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ECONOMIC INTELLIGENCE REPORT

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THE MACHINE TOOL INDUSTRY IN THE USSR



CIA/RR 47

22 November 1954

CENTRAL INTELLIGENCE AGENCY

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(ORR Project 34.229)

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CONTENTS

	<u>Page</u>
Summary	1
I. Introduction	2
A. General	2
B. History	3
C. Technology	4
D. Organization	5
II. Supply	6
A. Plants and Production	6
1. Estimated Production	6
2. Plants	6
B. Imports	9
C. Inventory	12
III. Demand	12
A. Use Pattern	12
B. Exports	13
C. Substitutes	14
IV. Future Expansion	14
A. Existing Capacity	14
B. Expansion Under Way or Projected	14
C. Requirements for Plant Expansion or Conversion	15
V. Inputs	16
A. For Production	16
B. Expansion	18

S-E-C-R-E-T

S-E-C-R-E-T

	<u>Page</u>
VI. Vulnerabilities and Intentions	18
A. Vulnerabilities	18
B. Intentions	18

Appendixes

Appendix A. Summary of Available Data on Machine Tool Plants in the USSR, Primary Producers	21
Appendix B. Summary of Available Data on Machine Tool Plants in the USSR, Partial Producers	23
Appendix C. Summary of Available Data on Machine Tool Plants in the USSR, Ancillary Producers	25
Appendix D. Definitions	27
Appendix E. Technology	31
Appendix F. Methodology	37



50X1

Tables

1. Estimated Production of Metal-Cutting Machine Tools in the USSR, 1927-54	7
2. Comparison of Production of Machine Tools by Weight in the USSR and in the US	8
3. Distribution of Plants and Percent of Estimated Machine Tool Production by Economic Region in the USSR, 1954	10

S-E-C-R-E-T

S-E-C-R-E-T

	<u>Page</u>
4. Calculated Input Requirements for Estimated Production of Machine Tools in the USSR, 1954	17
5. Comparison of Two Production Estimates for the Machine Tool Industry in the USSR, 1940 and 1945-51	38
6. Published Information on Ratio of Change in Plans and Production of Machine Tools in the USSR, 1946-51	39
7. Published Inventory of Machine Tools in the USSR	44
8. Calculated Inventory of Machine Tools in the USSR, 1940-54	45
9. Proportions of Metals Used in Machine Tools in the US, 1947	46
10. Conversion to B.t.u.'s of Fuels Used by the Machine Tool Industry in the US, 1947	50

Illustrations

	<u>Following Page</u>
Figure 1. USSR: Organization of the Machine Tool Industry, 1954 (Chart)	6
Figure 2. USSR: Estimated Production of Machine Tools, 1927/28-1954 (Chart)	6
Figure 3. USSR: Machine Tool Producing Plants (Map)	10

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S-E-C-R-E-T

THE MACHINE TOOL INDUSTRY IN THE USSR*

Summary

The machine tool industry in the USSR has the current active capacity to support any anticipated program of industrial expansion and has sufficient reserve facilities to meet the needs of a wartime economy. Consisting of fewer than 100 plants with a labor force of about 100,000, the industry has an estimated production for 1954 of 92,000 machine tools. The rate of production is steadily rising. The estimated value of machine tool production in the USSR during 1954 is 1 billion dollars -- an amount equaling the estimated value of machine tool production in the US during that year.

The current inventory of machine tools in the USSR is estimated at 1.5 million units, or about 65 percent of the US inventory in 1953. At least 65 percent of the Soviet tools have been produced since World War II and are consequently of modern, efficient design, whereas only 45 percent of the US inventory has been produced during the past 10 years.

The machine tool industry has always been able to meet or exceed its quotas because it is given a high priority in government planning and makes small demands on the industrial resources of the USSR. Any type of machine tool could be produced with the facilities, materials, and skilled labor available. In case of war, the available plant space could be increased more than 50 percent by curtailment of present unrelated production.

The industry is undertaking an intensive research and development program, not only to improve the quality of Soviet machine tools, but also to develop more rapid production methods. Soviet tools are already precise and efficient, even by Western standards, and experimentation with unconventional types has received more attention than

* The estimates and conclusions contained in this report represent the best judgment of the responsible analyst as of 30 June 1954.

S-E-C-R-E-T

S-E-C-R-E-T

it has in the US. Superior production methods are made possible by standardization of components and conveyor assembly techniques. In the US, diversification of models usually renders conveyor lines impracticable.

Information on the types produced is sparse, but there is evidence that the industry is producing a large number of the heavier, special-purpose units.

When the Russians consider their inventory satisfactory, they can be expected to enter the world market on a large scale. They have advertised extensively and have signed reciprocal trade agreements to export machine tools. Thus far, however, their shipments have been insignificant and have been confined to the Soviet Bloc countries. At the present rate of production, the Soviet inventory requirement should be filled by the end of the next Five Year Plan, and it is likely that Soviet machine tools will begin to appear on the world market.

Such an increase in exports may be taken as evidence that the Soviet machine tool inventory is adequate to meet estimated wartime demands. There is no indication whether Soviet planning has considered the vulnerability to air attack of the machine tool industry. Nearly half of Soviet production is concentrated in the Central Region, 30 percent in Moscow Oblast alone. In addition, production of certain essential types is concentrated in a few individual plants.

I. Introduction.

A. General.

The machine tool industry in any country is a key industry in peacetime and a strategic one in preparing for war. Interchangeable parts made possible by this industry are the foundation of modern mass production, civilian and military. Machine tools are the producers of other machines and are the only machines which are able to reproduce* themselves. They are used in experimentation, production, and

* See Appendix D for definition.

S-E-C-R-E-T

S-E-C-R-E-T

maintenance and repair of industrial equipment. Although the industry represents a small part of capital investment, material inputs, and number of employees of an industrialized country, the level of industrialization of a country depends to a large extent upon the size and quality of its machine tool inventory. 1/*

B. History.

Before the Revolution of 1917, Russia was not a large producer of machine tools. Predominantly agricultural, the country filled most of its relatively small requirements by imports. Machine tool production was 1,500 units in 1913. 2/ The machine tools in use were predominantly of simple design. In 1918, 76 percent of the inventory was of foreign origin. 3/

Significant development of the Soviet machine tool industry began with the First Five Year Plan (1928-32). Production and inventory grew in quantity and variety until the German invasion in June 1941. At this time, machine tool production dropped sharply because of the destruction of plants, the movement of facilities to the east, and the conversion of the industry to the production of war materials. By December 1941 the German advance had cut off an estimated 70 percent of the Soviet machine tool producing capacity. 4/ Total war losses of the Soviet machine tool industry were 18 machine tool plants 5/ and 175,000 machine tools 6/ out of a 1940 inventory of 630,000 machine tools. 7/

During the Fourth Five Year Plan (1946-50), machine tool building capacity was increased by restoration of the 18 machine tool plants destroyed by the Germans. Two new plants were constructed for the production of heavy machine tools and three new plants for the production of combination and special machine tools. 8/ In late 1947 or early 1948, the prewar (1940) production rate of 49,000 units was attained as planned. 9/ In 1950 the enterprises under the Ministry of Machine Tool Construction fulfilled their planned production by 102 percent, 10/ accounting for about 75 percent of the total production. Although a figure is not available for the nonministry plants, they are believed to have made up the remaining 25 percent of the total output.

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S-E-C-R-E-T

The Fifth Five Year Plan (1951-55) goals are "to expand substantially the existing capacities and commission new capacities for the manufacture of the big machine tools, cutting machines, and presses, as well as precision measuring instruments, and instruments for the automatic guidance of technological processes." ^{11/} There is no evidence of new plant construction since 1950. Existing facilities are being utilized more efficiently. The Soviet postwar experience in machine tool building is yielding machine tools that are much more productive and of much better quality than the prewar products.

C. Technology.

Whenever any industry makes a major shift from one product to another, it usually requires a corresponding shift in the types of machine tools produced. Soviet machine tool technology has been able to cope with these conversions, even the major ones of World War II. Considering the limited Soviet experience, the solutions of conversion problems were surprisingly successful.

Since World War II, the industry has progressed from copying foreign machine tools to designing and building complex, electronically controlled machines equal to any in the US technology and is also building larger machine tools than the US has ever built. Standardization of basic types of machine tools is going on to a greater degree than in the US, and will aid the USSR to mass-produce more types of machine tools in the near future. Production methods in a few plants equal or surpass US methods.*

Research in the variety of fields related to machine tool building is carried out on a much greater scale in the USSR than in the US. Soviet centralized control of research plants and facilities tends to produce results that can be disseminated throughout the industry more quickly than the results of research done in the US by individual companies. Technical assistance was offered by the USSR to foreign countries for building, remodeling, and modernizing machine tool plants in 1953. ^{12/} Technology in this industry at the present time should enable the USSR to convert to a wartime production economy without any major difficulty.

* See Appendix D.

S-E-C-R-E-TD. Organization.

Since April 1954 the production, design, and sales of machine tools in the USSR have been under the direction and control of the Ministry of Machine Tool Building and Tool Industry, headed by A.I. Kostousov. ^{13/} Figure 1* shows the organization chart of the machine tool industry in the USSR in 1954, including the subordinate bodies mentioned under the ministry which has controlled the industry at various times from 1948 up to 1953. ^{14/} It is believed that this chart portrays the current status of the organization.

The industry has been reorganized twice since 1953. In March of 1953 the ministry, then known as the Ministry of Machine Tool Building, was given main administration status under a reorganized Ministry of Machine Building headed by M.Z. Saburov. In April 1954 it was changed back to ministerial status, headed again by A.I. Kostousov, and the name was changed to the Ministry of Machine Tool Building and Tool Industry. The announcements of the above changes specified only those at ministry level; therefore the exact status of the main administrations shown in Fig. 1 is not known during the period of control by the Ministry of Machine Building, March 1953 to April 1954.

The dominant personality of the industry is the present Minister, A.I. Kostousov. He was first associated with this industry as a student of the Stalin Institute for Machine Tools and Precision Instruments. He is the author of articles on machine tool technology and production and was among a group of machine tool experts receiving a Stalin Prize in 1947. His first high-level position in the industry was in 1946 as Deputy Minister of Machine Tool Construction. In 1949 he became the Minister and remained at this post till 1953, despite very strong criticism of him in the press, which accused him of "slowness in introducing and mastering new technology." In March 1953, he became Deputy Minister of Machine Building and in April 1954 was again appointed to head the present ministry. ^{15/}

* Following p. 6.

S-E-C-R-E-TII. Supply.A. Plants and Production.1. Estimated Production.

Production of machine tools in the USSR rose from 1,800 units in 1927-28 to a prewar peak of 55,000 units in 1939. As a result of the German invasion, production dropped to 10,000 units in 1942. Postwar recovery has been rapid, with the result that the estimated production for 1954 is 92,000 units.* Table 1** presents estimates of the annual production of machine tools in the USSR in 1927-54, and Figure 2*** presents these data in graphic form.

The rate of growth of the Soviet machine tool inventory has declined slightly since 1950, but the annual unit production is now higher than the normal peacetime output of the US.

It is probable that the Russians intend to level off their production at approximately 100,000 units per year. This output could be attained by an increase in productivity without any additional plant capacity. An increase in productivity would mean an increase in the number of light-type units produced.

A comparison of Soviet and US production of machine tools according to weight is given in Table 2.**** Percentages for the USSR are estimates for 1954. Percentages for the US are the latest data available for 1952.

2. Plants.

The machine tool industry, originally concentrated in the Moscow area and around other industrial cities in European USSR, has to some extent been diversified, partly as a conscious effort under the planning era and partly under the pressure of the German invasion. The original locational pattern, however, has been only slightly modified. In 1954, more than 40 percent of the estimated production

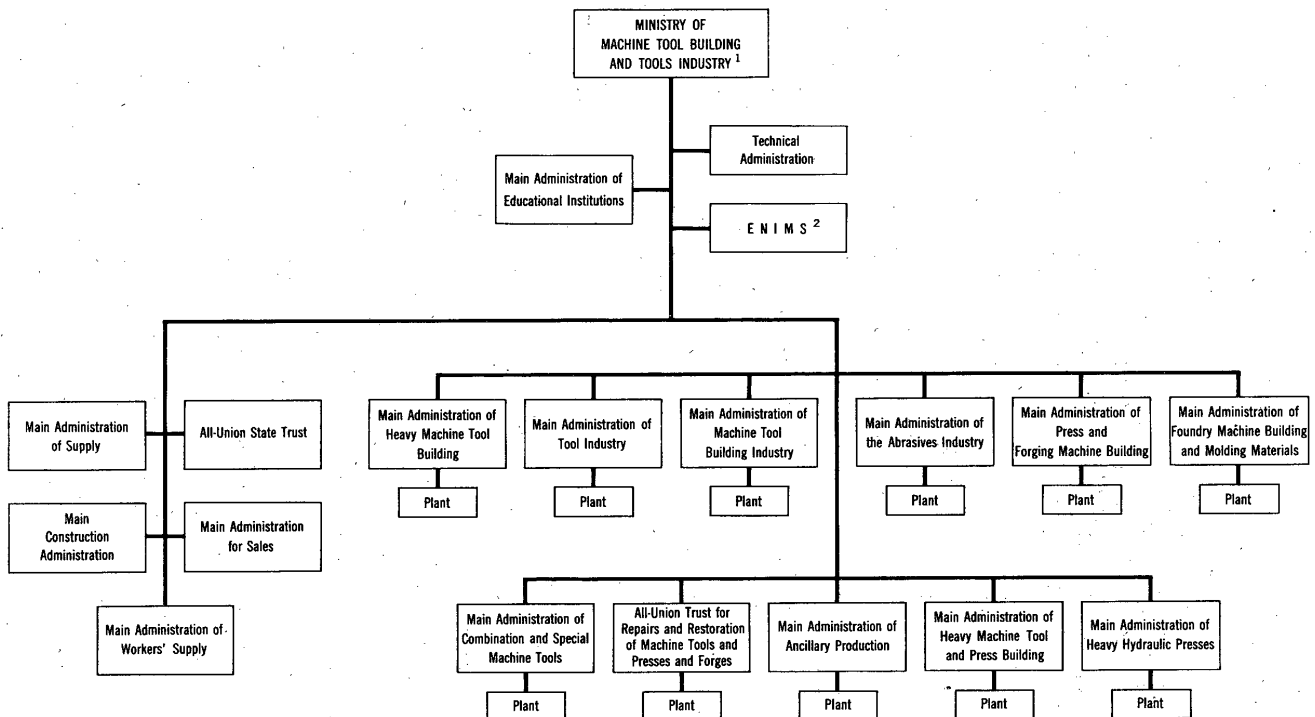
* See Appendix F, Methodology, for derivation of estimates.

** Table 1 follows on p. 7.

*** Following p. 6.

**** Table 2 follows on p. 8.

USSR ORGANIZATION OF THE MACHINE TOOL INDUSTRY, 1954



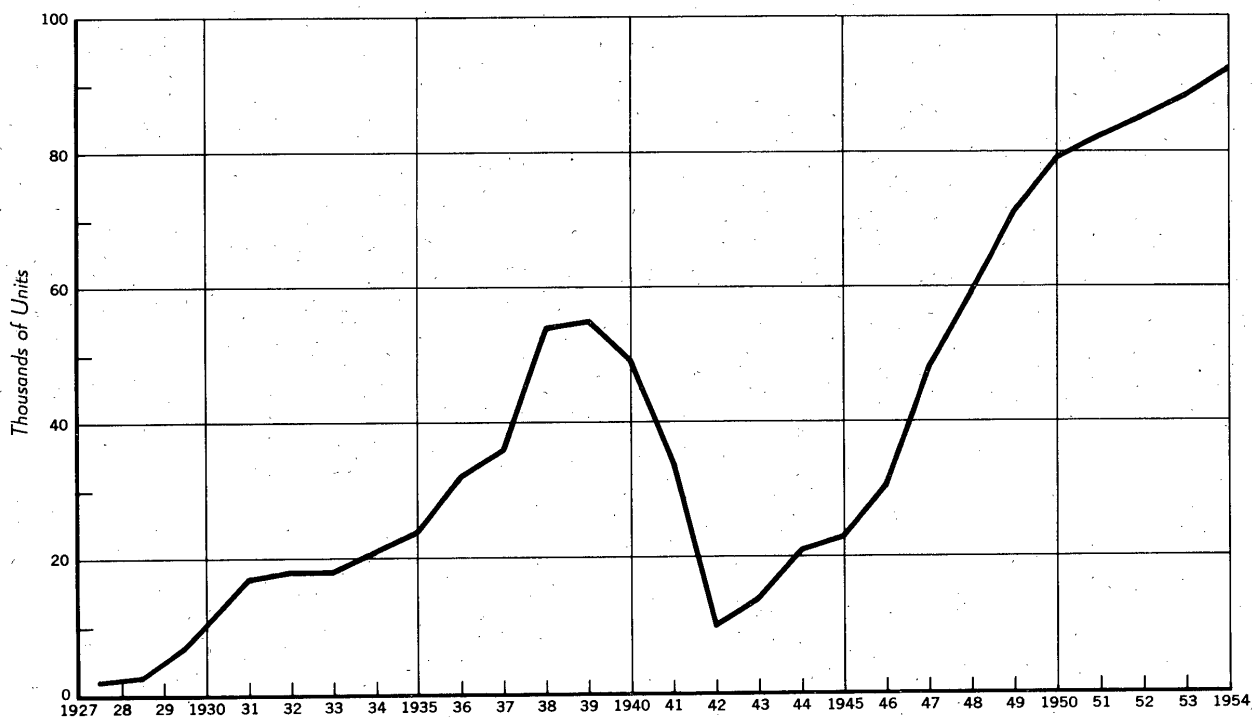
¹ Up to March 1953 was Ministry of Machine Tool Building, then was changed to Ministry of Machine Building. In April 1954 was changed to current designation.

² Experimental Scientific Research Institute of Metal-Cutting Machine Tools.

Figure 2

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USSR
ESTIMATED PRODUCTION OF MACHINE TOOLS, 1927/28 - 1954



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S-E-C-R-E-T

Table 1

Estimated Production of Metal-Cutting Machine Tools
in the USSR a/
1927-54

Thousand Units		
Year	Published and Estimated Production <u>b/</u>	Published Planned Production <u>17/</u>
1927-28	1.8	N.A.
1928-29	3.8	N.A.
1929-30	7.1	N.A.
1931	17.0	N.A.
1932	18.0	N.A.
1933	18.0	N.A.
1934	21.0	N.A.
1935	24.0	N.A.
1936	32.0	32.0
1937	36.0	41.0
1938	54.0	N.A.
1939	55.0	N.A.
1940	49.0	N.A.
1941	34.0	58.0
1942	10.0	70.0
1943	14.0	N.A.
1944	21.0	N.A.
1945	23.0	N.A.
1946	31.0	N.A.
1947	48.0	N.A.
1948	59.0	N.A.
1949	71.0	N.A.
1950	79.0	74.0
1951	82.0	N.A.
1952	85.0	N.A.
1953	88.0	N.A.
1954	92.0	N.A.

a. Estimated margin of error, plus or minus 2 percent for 1927-39; estimated margin of error, plus 15 percent for 1940-54.

b. Figures for 1927-39 published, 16/ figures for 1940-54 estimated. See Appendix F, Methodology, for derivation of estimates.

- 7 -

S-E-C-R-E-T

S-E-C-R-E-T

Table 2

Comparison of Production of Machine Tools by Weight in the USSR
and in the US

Weight	Percent	
	USSR (1954) <u>a/</u>	US (1952)
Light (Under 3 Metric Tons)	61	58
Medium (30 Metric Tons)	35	37
Heavy (Over 30 Metric Tons)	4	5

a. Estimated.

of machine tools in the USSR came from 5 plants in the Central Region.* Moscow and Moscow Oblast were reported to be producing about 30 percent of all machine tools produced in the country in 1952. 18/ There is also a heavy concentration of machine tool production in the South Region. All but 8 of the 69 producers are located west of the Urals. Plants located east of the Urals are estimated to produce only 5 percent of the production.

The exact number of plants in the industry has not been established. An analysis has been made of all plants reported at various times as machine tool plants. The plants shown in Appendixes A, B, and C are believed to be those presently producing machine tools.

Forty-four plants have been identified as primary producers of machine tools in the USSR.** These plants are estimated to have produced in 1954 approximately 78 percent of the output of the Soviet machine tool industry. Twenty-five additional plants have been identified as partial producers,*** or plants producing some machine tools in addition to their principal products. These plants are estimated to have produced in 1954 approximately 22 percent of the

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

** See Appendix A.

*** See Appendix B.

S-E-C-R-E-T

S-E-C-R-E-T

output of the Soviet machine tool industry. Figure 3* shows the plant locations and Table 3** the percentage of estimated production for 1954 by economic region.

The geographic distribution of plants is similar for the primary and partial producers. Seventeen of the 44 primary producers and 14 of the 25 partial producers are located in the South and Central Regions. Taken together, these 2 regions account for 56 percent of the output by both the primary and secondary producers.

In addition to plants producing machine tools, 14 plants have been identified as ancillary, or supporting producers.*** Four of these plants have been identified under a Main Administration of the Ministry of Machine Tools. It can be assumed that the major portion of their production goes to supply the machine tool industry.

Capacity and volume of production are not known, but reports indicate that 4 of the plants provide the machine tool industry with castings, 3 furnish attachments and accessories, 2 furnish hydraulic apparatus, 3 provide electric motors and controls, 1 furnishes parts (for example, flywheels, handles, levers, and pulleys), and 1 is a repair plant for finished products. Eight of the 14 supporting plants are located in the Central Region, and the others are in 3 regions west of the Urals.

B. Imports.

Since the end of Lend-Lease shipments in 1946, Soviet imports of machine tools have amounted to less than 2 percent of their estimated annual production. Before 1946, imports varied from a low of 8 percent in 1940 to a high of 120 percent in 1943. 19/ Since the imposition of export controls by the US and the Western European countries, the West has supplied less than 0.5 percent of current Soviet unit production. The largest individual Western supplier is Switzerland, although Italy, France, the UK, and other countries supply a few machines within the quotas allowed by the controls. Most of the imports from Switzerland are gear-making machines and

* Following p. 10.

** Table 3 follows on p. 10.

*** See Appendix C.

S-E-C-R-E-T

S-E-C-R-E-T

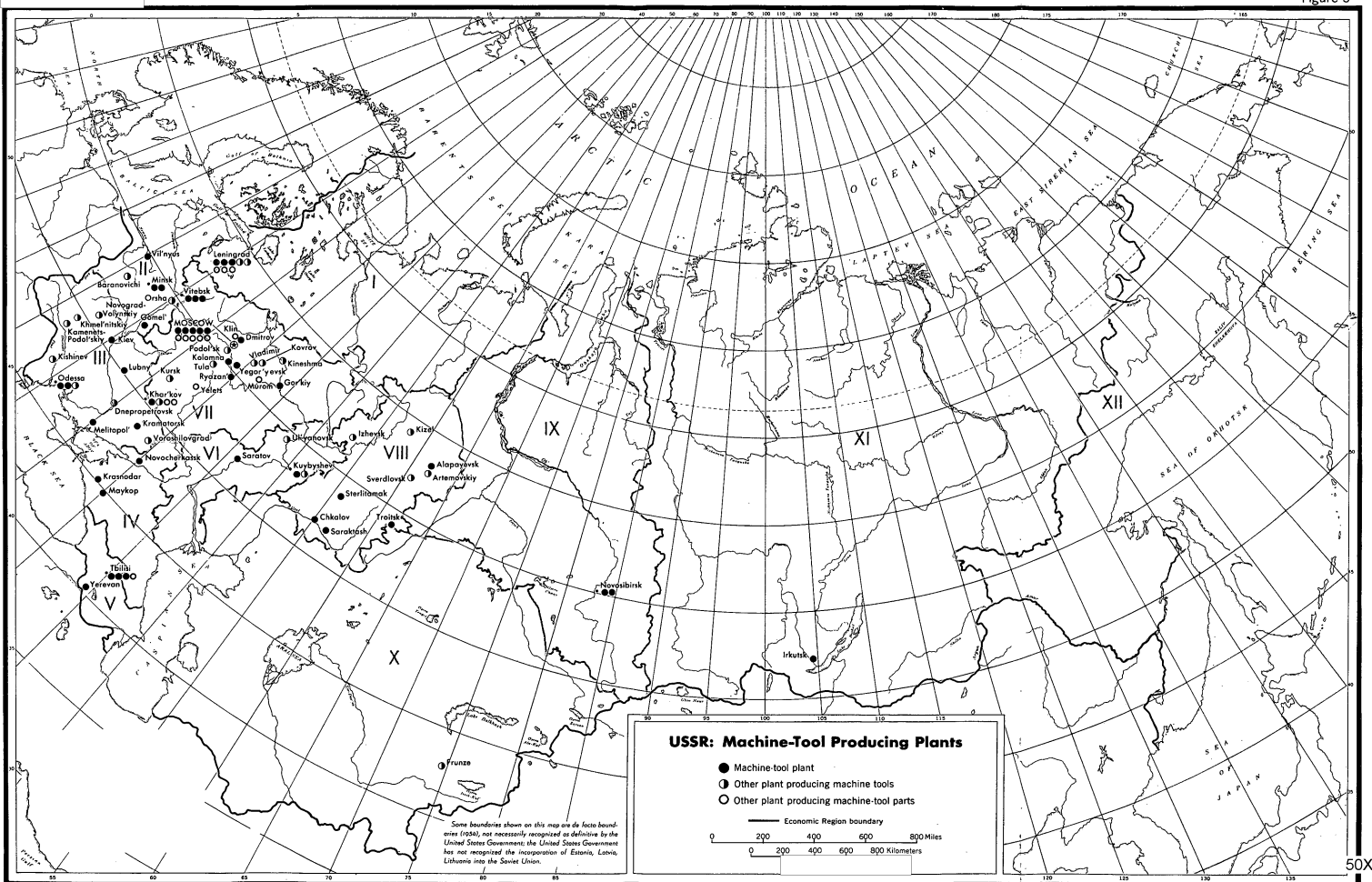
Table 3

Distribution of Plants and Percent of Estimated Machine Tool
Production by Economic Region in the USSR
1954

<u>Economic Region</u>	<u>Machine Tool Plants</u>			<u>Percent of Production</u>		
	<u>Primary</u>	<u>Partial</u>	<u>Total</u>	<u>Primary</u>	<u>Partial</u>	<u>Total</u>
I North and Northwest	3	2	5	8.3	1.8	10.1
II West	7	2	9	9.1	1.8	10.9
III South	7	8	15	6.7	7.0	13.7
IV Southeast	3	0	3	1.1	0	1.1
V Transcaucasus	4	0	4	4.0	0	4.0
VI Volga	2	2	4	3.6	1.8	5.4
VII Central	10	6	16	37.4	5.2	42.6
VIII Urals	5	4	9	5.7	3.5	9.2
IX West Siberia	2	0	2	1.8	0	1.8
X Kazakhstan and Central Asia	0	1	1	0	0.9	0.9
XI East Siberia	1	0	1	0.3	0	0.3
XII Far East	0	0	0	0	0	0
Total	<u>44</u>	<u>25</u>	<u>69</u>	<u>78.0</u>	<u>22.0</u>	<u>100.0</u>

- 10 -

S-E-C-R-E-T



S-E-C-R-E-T

jig borers.* All are of top quality. Imports from the other Western countries are types that are not under embargo, usually general-purpose equipment.

The majority of Soviet imports come from the Soviet Bloc, with East Germany as the major supplier. Czechoslovakia, Hungary, and Poland follow in the order named.** Since the beginning of the current Soviet Five Year Plan, imports from East Germany and Czechoslovakia have included heavy machine tools, such as large planers, vertical boring mills, and lathes; and precision machine tools, such as jig borers. 20/

In February 1954, the Russians were negotiating with UK machine tool manufacturers for the placement of machine tool orders subject to UK government approval of export licenses. 21/ The types the Russians were attempting to purchase were the heavy and precise types which normally had been imported from Switzerland and East Germany. UK official approval for shipments has not yet been granted.

The emphasis on importation of heavy and precise machine tools coincides with the emphasis on domestic production of the same types. The production of prewar Germany and Czechoslovakia included a large percentage of heavy and precise machines; therefore the Soviet demand from these countries is not unusual. It appears to be an effort to aid the Satellites to attain their prewar production, while the Soviet authorities hasten fulfillment of their own Plan to provide more heavy and precise machine tools.

The USSR imports some of each type of machine tool that Hungary produces, mainly radial drills, turret lathes, small milling

* Swiss information is confined to a number of reports giving shipments in weight or value or both. Switzerland is rated the largest supplier only because shipments from other Western countries are negligible. When items are identified, they are usually gear machinery or jig borers.

** The relative rating of the Soviet Bloc countries as machine tool suppliers to the USSR was estimated by summarizing all available reports on the known machine tool producers.

S-E-C-R-E-T

S-E-C-R-E-T

machines, and lathes. 22/ Practically all the imports from Poland are railroad-type axle lathes. 23/ The quality of the East German and Czechoslovak machine tools is very good. Hungarian and Polish equipment is not quite up to the same standard, but is adequate for the purpose intended and is improving.

Water and railroad transport are used, with Switzerland and West Germany using the railroad through Austria. Satellite shipments usually travel by rail. Most of the transport by water is to the ports of Gdynia, Poland; Constanta, Rumania; Stalin, Bulgaria; and Ventspils, Odessa, and Rostov, USSR, although some shipments move up the Danube.

Soviet importation of machine tools is handled by Stanko-Import.*

C. Inventory.

It is calculated that the Soviet inventory** of machine tools will reach approximately 1.5 million units by the end of 1954.*** The US inventory was reported to be more than 2 million units in November 1953. 24/ Since World War II the Soviet inventory has more than doubled, while the US inventory has risen about 15 percent. Repairs accounted for approximately one-third of the Soviet increase. 25/ About 65 percent of the present Soviet inventory is estimated to be less than 10 years old, whereas about 45 percent of the US inventory in 1953 was reported to be less than 10 years old. 26/

Inventory breakdown by type of machine tool was not attempted, because the necessary information is not available, the percentages of demand by each consumer industry for each type are not known, and US statistics are not considered analogous.

III. Demand.A. Use Pattern.

The fragmentary information available did not indicate any meaningful pattern of Soviet machine tool distribution, and the

* Machine Tool Import.

** Often referred to in the USSR as "park."

*** See Appendix F, Methodology, for derivation of calculations.

S-E-C-R-E-T

Russians have not published any statistics that provide a basis for estimating the percentage demands of the Soviet metalworking industries. Even if data on the US machine tool use pattern were available, the use patterns of the US and the USSR could not be considered analogous, because of the great differences between the two metalworking industries. In peacetime, for example, the largest single US consumer of machine tools is the automotive industry; however, in the USSR the automotive industry is very small. During wartime, practically all machine tools produced in either country would be used by war industries.

Machine tools are ordinarily used for capital investment to produce end products and other machines, research and development, and maintenance of existing equipment. The demands for machine tools vary with each change in priority of types of goods to be made by the metalworking industries. It can be assumed that Soviet machine tools are being distributed according to the priority assigned to industries in the current Five Year Plan.

B. Exports.

The quantity of machine tools exported by the USSR is insignificant, estimated at 1 or 2 percent of current production.* The Russians have been exporting some machine tools since 1948, but thus far have confined such shipments to the Soviet Bloc countries, Communist China, and North Korea. Soviet machine tools have been displayed at Bloc trade fairs since 1948, and in Western European countries since 1951. 27/ In 1952, tools were exhibited at Bombay, India. 28/ Although the Russians advertise these tools as available, there is no evidence of any sales taking place, except that a few of the demonstrator models have been sold on the spot to avoid the expense of shipping them back to the USSR. During 1953 the USSR signed numerous trade agreements with various Western countries, some of these agreements including the shipment of machine tools from the USSR. 29/ To date, however, there is no evidence of such shipments having been made.

Exports of machine tools to the Soviet Bloc are confined to the basic types of general-purpose machines. Most reports refer to lathes, milling machines, and drilling machines.** In some instances

* See Appendix F, Methodology.

** Reports consist largely of Soviet press comments on individual machines being made by some named or unnamed machine tool plant.

S-E-C-R-E-T

S-E-C-R-E-T

the Russians are exporting to the Satellites the same types of machine tools that they import from the same Satellites, but the quantities are small and there are technical differences, such as precision, capacity, and number of speeds, in the machines exchanged. There is no evidence that the USSR is exporting any precision machine tools, such as jig borers, or any heavy machines, such as vertical boring mills.

Except to Bulgaria, Communist China, and North Korea, export shipments are by rail. Shipments to Bulgaria are usually made by water from Odessa to Stalin (Varna), in Bulgaria. Soviet export of machine tools is handled by Stanko-Import, the same organization that handles import of machine tools.

C. Substitutes.

There is only a slight degree of substitutability between machine tool types, although a few of the operations they perform can be accomplished by other means. Improved casting and forging methods hold tolerances close enough for some products, eliminating the need for machine tools. Other products can be fabricated by welding. Nevertheless, machine tools are still needed to provide casting, forging, and welding equipment, and to maintain this equipment. Machine tools are the only machines that can perform all of the operations required to build and maintain precision machinery. They are also the only machines that can perform all operations to reproduce themselves.

IV. Future Expansion.A. Existing Capacity.

The Fourth Five Year Plan for machine tools was to achieve by 1950 a productive capacity of 94,800 metal-cutting machine tools. 30/ The plants identified in Appendixes A, B, and C, are capable of this productive capacity, which is approximately the current production of machine tools.

B. Expansion Under Way or Projected.

The Fifth Five Year Plan does not call for construction of any new enterprises that can be identified as machine tool plants, but does mention the "commissioning of new enterprises and units." 31/ The absence of any evidence of new machine tool plants

S-E-C-R-E-T

being built at this time, halfway through the Plan period, suggests that "commissioning of new enterprises" means assignments to build machine tools at existing plants which have not previously built them.

Modernization of facilities and methods is constantly going on in most of the Soviet machine tool plants. New methods of production are being initiated, 32/ such as installation of conveyors for the painting of machine tools. A number of plants have created "complex brigades" made up of engineers and Stakhanovites for the purpose of reviewing the designs and manufacturing technology of machine tools. 33/ Their efforts are concentrated on increasing productivity by shortening machining and handling time. In one plant at Gomel, the Russians claim to have saved 16,000 man-hours in 11 months in 1953. 34/

C. Requirements for Plant Expansion or Conversion.

It is highly probable that the existing plants producing machine tools in the USSR may be the extent of capital construction that Soviet authorities intend for this industry. Factors to bear this out are as follows:

(1) Existing plant capacity can be increased to produce approximately 100,000 units annually, which is more than US peacetime production.

(2) If necessary, the plants can go on a multiple shift basis to produce at least 50 percent more with existing facilities.

(3) Since 1953, the existing plants have been aiding the agricultural program by devoting part of their facilities to production of tractor and other parts. These facilities could be reconverted to machine tool production.

(4) Since import and export of machine tools are about equal, the annual Soviet increase in machine tool inventory is about equal to the annual production. The Soviet economy probably cannot absorb such rapid increase for any prolonged period of time without an increase in exports. An alternative might be a leveling off of production, possibly during the next Plan period.

If the Soviet authorities do intend to expand their plant base, however, the material inputs required would depend upon the

S-E-C-R-E-T

expansion plan. For example, constructing a new plant to produce 2,000 units annually may require five times more inputs than the re-conversion of an existing plant to produce an additional 2,000 units annually.

It is doubted that Soviet machine tool plants will ever be converted from building machine tools to any great extent during a peacetime economy. If conversion takes place, it will probably be a change to the production of engineering equipment or products requiring approximately the same capacities, productive equipment, and skills that the industry employs at present. A conversion of this type can be made with an estimated time lag of only 2 months.

A conversion to wartime economy would involve an estimated lag of about 6 months, because the industry would be called upon to tool up all the other war material producers. The USSR would not be in so poor a position as the US was at the beginning of the Korean conflict, because the current Soviet plan places most emphasis on the heavy and the precise tools. The US in 1950 was short of such types as large vertical boring mills, large planers, and jig borers, and it took up to 18 months to produce them. The present Soviet program, if successfully carried out during this Plan period ending in 1955, may leave the USSR in the position of needing only the smaller and the specialized mass-production type machine tools to convert to full-scale war requirements.* Expansion would not be necessary, since the conveyor assembly lines in some of the machine tool plants can be adapted to most of the smaller single-purpose machine tools used in quantity during wartime.

V. Inputs.

A. For Production.

Soviet input requirements to produce the estimated output of 92,000 machine tools in 1954 are shown in Table 4.** These requirements are very small when compared with total industrial requirements of the national economy. Estimates for electric motor requirements are the highest, about 4 percent of the total national output. The estimated requirements for antifriction bearings amounted to 2.5 per-

* There is much evidence to substantiate the fact that the production of heavy and precise tools is being emphasized, although quantities cannot be determined. Emphasis is also being placed on the import of these tools.

** Table 4 follows on p. 17.

S-E-C-R-E-T

S-E-C-R-E-T

Table 4

Calculated Input Requirements for Estimated Production
of Machine Tools in the USSR a/
1954

Item	Quantity b/
Steel	149,000 MT
Iron Castings	316,000 MT
Copper	2,400 MT
Aluminum	1,400 MT
Rubber	835 MT
Lumber	20,000 MT
Preservatives	250 MT
Paint	655,000 Litres
Bearings, Antifriction	3,680 Thousand Units
Motors	851,000 (Total Rating) Kw
Electric Energy	684 Million Kwh
Coal	568,000 MT
Labor (All Types)	84,000 Workers

a. On basis of total estimated production of 92,000 units. See Appendix F, Methodology, for derivation of data.

b. Estimated margin of error, plus 10 percent.

cent of the total national output. It is estimated that other major inputs, such as metals, electric energy, coal, and labor used less than 2 percent of the total Soviet production or availability.

It is estimated that plant floor space used by the industry is 25,200,000 square feet,* or no more than 1 percent of the total Soviet industrial plant capacity. The number of machine tools required is estimated to be 25,000, or less than 2 percent of the estimated Soviet machine tool inventory.**

* See Appendix F, Methodology, for derivation of data.

** See Table 7, p. 44, below, for calculated inventory.

S-E-C-R-E-TB. Expansion.

Expansion of the machine tool industry in the USSR would not be difficult. The industry is located mainly in the industrialized regions of the country, where materials are available in the small quantities needed. Skilled labor should be available, since the Russians are constantly training apprentices in the trade. As expansion progressed, floor space and machine tools needed to expand production would be required at a constantly diminishing rate. Transportation of materials would become a problem only if the expansion took place in areas remote from rail centers.

VI. Vulnerabilities and Intentions.A. Vulnerabilities.

The chief strategic vulnerability of the Soviet machine tool industry is the extent to which production is concentrated in the Leningrad and Moscow areas. These two cities produce approximately one-third of all Soviet machine tools.

Another vulnerability is the concentration of production of basic machine tools in a few plants. The Krasnyy Proletariy Plant in Moscow produces approximately 50 percent of all lathes, and the Gor'kiy Milling Machine Plant produces about the same percentage of all milling machines. The Komsomolets Plant at Yegorevsk produces approximately 75 percent of the gear processing machines.

The most strategic machine tool input is electric motors, without which the tools are of no value. A curtailment in motor supply would result in a corresponding curtailment of machine tool production. All inputs are provided from the Soviet economy, and the percentages of available totals used by the industry are so small that imports of materials are of negligible importance. The USSR depends on imports for only one type of machine tool, the jig borer.

B. Intentions.

The Soviet machine tool industry appears to be operating at a near-capacity level on a 1-shift basis. There is no evidence at the present time of the sudden rise in production characteristic of this industry when war is imminent, nor is there any sign of a sudden

S-E-C-R-E-T

S-E-C-R-E-T

shift to single-purpose, munitions-making equipment. This lack of indicators does not mean that the Russians are neglecting to build up war potential. Every machine tool can contribute to a war. Under the guise of a long-range industrial plan, it would be possible for the USSR to expand its machine tool inventory to meet wartime demands. The US Strategic Bombing Survey of German industry showed this to be true of the German machine tool inventory. 35/

Soviet concentration on production and importation of heavy machines is probably the result of past experience. Both the US and the USSR were short of heavy machines for the World War II effort.

Although all Soviet production is officially reported to be going to industries producing consumer goods and civilian capital investments, machine tools of any kind can be regarded as potential instruments of military production. The present buildup in the Soviet machine tool inventory is progressing at a faster rate than any country has ever experienced. A continuation of this rate of buildup with continued emphasis on the heavy type tools, if carried on through the next Five Year Plan, will put the USSR in the position of having the best equipped base in the world for the production of war materials.

Although the USSR is building more machine tools than any other country and can control the building of machine tools in some Satellite countries, it is not yet in the world market. 36/ It is, nevertheless, advertising machines for export, showing them to the Western world at trade fairs, and even offering technical assistance to less industrialized countries. These publicity efforts may be politically motivated to let the world know that the USSR is a contender in this field. Actually, the USSR is exporting very few machine tools, most of which go to the Satellites.

The USSR is probably trying to build up a large inventory of machine tools that can easily be converted to production of war equipment. When the USSR considers this inventory to be adequate, it can be expected to enter the world market on a large scale, probably underselling where necessary to gain economic advantage.

S-E-C-R-E-T

S-E-C-R-E-T

APPENDIX A

SUMMARY OF AVAILABLE DATA ON MACHINE TOOL PLANTS IN THE USSR
PRIMARY PRODUCERS

Plant	Region	WAC Number a/*	Principal Products
Alapayevsk Machine Tool Building Plant	VIII	156	Turret lathes. 37/
Chkalov Machine Tool Building Plant	VIII	236	Shapers, slotters, and horizontal boring machines. 38/
Dmitrov Milling Machine Plant	VII	154	Milling machines. 39/
Gomel' Machine Tool Building Plant imeni Kirov	II-b	167	Shapers and slotters (hydraulic) and planers. 40/
Gor'kiy Milling Machine Plant	VII	154	Milling machines. 41/
Irkutsk Machine Tool Building Plant (No. 4)	XI	200	Lathes. 42/
Khar'kov Machine Tool Plant imeni Molotov	III	234	Grinding machines and boring machines. 43/
Kiev Machine Tool Building Plant imeni Gor'kiy	III	233	Multispindle lathes and automatics, and horizontal boring mills. 44/
Kolonna Heavy Machine Tool Plant	VII	167	Heavy lathes and gear-making machines and vertical boring mills. 45/
Kramatorsk Heavy Machine Tool Building Plant	III	234	Heavy lathes. 46/
Krasnodar Machine Tool Building Plant imeni Sedin	IV	249	Vertical boring mills. 47/
Kuybyshev Machine Tool Building Plant Middle Volga (Srednevolzhskiy)	VI	165	Screw-cutting lathes and thread mills. 48/
Leningrad Machine Tool Building Plant Avtomat	I-a	153	Automatic lathes and long-bed lathes. 49/
Leningrad Machine Tool Building Plant imeni Sverdlov	I-a	153	Horizontal boring mills, profile mills, and special boring machines. 50/
Leningrad Machine Tool Building Plant imeni Il'ich	I-a	153	Profile grinders, and polishing machines. 51/
Lubny Machine Tool Building Plant imeni Kommunar	III	233	Lathes, screw-cutting and turret types. 52/
Maikop Machine Tool Building Plant imeni Frunze	IV	249	Diamond boring machines. 53/
Melitopol Machine Tool Building Plant imeni 23 October	III	249	Automatic screw- and thread-cutting machines. 54/
Minsk Machine Tool Building Plant imeni Voroshilov	II-b	168	Planers. 55/
Minsk Machine Tool Building Plant imeni Kirov	II-b	168	Broaches, cut-off saws, and lathes. 56/
Moscow Krasnyy Proletariy Machine Tool Building Plant imeni A.I. Efremov	VII	167	Lathes, all sizes, screw-cutting and multicut. 57/
Moscow Machine Tool Building Plant imeni Sergo Ordzhonikidze	VII	167	Multispindle automatics. 58/
Moscow Grinding Machine Building Plant MSZ	VII	167	Grinding machines, surface and cylindrical types. 59/
Moscow Internal Grinding Machine Building Plant ZVShS	VII	167	Internal grinders, transfer lines, and jig borers. 60/

* Footnote for Appendix A follows on p. 22.

S-E-C-R-E-T

Plant	Region	WAC Number ^{a/}	Principal Products
Moscow Machine Tool Building Plant Stankokonstruktsiya	VII	167	Experimental models of machine tools, and transfer lines. <u>61/</u>
Novocherkassk Machine Tool Building Plant	IV	249	Turret lathes. <u>62/</u>
Novosibirsk Machine Tool Building Plant imeni 16th Party Congress	IX	162	Combination machine tools. <u>63/</u>
Novosibirsk Heavy Machine Tool and Hydraulic Press Building Plant imeni Efremov (Tyazhstankogidro- press)	IX	162	Heavy lathes, vertical boring mills, planers, milling machines, and hydraulic presses. <u>64/</u>
Odessa Radial Drilling Machine Tool Building Plant	III	250	Radial drilling machines. <u>65/</u>
Odessa Milling Machine Tool Building Plant imeni Kirov	III	250	Milling machines, and copying machines. <u>66/</u>
Ryazan' Heavy Machine Tool Building Plant	VII	166	Screw-cutting lathes and large turning lathes. <u>67/</u>
Saraktash Machine Tool Building Plant imeni Kommunar	VIII	236	Grinders and polishing machines. <u>68/</u>
Saratov Machine Tool Building Plant	VI	235	Shapers, drill presses, and internal grinders. <u>69/</u>
Sterlitamak Machine Tool Building Plant imeni Lenin	VIII	165	Upright drilling and honing and lapping machines. <u>70/</u>
Tbilisi Machine Tool Building Plant imeni Kirov	V	325	Screw-cutting lathes and pipe-threading machines. <u>71/</u>
Tbilisi Machine Tool Building Plant imeni Stanok	V	325	Screw-cutting lathes and bolt threaders. <u>72/</u>
Tbilisi Casting and Machinery Plant	V	325	Screw-cutting lathes and accessories. <u>73/</u>
Troitsk Machine Tool Building Plant	VIII	164	Power hack saws, and pipe cut-off machines. <u>74/</u>
Vil'nyus Machine Tool Building Plant imeni Zhalgiris	II-a	168	Bench drills, shapers, and milling machines. <u>75/</u>
Vitebsk Machine Tool Building Plant imeni Kirov	II-b	167	Surface grinders and milling machines. <u>76/</u>
Vitebsk Machine Tool Building Plant imeni Komintern	II-b	167	Drills, radial, upright, and multispindle. <u>77/</u>
Vitebsk Tool Grinding Machine Building Plant (Zavod Zatochnyy Stanki)	II-b	167	Tool grinders and hob grinders. <u>78/</u>
Yegorevsk Machine Tool Building Plant imeni Komsomlets	VII	166	Gear-making machinery. <u>79/</u>
Yerevan Machine Tool Building Plant imeni Dzerzhinsky	V	325	Screw-cutting lathes. <u>80/</u>

a. Numbers refer to US Air Force World Aeronautical charts.

S-E-C-R-E-T

S-E-C-R-E-T

APPENDIX B

SUMMARY OF AVAILABLE DATA ON MACHINE TOOL PLANTS IN THE USSR
PARTIAL PRODUCERS

Plant	Region	WAC Number	Machine Tool Produced
Artemovskiy Machine Building Plant	VIII	156	Lathes and drill presses. <u>81/</u>
Baranovich Machine Building Plant	II-b	168	Lathes. <u>82/</u>
Dnepropetrovsk Machine Building Plant imeni Kaganovich	III	234	Milling machines. <u>83/</u>
Frunze Tool Plant	X-b	328	Screw-cutting lathes. <u>84/</u>
Izhevsk Machine and Armaments Plant	VIII	155	Lathes, turret lathes, and milling machines. <u>85/</u>
Kamensk-Podolski Lathe Building Plant	III	233	Lathes. <u>86/</u>
Khark'ov Combination Machine Tool Plant	III	234	Machine tool production - combination machine tools. <u>87/</u>
Kineshma Machine Building Plant imeni Kalinin	VII	154	Shapers, milling machines, and special lathes. <u>88/</u>
Kishelev Machine Plant imeni Kotovskiy	III	250	Grinding and polishing machines, and lathes. <u>89/</u>
Kizel Machine Tool Plant imeni Gor'kiy	VIII	156	Turret lathes. <u>90/</u>
Kovrov Kirgizh Arms Plant	VII	154	Vertical milling machines. <u>91/</u>
Kuybyshev Plant No. 525 (Bezmyanka Suburb)	VI	165	Milling machines, drilling machines, lathes, and shapers. <u>92/</u>
Kursk Machine Plant	VII	234	Lathes and upright drilling machines. <u>93/</u>
Leningrad Vtory Pyatiletka Machinery Plant	I-a	153	Anode-mechanical machines. <u>94/</u>
Leningrad Vulcan Machine Plant	I-a	153	Grinding machines and special milling machines. <u>95/</u>
Novograd-Volinski Machine Tool Building Plant imeni Stalin	III	233	Lathes. <u>96/</u>
Odesa Plant imeni 16th Party Congress	III	250	Drills and parts for transfer lines. <u>97/</u>
Orsha Machine Tool Plant Krasnyy Borets	II-b	167	Upright drills. <u>98/</u>
Pololsk Machine Building Plant imeni Kalinin	VII	167	Lathes and grinders. <u>99/</u>
Khmal Nitskiy Lathe Building Plant	III	233	Lathes. <u>100/</u>
Sverdlovsk Heavy Machine Building Plant imeni Ordzhonikidze	VIII	156	Lathes. <u>101/</u>
Tula Machine Building Plant	VII	167	Milling machines. <u>102/</u>
Ulyanovsk Plant Volardarskiy No. 3	VI	165	Lathes. <u>103/</u>
Vladimir Plant	VII	154	Grinders and drilling machines. <u>104/</u>
Voroshilovgrad Plant 270	III	234	Grinders. <u>105/</u>

S-E-C-R-E-T

APPENDIX C

SUMMARY OF AVAILABLE DATA ON MACHINE TOOL PLANTS IN THE USSR
ANCILLARY PRODUCERS

<u>Name</u>	<u>Region</u>	<u>WAC Number</u>	<u>Products</u>
Khar'kov Hydraulic Equipment Plant Giproprivod	III	234	Hydraulic machine tool driving equipment. <u>106/</u>
Khar'kov Electrostanok (Electrical Equipment)	III	234	Electric controls, switches, speed selectors, and limit switches for automatic control. <u>107/</u>
Klin Repair Plant	VII	154	Machine tool and press and forging equipment repair. <u>108/</u>
Leningrad Dividing Head Plant	I-a	153	Machine tool accessories, including dividing heads. <u>109/</u>
Leningrad Machine Tool Attachments Plant	I-a	153	Machine tool attachments, including pneumatic chucks, and accessories. <u>110/</u>
Leningrad Machine Tool Foundry Lenstankolit	I-a	153	Castings for machine tools. <u>111/</u>
Moscow Electric Pump Plant	VII	167	Machine tool components, including small electric motors. <u>112/</u>
Moscow Low-Voltage Equipment Plant	VII	167	Electrical machine tool controls, starters, and parts. <u>113/</u>
Moscow Attachments Plant Prisosobleni	VII	167	Machine tool attachments, including pneumatic chucks. <u>114/</u>
Moscow Stankolit Works	VII	167	Machine tool castings. <u>115/</u>
Moscow Stankonormal Plant	VII	167	Standardized parts for machine tools -- chuck jaws, flywheels, handles, levers, and so on. <u>116/</u>
Murom Stankopatron Plant Imeni Ordzhonikidze	VII	166	Machine tool attachments, including chucks. <u>117/</u>
Tbilisi Tsentrallit Foundry	V	325	Castings for machine tools. <u>118/</u>
Yelets Plant for Machine Tool Hydraulic Apparatus	VII	167	Castings and hydraulic apparatus for machine tools. <u>119/</u>

S-E-C-R-E-T

APPENDIX D

DEFINITIONS1. Definition of Machine Tools.

There are six basic arts of metalworking: drilling and boring, milling, turning, planing, grinding, and shearing and pressing. This report is confined to equipment performing the first five operations.

The National Machine Tool Builders' Association (N.M.T.B.A.) defines a machine tool as a "power-driven, complete metal-working machine, not portable by hand, having one or more tools or work-holding devices and used for progressively removing metal in the form of chips." ^{120/} Grinding, honing, and lapping machines are included in this definition, even though the chips removed are microscopic. The Soviet definition of machine tools is "all machines for machining metals by cold chip removal" ^{121/} and/or "machine tools for the machining of metals through the cutting-off of shavings from metals by any method." ^{122/} This definition coincides with that of the US with respect to the method of metal removal. This report has assumed, therefore, that Soviet sources have a similar definition for machine tools, unless the Soviet source stated otherwise.

2. Machine Tool Types.

The basic types of machine tools are drilling machines, boring machines, milling machines, lathes, planers, shapers, and grinding machines. Within the type category there are numerous breakdowns, for example:

- (1) Degree of automatism, semiautomatic or fully automatic.
- (2) Position (plane) of cutting spindle or tool movement, horizontal or vertical.
- (3) Number of spindles or heads, single, duplex, or multi-spindle.
- (4) Surface that the machine works on, internal or external.
- (5) Degree of versatility, plain or universal.

A semiautomatic machine tool performs a predetermined cycle of operations automatically, but a worker is required to start each cycle. An automatic machine tool repeats a predetermined cycle of operations, as long as power is available and a work piece is kept in the machine.

S-E-C-R-E-T

A "type-size" represents the capacity of a machine in various terms, for example, a 16-inch lathe with a 24-inch center distance, or a 10-ton broaching machine with a 36-inch stroke.

In the US and the USSR, the word "universal" is used to indicate the versatility of a machine. Plain and universal cylinder grinders, for example, both grind workpieces, but the universal can grind tapers while the plain cannot do so. The term is also used to distinguish between single-purpose and general-purpose machine tools. In this report, "universal" refers to machines adaptable to more than one operation, either by means of built-in features, or by addition of attachments and accessories. This type is not normally as productive as specialized types.

Other types mentioned in the report are "combination" and "transfer" machine tools. The term "combination" refers to a multitool machine that automatically performs more than one predetermined operation, such as drilling, boring, or milling on more than one surface of the workpiece. The machines usually called horizontal boring, drilling, and milling machines are classed as boring machines and not "combination."

A "transfer" machine tool is a series of combination types which pass workpieces automatically from one working station to the next until all required operations are completed. All operations are performed in a predetermined sequence and are electrically or hydraulically controlled. Manual work consists of inserting the workpiece into the line and removing it after completion.

3. Unit of Measure.

This report has used the number of machine tools as a basis for its measurement of production and inventory. This is far from an ideal measure, because machine tools are heterogeneous with respect to type, size, quality, productivity, and age.* Standard machine tools in the US include

* A better measure of the volume of machine tools has not been used, either, to describe the output of machine tools in the US. An index of production based on a deflated dollar volume of production adjusted for productivity would probably be better and could be developed with respect to output in the US. It probably would not be possible to develop a similar index for the USSR from the scanty information available, nor would it be proper to compile such an index for the USSR based on US weights.

S-E-C-R-E-T

drilling machines weighing as little as 400 pounds and costing \$500, as well as 72-inch planers weighing as much as 60 tons and costing \$100,000. ^{123/} Heavier and more costly machines are often built on special order, yet each has been counted as one. The capacity ranges of Soviet and US machine tools are estimated to be the same, but the proportionate mix of each range and type cannot be determined.

Units are used as the basis for measurement in this report, because Soviet statistics on production and inventory, when they make a distinction between unit and value, are usually given in units.

S-E-C-R-E-T

APPENDIX E

TECHNOLOGY

The majority of machine tools produced by the Russians in the early 1930's were general-purpose or universal type. Only 5 automatic and 7 semiautomatic machine tools were displayed at the 1935 Moscow Machine Tool Exhibition. 124/

Industrial expansion and World War II brought heavy demands for mass production of equipment and the saving of manpower. The result was a greater concentration on the building of special and single-purpose machine tools and led to the development of combination and transfer lines.

The transfer line is the outstanding Soviet achievement in this industry. The lines are being built for the food, agriculture, automobile, tractor, timber, and even construction industries. Twelve transfer lines were installed in the Moscow Automobile Plant in 1952, 125/ and the USSR claimed to have 39 such lines in May 1953. 126/ These lines are many times more productive, use less space, and require less labor than an equivalent setup of universal tools. A line for tractor piston pins will reduce both production area and number of employees by a large percentage. 127/ A Soviet radio broadcast in English to the UK is reported 3 January 1954 as stating that the "Soviet Union has more than 100 such lines." The previous statement of 39 lines is considered more accurate, and the building of 61 lines in the period between May 1953 and January 1954 is inconceivable.

It is believed that since 1950 the USSR has emphasized the production of very large machine tools, for example, the following:

<u>Type</u>	<u>Weight (Metric Tons)</u>	<u>Capacity</u>
Lathe	450	3 meters diameter x 30 meters length
Gear Cutter	180	60-ton gear
Vertical Boring Mill	500 (estimated)	13 meters diameter x 5 meters height

S-E-C-R-E-T

Presently under construction is a vertical boring mill which will weigh 1,700 metric tons and process parts 22 meters in diameter. 128/ The largest size built in the US had a capacity of 43 feet, the equivalent of the Soviet 13-meter size.

Modern technological advancement manifests itself in Soviet machine tools by the use of the following:

- (1) Speeds of 3,000 rpm on engine lathes
- (2) Stepless electronic speed controls
- (3) Electronic copying and contouring devices
- (4) Hydraulic gear shifting
- (5) Built-in optical measuring devices.

These features are all used on US machine tools but are usually confined to the top-quality machines.

The Soviet degree of automatism is estimated to be comparable to that of the US in the postwar period. They are not behind the US in the required technology, but are still producing a higher percentage of universal machines than the US now produces. The need for increasingly specialized and consequently more productive machine tools is constantly being stressed by Soviet authorities, engineers, and plant directors. The proposed solution is to expand standardization of machine tool components and profit by the savings of labor and materials which result from mass production. At present, such standardized components as main drive mechanisms, beds, and feed drive mechanisms are being assembled into more types of general-purpose machine tools than in the US.

In a few of their more highly productive plants, the Russians have copied the mass production technique of the automotive industry by installing conveyors for assembling lathes and milling machines. 129/ This type of mass production is feasible only where the number of uniform products to be assembled runs into the thousands. Conveyors of this type automatically carry to the assembly stations the parts and subassemblies of the unit being built. They provide a steady flow of parts to maintain a continuous stream of finished products. US machine tool builders cannot afford this type of installation, because they produce only a limited number of machine tools in any one model. Conveyors capable of handling the range of models made by any one of the large US machine tool builders would not be economically justifiable.

S-E-C-R-E-T

Most Soviet plants do not use conveyors for assembly, but produce in batches of 10 or 20 machines, depending upon requirements. Large machines and special single-purpose machines are usually custom-built individually.

The variety of machine tools manufactured in the USSR has expanded greatly. The USSR claims to have perfected or produced 55 type-sizes by 1933, 500 by 1950, and 2,000 by 1950. 130/ Claims such as these are misleading. It is known that every time they make a revision, however minor it is, they claim to have perfected a new type-size. They are, nevertheless, known to be producing every basic type of machine tool required by a metal working industry and are rapidly increasing the number of variations on an unknown number of types.

Examinations and tests of Soviet machine tools built in 1950 and 1951 show them to be of good quality, with their accuracy to US standards. 131/ The machines are well designed, the materials are good, and performance tests prove them adequate for the purposes intended. Lubrication is adequate, and antifriction bearings are used on all parts moving at high speeds. The designs facilitate maintenance and assembly.

The safety of operators has not been overlooked. All exposed rotating parts are guarded to prevent accidental contact by the operator. Electrical lighting and controls have been stepped down to safe voltage operation.

Standardization is evident in the accessories, such as chucks, and in the lighting systems and coolant pumps. Machines built in the larger plants indicate that jigs and fixtures are being used for manufacturing parts. Machines built in the smaller plants show evidences of handwork instead of jig and fixture production.

The workmanship is generally good. Close fits and finished parts are used where required, but the Russians do not put good finishes on machined parts that do not mate. Their aim appears to be to turn out adequate machines with a minimum of labor and expense. Some of their machines, therefore, lack the eye appeal of US and Western European products. This condition will change rapidly when they start competing with Western machines on a world market, because the buyer of precision equipment expects precision appearance.

S-E-C-R-E-T

Soviet technology in this industry is at least equal to that of the West. The industry fosters the interchange of technical information by promoting plant, interplant, and industrywide engineering conferences. Extensive research for this industry is carried on at the Experimental Scientific Research Institute for Metal-Cutting Machine Tools (ENIMS), which in 1950 had the following laboratories 132/:

- Laboratory for Architecture and Modeling of Machine Tools
- Laboratory for Automatic Lathe Work
- Laboratory for Electrification of Machine Tools
- Laboratory for Grinding and Finishing Work
- Laboratory for Hydraulic Driving Gears
- Laboratory for Machine Tool Testing
- Laboratory for Metals
- Laboratory for Optical Study of Stresses
- Laboratory for Testing Experimental Models in Connection with the Planning of Standards and Departmental Norms
- Laboratory for Testing of Surfaces
- Chemical Laboratory
- Control and Measuring Laboratory
- Mechanical Laboratory
- Thermic Laboratory
- Tool and Cutting Laboratory
- Welding Laboratory
- X-Ray Laboratory
- Laboratory for Treatment of Plane Surfaces.

The variety of fields covered by these laboratories indicates that the USSR is making efforts to develop techniques which yield efficient, economical, and durable machine tools.

Technical information has been widely circulated in the machine tool industry. A highly competent technical journal of the machine tool industry (Stanki i Instrument) has been published since 1930. Theoretical monographs such as Research on Machine Tool Bearings, Calculation of Machine Tools, Testing of Surface, and the like, indicate the accumulation of technical knowledge.

Other evidences of an advanced technological level are numerous. Designers, for example, are working on a photoelectric eye device which responds to changes in profile on a drawing of a required part and actuates the machine tool movements to produce a duplicate in metal. 133/

S-E-C-R-E-T

Such a device was developed in the US in 1953 and used on one model. The Russians have also constructed plants which automatically cast, machine, inspect, sort, and pack aluminum pistons ready for shipment. 134/ Soviet designers are exploring new techniques of metal removal, such as the electrosark and anode-mechanical methods. The former technique has limited application in the US; the latter is not yet perfected.

In spite of adequate theoretical progress, the USSR is apparently short of some of the indefinable experience acquired by the common practice of "cut and try" and "scrape and fit" methods. Lack of this know-how is reflected in their reticence regarding jig borers, the production of which requires a high degree of practical experience and skill.

There is evidence, on the other hand, that some plants are not profiting by advanced techniques. Individual plants are sometimes criticized at engineering conferences for failure to use modern methods. There is no indication, however, that such failure has prevented their fulfilling production quotas.

S-E-C-R-E-T

S-E-C-R-E-T

APPENDIX F

METHODOLOGY1. Production.a. Basis of Production Estimates (1949-51).

All estimates for 1940 and for 1946 through 1951 were based on the 1950 planned output of 74,000 units 135/ and published figures on percentage increases. No clear sequence of percentages has been found to cover total production for these years. Figures refer variously to ministerial production of all products, ministerial production of machine tools, ministerial production of special and aggregate machine tools, and total production of machine tools. The categories to which these percentages apply are often not specified.

Table 6,* which presents the available information on the production of machine tools for 1949-51, shows how little information there is on total production. Most of the information refers to ministerial production.

Two estimates were made on the basis of these data. The first of these is presented in Table 1 and in Table 5,** and is based on the following assumptions and data:

- (1) Total production for 1950 was planned at 74,000 units.
- (2) The 1950 Plan for ministerial production, which was 150 percent of the 1940 ministerial output, was assumed to apply to total output as well.
- (3) The total output for 1951 was 165 percent of that for 1940.
- (4) The unassigned production for 1948 divided by the unassigned production for 1947 is a ratio of 1.24, which is assumed to apply to total production.
- (5) The percentages for ministerial production for 1950 divided by 1949, 1949 divided by 1948, and 1947 divided by 1946 were assumed to apply to total production as well.

* P.39, below.

** Table 5 follows on p. 38.

S-E-C-R-E-T

(6) The ratio of 1.34 for 1946 divided by 1945, listed in both the unassigned and special and aggregate columns, was assumed to apply to total production. Further data are presented in Table 6.*

The second estimate resulted from calculating forward from a 1940 production figure based on Vosnesensky's statement that 1941 production of machine tools was scheduled to exceed 1940 production by 28 percent. $\frac{136}{100}$ Since the 1941 State Plan set machine tool production at 58,000 units, 1940 actual production would have been 45,000. Production in 1950 was 1.6 times that of 1940 and in 1951, 1.65 times that of 1940. Output for the years 1945-49 was calculated for 1950 production on the basis of the same percentage increases for those years used in the first estimate.

Table 5

Comparison of Two Production Estimates
for the Machine Tool Industry in the USSR
1940 and 1945-51

<u>Year</u>	<u>Thousand Units</u>	
	<u>First Estimate</u>	<u>Second Estimate</u>
1940	49	45
1945	23	22
1946	31	29
1947	48	44
1948	59	55
1949	71	65
1950	79	73
1951	82	75

The methodology employed in producing both estimates is identical with the exception of the derivation of the base-year (1940) estimate. As a result of this difference the first estimate is about 10 percent above the second. This higher estimate has been selected for inclusion in this report because it is more consistent with other known developments in and indications of the growth of the industry.

* Table 6 follows on p. 39.

S-E-C-R-E-T

Table 6

Published Information on Ratio of Change in Plans and Production
of Machine Tools in the USSR a/*
1946-51

<u>Ratio</u>	<u>Ministerial Production</u>	<u>Special and Aggregate Production</u>	<u>Total Production</u>	<u>Unassigned Production</u>
$\frac{1946 \text{ Output}}{1945 \text{ Output}}$		1.34 <u>137/</u>		1.34 <u>138/</u>
$\frac{1947 \text{ Output}}{1946 \text{ Output}}$	1.52 <u>139/</u>	1.30 <u>140/</u>		1.50 <u>141/</u>
$\frac{1948 \text{ Output}}{1947 \text{ Output}}$		1.42 <u>142/</u>		1.24 <u>143/</u>
$\frac{1949 \text{ Output}}{1948 \text{ Output}}$	1.19 <u>144/</u>			
$\frac{1950 \text{ Output}}{1949 \text{ Output}}$	1.12 <u>145/</u>			
$\frac{1950 \text{ Output}}{1940 \text{ Output}}$				1.6 <u>146/</u>
$\frac{1950 \text{ Output}}{1946 \text{ Output}}$				2.58 <u>147/</u>
$\frac{1951 \text{ Output}}{1940 \text{ Output}}$			1.65 <u>148/</u>	
$\frac{1952 \text{ Output}}{1951 \text{ Output}}$	1.03 <u>149/</u>			
$\frac{1946 \text{ Output}}{1946 \text{ Plan}}$	0.98 <u>150/</u>			

* Footnote for Table 6 follows on p. 40.

S-E-C-R-E-T

S-E-C-R-E-T

Table 6

Published Information on Ratio of Change in Plans and Production
of Machine Tools in the USSR a/
1946-51
(Continued)

<u>Ratio</u>	<u>Ministerial Production</u>	<u>Special and Aggregate Production</u>	<u>Total Production</u>	<u>Unassigned Production</u>
<u>1947 Output</u> <u>1947 Plan</u>	1.06 <u>151/</u>			
<u>1948 Output</u> <u>1948 Plan</u>	1.08 <u>152/</u>			
<u>1949 Output</u> <u>1949 Plan</u>	1.06 <u>153/</u>			1.03 <u>154/</u>
<u>1950 Output</u> <u>1950 Plan</u>	1.02 <u>155/</u>			
<u>1951 Output</u> <u>1951 Plan</u>	1.00 <u>156/</u>			
<u>1950 Plan</u> <u>1940 Output</u>	1.50 <u>157/</u>	9.5 <u>158/</u>		

a. Spaces left blank in this table indicate that data are not available.

S-E-C-R-E-T

S-E-C-R-E-T

The base period figure of 49,000 units used in the first estimate is more nearly in accord with the reported output for 1939 of 55,000 units and planned production for 1941 of 58,000 units, than is the lower figure used in the second estimate. It is very difficult to explain the 20-percent decline in output between 1939 and 1940 which would follow from the acceptance of the second estimate.

Scattered reports of increases in plant output and plant productivity indicate that actual production increases have been above those given in Table 5. The higher output figures in the first estimate are more consistent with these reports.

Finally, independent estimates of plant capacity used in the preparation of the 1954 capacity estimates support the conclusion that the capacity in 1951 was more than adequate to meet the output levels of the first estimate. Since there is no evidence that the USSR was producing below capacity during this period, both estimates are conservative, although the first is closer to reality than the second.

The 1941 production estimate of 34,000 units was based on these hypotheses. First, the output up to the German invasion of 21 June 1941 was approximated at 26,000, prorating the average of the 1940 production of 49,000 and the 1941 Plan of 58,000. Second, the output for the rest of the year was judged to be about 8,000 units. This was based on an examination of the maps of the German advance, 159/ which suggested that the USSR lost 70 percent of its machine tool production capacity for the last 6 months of 1941.

b. Basis of Estimates of Production (1953-54).

The estimates for this period were based on an arithmetic straight line projection of the 1950-52 increase in production.

The low rate of annual growth for this period (4 percent) can be attributed to the Soviet effort to fulfill planned production. The current Five Year Plan (1951-55) calls for increased production of heavy and higher precision machine tools by 1955, setting the respective goals at 2.6 and 2.0 times the 1950 level. 160/ The Plan does not specifically call for an increase in the capital investments of the machine tool industry or in its material or labor inputs. It must be assumed, therefore, that any concentration on units of the heavy or precise types must be reflected in a decline in the number of units produced.

S-E-C-R-E-T

S-E-C-R-E-T

A reported production increase of 14 percent in 1953 was not used because the figure is lower than the stated margin of error in the production estimates. 161/ The administrative changes of 1953 may have changed reporting methods to include machines not previously reported. Reports now include a simple babbitt boring machine of the type now used in US garages. 162/ In addition, in 1953 the industry started producing parts for agricultural machines and tractors.

c. Use of Percentage Figures.

For many years, production reports gave percentage relationships between production in various years or between actual production and planned production. In some cases, however, it was not stated whether these ratios were based on units or on the value of machine tools produced. It has been assumed, unless otherwise stated in the source, that percentage figures referred to units.

d. Derivation of Weights of Soviet Machine Tool Output in 1954.

Some very bold procedures were used to derive the proportion of 1954 production in the various weight classes. The light and medium classifications were arbitrary selections, but the heavy classification conforms to Soviet definition. 163/ The Soviet special heavy class (over 100 tons) was included in heavy, since the quantity produced is small and would not change the percentages. More than a year is required, in fact, to build some of the larger machines; thus only a part of the total is produced annually. A machine tool expert estimated the 1954 output of each of the 44 known primary plants on the basis of the data presented in Appendixes A, B, and C. The following outputs of machine tools were derived for the primary producer plants: light-weight tools (under 3 metric tons), 36,140; medium-weight tools (3 to 30 metric tons), 32,220; and heavy-weight tools (over 30 metric tons), 3,490 units, totaling 71,850 units.

This method accounted for only 71,850 of the 92,000 machine tools estimated to have been produced in 1954. It was assumed that the difference (20,150) was entirely in the light category and was added to the 36,140 light-weight units, bringing the total to 56,290. Plants other than the primary producers are assumed to be producing light-weight machines, and heavier machines are probably produced in the 44 known primary plants. This was the basis for the calculation of the percentage distribution among weight classes which was presented in the chapter on production.

S-E-C-R-E-Te. Derivation of Weights of Output of Machine Tools in the US in 1952.

The calculation of the US percentage distribution of machine tool production in 1952 was based on 1952 output data in a Department of Commerce publication together with weights of the various items as estimated by a machine tool expert. 164/

f. Value of Production.

The \$1-billion estimate of the value of production in the USSR is based on an average estimated price per unit of \$11,000. This was derived by converting the annual yield per Soviet employee of 1.1 units of machine tools to number of hours. The Soviet employee works 48 hours per week for 50 weeks, a total of 2,400 hours annually. This figure divided by 1.1 equals 2,182 hours required to produce a unit. A \$5.00 estimate* of the value produced in each hour was multiplied by 2,182, giving \$10,910 as the value per unit. The unit value multiplied by the number of units produced gives a total of \$1 billion. (10,910 x 92,000 = 1,003,720,000).

g. Soviet Data.

This report has assumed that Soviet published statistics are reasonably accurate reports of production and inventory.

2. Inventory.

Quantitative information on the Soviet inventory of machine tools is fragmentary. Figures released by the USSR are limited to those shown in Table 7.**

The Soviet inventory was calculated as shown in Table 8,*** beginning with the year 1940, which was the last year for which a Soviet census figure was available.

* A rule of thumb estimate by a machine tool expert. Estimate of error, plus 20 percent.

** Table 7 follows on p. 44.

*** Table 8 follows on p. 45.

S-E-C-R-E-T

Table 7

Published Inventory of Machine Tools in the USSR

<u>Date</u>	<u>Units</u>
Before 1917	72,000 <u>165/</u>
1928	93,000 <u>166/</u>
10 April 1932	181,400 <u>167/</u>
January 1938	380,000 <u>168/</u>
November 1940	630,000 <u>169/</u>
End of 1950 (Plan)	1,300,000 <u>170/</u>

Production figures were taken from Table 1.* Imports for the years 1941 through 1948 are a total of calculated shipments from the US, the UK, and Germany. 171/ Since war losses were reported to be 175,000 machine tools, 172/ half of this figure was subtracted for each of the 2 war years of German occupation. For purposes of retirement, a maximum useful life of 30 years was used. This figure is based on the assumption that the Soviet need for machine tool units is greater than that of the US, and that they would not discard them as quickly. According to the US Treasury, the useful life of a machine tool, for amortization purposes, is 15 to 25 years. There are many machine tools in the US, however, which are over 40 years old and are still in active use. A breakdown by year of installation or manufacture was reported in the Soviet census of April 10, 1932. 174/ The inventory prior to 1913 was given as 37,900 units; therefore this figure was deducted in 1943, the year these machines became 30 years old. Other figures were reported for a span of years, such as 1914-17, 20,500 units; 1918-22, 9,400 units; and 1923-27, 25,100 units. 175/ The reported figures were divided equally for the years covered, and these amounts were deducted as retirements.

It is doubtful that the Russians retired the 48,000 units during the war years 1943-45 as shown in Table 8. It is more logical to assume that they were retired in the postwar years; however, for purposes of calculation, all units were considered as retired when they were known to be 30 years old.

* P. 7, above.

S-E-C-R-E-T

Table 8

Calculated Inventory of Machine Tools in the USSR
1940-54

					Units
<u>Year</u>	<u>Production</u>	<u>Imports</u>	<u>Retirement and War Losses</u>	<u>Reparations</u>	<u>End-of-Year Inventory</u>
1940					630,000 <u>173/</u>
1941	34,000	6,000	-87,000		583,000 <u>a/</u>
1942	10,000	7,000	-87,000		513,000 <u>a/</u>
1943	14,000	17,000	-38,000		506,000 <u>a/</u>
1944	21,000	22,000	-5,000		544,000 <u>a/</u>
1945	23,000	10,000	-5,000		572,000 <u>a/</u>
1946	31,000	5,000	-5,000	68,000	671,000 <u>a/</u>
1947	48,000	1,000	-5,000	68,000	783,000 <u>a/</u>
1948	59,000	1,000	-2,000	68,000	909,000 <u>a/</u>
1949	71,000	b/	-2,000	68,000	1,046,000 <u>a/</u>
1950	79,000	b/	-2,000		1,123,000 <u>c/</u>
1951	82,000	b/	-2,000		1,203,000 <u>c/</u>
1952	85,000	b/	-2,000		1,286,000 <u>c/</u>
1953	88,000	b/	-5,000		1,369,000 <u>c/</u>
1954	92,000	b/	-5,000		1,456,000 <u>c/</u>

a. Estimated margin of error, plus or minus 20 percent.

b. No estimates are made for these years. As the USSR started exporting at about this period, it was assumed that imports and exports would cancel each other. If they did not exactly cancel, the difference would not affect the inventory significantly.

c. Estimated margin of error, plus 15 percent.

The USSR was reported to be dismantling and acquiring 270,000 units for reparations. 176/ This figure was divided by 4 and added as a gain for the 4 postwar years. The estimate for the percentage of inventory less than 10 years old was arrived at by totaling production, reparations, and imports for the years 1945 through 1954.

S-E-C-R-E-T3. Inputs.a. Production.

To arrive at the material input requirement of the Soviet machine tool industry, it was necessary to determine the average weight per machine tool unit. In 1951, A. I. Kostousov, Minister of Machine Tool Building, stated that the average weight of a machine tool was 1.92 tons* in 1940 and 2.85 tons in 1950. 177/ He also said that the weight of the average machine tool in 1952 must be increased 25.3 percent. 178/ Assuming the average weights for 1950 and 1951 to be about the same, an increase of 25.3 percent would bring the 1952 average to 3.56 metric tons. A 10-percent annual increase was estimated for 1953 and 1954 because of current plans calling for an increase of heavy machine tools by 2.6 times (units). 179/ The average weight for the Soviet finished machine tool unit, motorized and equipped, was estimated at 4.3 metric tons, or 9,477 pounds. To find the proportion of the various metals entering into the manufacture of machine tools in the US, the weights of these metals given in the US Census of Manufactures 180/ were expressed in percentages of the total, as shown in Table 9.

Table 9

Proportions of Metals Used in Machine Tools in the US
1947

	<u>Short Tons</u>	<u>Percent</u>
Steel, All Shapes	61,995	31.8
Iron Castings	130,964	67.4
Copper and Alloys	921	0.5
Aluminum and Alloys	609	0.3
Total	<u>194,449</u>	<u>100.0</u>

* Soviet weights are assumed to be in metric tons.

S-E-C-R-E-T

In order to utilize properly the above developed percentages, the weight of items manufactured outside the machine tool industry, that is, motors, antifriction bearings, rubber, and paint, was deducted from the weight of the finished, equipped machine tool. The total weight of these items was estimated at 563 pounds per unit. Subtracting this from 9,477 pounds leaves 8,914 pounds as the portion of the total weight which is produced by the Soviet machine tool manufacturer. Data gathered from US machine tool manufacturers reveals that there is a 20 percent loss in producing the finished unit from the raw metals. Soviet chip removal for cast iron averages 28 percent of finished weight and runs as high as 40 to 50 percent for forgings. 181/ Chip loss on rolled steel is normally less than on cast iron. Since forgings comprise a small percentage of the finished unit, 25 percent was used as the chip loss in producing the average Soviet machine tool. On this basis, a Soviet machine tool requires 8,914 pounds plus 2,228 pounds, or 11,142 pounds (5.1 metric tons) of raw metals. This tonnage figure multiplied by the annual production figure of 92,000 units gives the metals requirement as 469,200 metric tons. This figure multiplied by the percentages previously established for each metal gives the tonnage input requirement for each metal.

b. Rubber or Synthetics (Deductible).

The items requiring rubber or synthetic materials include vee belts for drive, oil wipers, seals, and the like, and are estimated to weigh 20 pounds per unit. This figure multiplied by 92,000 units totals 1,840,000 pounds, or 834.6 metric tons.

c. Lumber.

It is assumed that the Russians prepare their product for shipment as carefully as do US manufacturers. On this basis, it is estimated that the requirement in lumber for skids, crates, bracing, packing boxes, and excelsior would be 5 percent of the weight of the finished equipped machine tool unit. Although lumber is measured in cubic meters in the USSR, the metric ton was used as a satisfactory index to include all the wood requirements. With 4.3 metric tons as the average weight of a finished equipped unit, the lumber requirement is 0.18 metric tons per unit (4.3 metric tons times 5 percent equals 0.22 metric tons), or 20,240 metric tons for the total production of 92,000 units.

S-E-C-R-E-T

S-E-C-R-E-Td. Preservatives.

It is estimated that an average of 6 pounds of preservative is used to protect exposed finished machined surfaces while the unit is in transit. This figure multiplied by 92,000 units equals 552,000 pounds of preservative, or 250 metric tons (552,000 pounds divided by 2204.6 equals 250).

e. Paint (Deductible).

The average unit machine tool is estimated to have a combined internal and external surface of 250 square feet requiring painting or sealing. The average coverage of one gallon of paint (enamel) is 400 square feet. 182/ The average unit requires at least one coat each of sealer, primer (or filler), and enamel totaling 750 square feet of area requiring 15 pounds or 1.88 gallons of paint per unit. The 1.88 gallons multiplied by the 92,000 units totals 172,960 gallons of paint required, or 654,652 liters (172,960 times 3.785 equals 654,652).

f. Antifriction Bearings (Deductible).

Forty antifriction bearings are estimated to be the requirement for the average Soviet machine tool unit. This figure multiplied by 92,000 units equals 3,680,000 antifriction bearings. The types of bearing used would be roller, ball, and thrust. The average bore is estimated to be about 50 millimeters. By tabulating the three types used that have a 50-millimeter bore, the average weight is established as 1.96 pounds per bearing, or 78 pounds per unit. 183/

g. Motors (Deductible).

In 1951, A. I. Kostousov stated that the average power rating of motors per tool was 3.7 kilowatts in 1940 and 5.5 kilowatts in 1950. 184/ In September 1953, power on milling, planing, and broaching machines was said to have increased 2 to 2.5 times over the prewar period. 185/ The 3.7 kilowatts reported in 1940 was multiplied by the 2.5 times reported increase in 1953, and the total of 9.25 kilowatts was used as the average for 1954 (3.7 times 2.5 equals 9.25 kilowatts). The 92,000 units multiplied by 9.25 kilowatts equals 851,000 kilowatts. A US motor with a rating of 15 horsepower, 3-phase, operating at 1,200 revolutions per minute, with its weight given as 380 pounds in a General Electric Company catalogue, is considered as equal in weight

S-E-C-R-E-T

to a Soviet 9.25-kilowatt motor. Suitable starters and switches are listed as weighing 50 pounds, and wiring is estimated to be about 20 pounds.

h. Electric Energy.

It is assumed that Soviet and US electric power requirements run in the same ratio as Soviet and US metal inputs. The US metal input of 194,449 short tons in 1947 required a total energy input of 257,000,000 kilowatt-hours. 186/ The 194,449 short tons equals 176,404 metric tons. (194,449 times .9072 equals 176,404). Therefore, the US 1947 requirement was 1,457 kilowatt-hours per metric ton of metal input (257,000,000 divided by 176,404 equals 1,457). The Soviet metal input of 469,200 metric tons multiplied by 1,457 kilowatt-hours equals 684 million kilowatt-hours (469,200 times 1,457 equals 683,624,400).

i. Coal.

It is assumed that coal requirements are proportional to weight of metal inputs. US fuel requirements for the machine tool industry are given in several categories, that is, coal, coke, fuel oil, and gas. 187/ There is substitutability among these fuels, and lacking information on their proportional use in the USSR, estimates were converted to coal, since it is probably the standard fuel for this industry in the USSR. The US 1947 fuel requirements amount to 5,950 billion British thermal units (B.t.u.'s), as shown in Table 10.* This means that each metric ton of metal consumed by the US machine tool industry required 33.7 million B.t.u.'s (5,950 billion B.t.u.'s divided by 176,404 metric tons equals 33,729,393). There are 27.8 million B.t.u.'s in 1 metric ton of coal 187/ therefore each metric ton of metal requires 1.216 metric tons of coal (33.7 million divided by 27.8 million equals 1.216). The 469,200 metric tons of metal consumed multiplied by 1.21 equals 567,732 metric tons, or the amount of coal required by the Soviet machine tool industry.

j. Labor.

Labor estimates are based on the US figure for the percentage of one machine tool which an employee would produce in one year. The estimated Soviet production was divided by the calculated percentage of unit per employee per year, to arrive at the number of Soviet employees.

* Table 10 follows on p. 50.

S-E-C-R-E-T

Table 10

Conversion to B.t.u.'s of Fuels Used by the Machine Tool Industry
in the US 188/
1947

<u>Fuel</u>	<u>Quantity</u>	<u>B.t.u.'s Per Unit</u>	<u>Total B.t.u.'s (Billion)</u>
Coal (short tons)			
Bituminous	112,000	26,000,000	2,900
Anthracite	12,000	24,000,000	290
Coke (short tons)	16,000	34,600,000	550
Fuel Oils (short tons)	40,152 <u>a/</u>	39,000,000	1,570
Gas (cubic feet)			
Natural	29,100,000	1,150	330
Manufactured	22,700,000	600	140
Mixed	21,300,000	800	170
Total			<u>5,950</u>

a. Multiplying 239,000 barrels times 336 pounds per barrel gives a total of 40,152 short tons.

The only available Soviet labor figure is that of 26,800 for 1935. 190/ Dividing this figure by the 24,432 units produced in 1935 shows that it took 1.097 employees to produce one machine tool per year; that is, each employee produced 0.912 machine tools. Many Soviet reports claim an increased productivity, and it seems fair to assume that labor productivity has increased since 1935. On the other hand, the machine tools produced today are larger and considerably more complicated, hence require more man-hours to produce. It might be assumed that the increase in productivity overbalances the greater complexity, so that the rate is now one machine tool per year per worker. In that case the labor force in 1954 would be 92,000.

Another method of computation is to compare US and Soviet labor productivity in the machine tool industry. US statistics for the years

S-E-C-R-E-T

1946 through 1950 are used.* This period did not include peak wartime rates of production, which would abnormally raise the yield per person.

The average number of units produced during this period was 52,200 per year. The average number of employees was 46,560 per year 191; production per worker was, therefore, 1.1 units. A yield of 1.1 units per employee for the USSR is therefore assumed. Applying this rate to the estimated 1954 production, a labor figure of 83,636 is derived (92,000 divided by 1.1 equals 83,636).

The second estimate is favored over the first because it is based on more recent data. Even though Soviet labor is less productive, the analogy is believed to be accurate, because the Soviet 48-hour week raises the annual yield per worker.

k. Floorspace.

Estimates for floorspace are based on US figures for average square feet of plant floorspace per employee. The data on floorspace and number of employees of 13 selected US machine tool plants were used. 192 The plants are geographically dispersed and include producers of small machine tools, producers of large machine tools, producers of a single type of machine tool, and producers of varied types. Data for 1951 have been selected because they are thought to be representative of a normal economy and 1-shift operation. Productivity factors are assumed to balance.

The average number of square feet of floorspace per employee is 300. This figure, multiplied by the estimated 84,000 Soviet employees, yields the estimated Soviet floorspace.

l. Machine Tools Used by the Industry.

The estimate for the number of machine tools used by the industry is considered tenuous but is presented for lack of better information.

* The National Machine Tool Builders' Association only reports statistics for its members, which include approximately 90 percent of the machine tool producers in the US. Data provided by this organization are therefore representative of machine tool industry conditions. It is felt that N.M.T.B.A. statistics are more accurate than Bureau of Census data. Bureau of Census data include many items (for example, thousands of bench grinders valued at about \$50.00) which are not defined as machine tools in this study. Since N.M.T.B.A. estimates were not available for 1950 and 1951, Department of Commerce figures were used.

S-E-C-R-E-T

The data used were obtained from two US machine tool plants in 1952. The information is considered accurate, but it is weak because the sampling is confined to only 2 plants, 1 specializing in the production of turret lathes, the other in milling machines. The floorspace for the 2 plants averages approximately the same as the average floorspace for the 13 US plants that are used for the Soviet floorspace estimates. This floorspace average is divided by the number of installed machines to arrive at the average floorspace for each installed machine, 1,000 square feet. The estimated figure for Soviet floorspace is then divided by 1,000 square feet to arrive at the number of machine tools used by the industry.

S-E-C-R-E-T

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