production.

24. Nitrogen Fertilizer Combine. 39/

a. Location. Kemerovo, Kemerovo Oblast (West Siberia, IX).
b. Coordinates. [redacted] 50X1
c. Estimated Annual Production of Nitric Acid. 85,000 tons per year for 1952-53.
d. Comment. [redacted] 50X1
[redacted] the nitric acid capacity of this plant was 240 tons of weak 50X1
acid per day in 1938. It is believed that the synthetic ammonia capacity of this installation was subsequently doubled in 1941, and it is probable that the nitric acid capacity was increased proportionately to about 480 tons of weak acid per day, equivalent to about 264 tons per day, or 96,500 tons per year of nitric acid, 100 percent basis.

Very little reliable postwar information regarding this plant is available. [redacted] 50X1
"four to six cylindrically shaped metal containers, each approximately

20 meters high and 5 to 7 meters in diameter, interconnected by pipes ... ." Assuming that these were nitric acid absorption columns, each 6 meters in diameter by 20 meters high, and that 6 of these columns were installed, the total absorption volume of the system was about 120,000 cubic feet in September 1949, the date of observation. If the absorption is carried out under slight pressure, about 397 cubic feet of absorption volume are required per daily ton of nitric acid, and the capacity of the plant is $\frac{120,000}{397}$, or about 300 tons per day, equivalent to about 110,000 tons per year of nitric acid. If, however, only 4 of these columns were installed, the capacity of the plant would be about 73,000 tons per year.

It appears, therefore, from the meager information available, that the nitric acid capacity of this plant is about 100,000 tons per year, which seems to be in conformity with the estimated synthetic ammonia capacity of about 70,000 to 75,000 tons per year. The production of nitric acid in 1952 and 1953 is estimated at 85 percent of capacity, or about 85,000 tons.

25. Stalin Electrochemical Combine. 40/

a. Location. Chirchik, Uzbek SSR, Tashkent Oblast (Central Asia, Xb).

b. Coordinates. [redacted] 50X1

c. Estimated Annual Production of Nitric Acid. 245,000 tons per year for 1952-53.

d. Comment. The production of mineral fertilizer by the Chirchik plant in 1941 was estimated at 90,000 tons. A Soviet press statement in 1950 stated that the production of mineral fertilizer at this plant increased almost 3-1/2 times in 9 years. Thus the rate of fertilizer production at the time of the press announcement, January 1950, probably was about 300,000 tons per year. Ammonium nitrate is believed to be the only mineral fertilizer produced by this plant in January 1950. The production of 300,000 tons of ammonium nitrate would necessitate a nitric acid production of about 245,000 tons. Based on this information and no indication of expansion since 1950, the production of nitric acid at this plant in 1952 and 1953 is estimated at 245,000 tons per year.

[redacted] the first section of this plant, having a capacity of 600 tons per day 50X1

of weak nitric acid, was put into operation in late 1940. Also [redacted] a second section was put into production in 1944, but the capacity of the second section is not given. A Soviet press statement in 1947 stated that the construction of a third section of this plant had begun. If it is assumed that the combined capacities of the second and third sections are equal to the capacity of the first section, then the total capacity of the plant is now about 1,200 tons of weak nitric acid per day, equivalent to about 240,000 to 250,000 tons per year of nitric acid, 100 percent basis, which corresponds closely to the 245,000 tons estimated as the annual production in 1952 and 1953. 50X1

26. Powder Plant. 41/

a. Location. Kuybyshevka-Vostochnaya, Amur Oblast (Far East, XII).
b. Coordinates. [redacted] 50X1
c. Estimated Annual Production of Nitric Acid. 5,000 tons per year for 1952-53.
d. Comment. [redacted] 50X1

the production of nitric acid at this plant in addition to production of smokeless powder and explosives. [redacted] 50X1
[redacted] an annual output (presumably in 1941 or 1942) of 6,300 tons of bar powder. If it is assumed that the output of nitric acid at this plant was just sufficient to meet the plant's requirements, the annual production in 1941 and 1942 was about 5,000 tons of nitric acid. Although further information is lacking, it is assumed that this plant operated in 1952 and 1953, producing about 5,000 tons of nitric acid per year.

II. Plants on Which There Is Insufficient Information.

In addition to the foregoing plants which are believed to be producing nitric acid, some evidence exists concerning production at the installations listed below. Most of the information concerning these plants is unconfirmed, and for this reason, or for the particular reasons stated, they are not considered as producers of nitric acid.

1. Rubezhansk Chemical Combine.

a. Location. Rubezhnoye, Voroshilovgrad Oblast (Ukraine, III).

b. Comment. [redacted] production of nitric acid at this plant, but this is not confirmed [redacted] 50X1 50X1 50X1

2. Nitrogen Plant.

a. Location. Derbent, Dagestan ASSR (Lower Don-North Caucasus, IV).

b. Comment. A synthetic ammonia, nitric acid, and nitrogenous fertilizer plant was planned for installation at this site before World War II. No postwar information is available, and it is believed that the plans were abandoned.

3. Kamensk Shakhtinskiy Chemical Combine [redacted] 50X1

a. Location. Kamensk, Rostov Oblast (Lower Don-North Caucasus, IV).

b. Comment. [redacted] this plant produced synthetic ammonia, nitric acid, and explosives before it was destroyed during World War II. Reconstruction is probable, but postwar production of either ammonia or nitric acid is not confirmed. 50X1 50X1

4. Rionskiy Nitrogenous Fertilizer Combine.

a. Location. Rion, Georgian SSR (Transcaucasus, V).

b. Comment. An extract from the Soviet press, dated 1948, stated that "on the basis of electric power from the Rion hydroelectric power plant and coal from Tkvibuli, the Rionskiy Nitrogenous Fertilizer Combinat is being built." Rion is located near Brotseuli, and this may be the same plant that was planned for installation at Brotseuli before World War II. Until further information is available, this installation will be considered as under construction but not as a producing plant.

5. Nitrogen Plant.

a. Location. Rustavi, Georgian SSR (Transcaucasus, V).

b. Comment. [redacted] confirmed the construction of a synthetic nitrogen plant at this location. [redacted] construction has been proceeding at a slow pace, and it is estimated that this plant will not be put into production until after 1953. 50X1 50X1 50X1

6. Chemical Plant [redacted] 50X1

a. Location. Dzerzhinsk, Gor'kiy Oblast (Central European USSR, VII).

b. Comment. During the postwar period a synthetic ammonia plant, utilizing dismantled German equipment, was installed at this location, probably in connection with the production of Kapron, a polyamide synthetic fiber of the nylon type. There are isolated reports of nitric acid production, but this is not sufficiently confirmed.

7. Kuybyshev Chemical Combine.

a. Location. Voskresensk, Moscow Oblast (Central European USSR, VII).

b. Comment. [redacted] production of nitric acid at this plant, but this is not confirmed [redacted] 50X1 50X1 50X1

8. Plant Name Not Available.

a. Location. Chelyabinsk, Chelyabinsk Oblast (Urals, VIII).

b. Comment. [redacted] indicate the production of nitric acid at a plant in the Chelyabinsk area. but such production is not sufficiently confirmed. 50X1 50X1

9. Plant Name Not Available.

a. Location. Gubakha, Molotov Oblast (Urals, VIII).

b. Comment. A 1943 Soviet publication mentioned that a nitrate fertilizer plant was under construction at Gubakha. Subsequent information is not available, and there are no indications that this installation has gone into production.

10. Copper Electrolysis Plant.

a. Location. Kyshtym, Chelyabinsk Oblast (Urals, VIII).

b. Comment. Production of nitric acid at this plant in 1940 [redacted] This has not been confirmed and is regarded as improbable. 50X1

11. Plant Name Not Available.

a. Location. Magnitogorsk, Chelyabinsk Oblast (Urals, VIII).

b. Comment. [redacted] 50X1
[redacted] a synthetic ammonia 50X1
and nitric acid plant was put into operation at Magnitogorsk in 1936. [redacted] 50X1
however, revealed that such a plant did not exist and was not yet under construction at that time. It is believed [redacted] 50X1
[redacted] misled by Soviet plans which had failed to materialize. 50X1
It is possible that this plant may have been constructed and put into operation since 1937, but there is no evidence to support this hypothesis.

12. Plant Name Not Available.

a. Location. Neyvo-Rudyanka, Sverdlovsk Oblast (Urals, VIII).

b. Comment. [redacted] the production of 50X1
nitric acid at a chemical plant in Neyvo-Rudyanka but stated that the production was not confirmed. This information is still unconfirmed, and the existence of a nitric acid plant at this location is regarded as improbable.

13. Plant Name Not Available.

a. Location. Nizhniy Tagil, Sverdlovsk Oblast (Urals, VIII).

b. Comment. [redacted] the production of 50X1
synthetic ammonia at this location, [redacted] 50X1
[redacted] possibility that such a plant was installed at Nizhniy Tagil. 50X1
[redacted] until further information 50X1
is received, Nizhniy Tagil will not be regarded as the site of a nitric acid plant.

14. Plant Name Not Available.

a. Location. Shaytanka, Sverdlovsk Oblast (Urals, VIII).

b. Comment. [redacted] nitric acid 50X1
was produced by a chemical plant at this location. This has not been confirmed.

15. Krasnyy Znamenosets Explosives Plant.

a. Location. Zlatoust, Chelyabinsk Oblast (Urals, VIII).

b. Comment. Production of nitric acid at this plant [redacted] 50X1
[redacted] Small-scale production is regarded 50X1
as possible but has not been confirmed.

16. Plant Name Not Available.

a. Location. Shorsu, Fergana Oblast, Uzbek SSR (Central Asia, Xb).

b. Comment. [redacted] the production of 50X1
nitric acid in a plant at this location, but this has not been confirmed.

17. Plant Name Not Available.

a. Location. Vladivostok, Primorskiy Kray (Far East, XII).

b. Comment. The Manchurian Chemical Company Plant at Dairen, which produced synthetic ammonia, nitric acid, and nitrogenous fertilizers, was dismantled by the Soviets and [redacted] transported to Vladivostok. There is no evidence, however, that this plant was re-erected in Vladivostok. 50X1

Next 9 Page(s) In Document Denied

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