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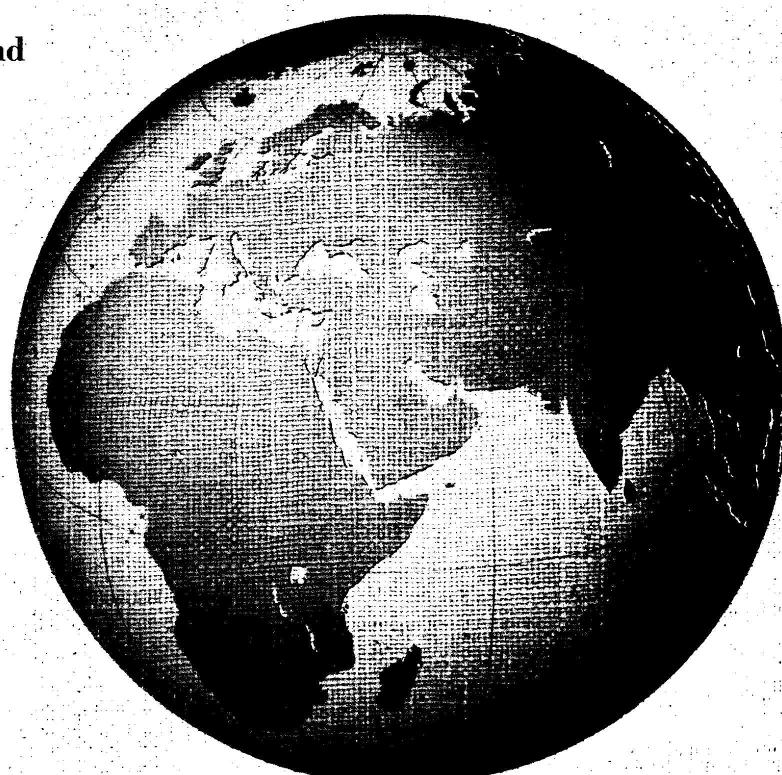
NATIONAL INTELLIGENCE SURVEY

U.S.S.R.

MANUFACTURING and CONSTRUCTION

DECEMBER 1967



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Approved For Release 2008/09/08 : CIA-RDP08S01350R000100030002-2

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Approved For Release 2008/09/08 : CIA-RDP08S01350R000100030002-2

Approved For Release 2008/09/08 : CIA-RDP08S01350R000100030002-2

TABLE OF CONTENTS

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Approved For Release 2008/09/08 : CIA-RDP08S01350R000100030002-2

Approved For Release 2008/09/08 : CIA-RDP08S01350R000100030002-2

Approved For Release 2008/09/08 : CIA-RDP08S01350R000100030002-2

Approved For Release 2008/09/08 : CIA-RDP08S01350R000100030002-2

Approved For Release 2008/09/08 : CIA-RDP08S01350R000100030002-2

Approved For Release 2008/09/08 : CIA-RDP08S01350R000100030002-2

Approved For Release 2008/09/08 : CIA-RDP08S01350R000100030002-2

Approved For Release 2008/09/08 : CIA-RDP08S01350R000100030002-2

Approved For Release 2008/09/08 : CIA-RDP08S01350R000100030002-2

Approved For Release 2008/09/08 : CIA-RDP08S01350R000100030002-2

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FIGURES

Approved For Release 2008/09/08 : CIA-RDP08S01350R000100030002-2

Approved For Release 2008/09/08 : CIA-RDP08S01350R000100030002-2

Approved For Release 2008/09/08 : CIA-RDP08S01350R000100030002-2

Approved For Release 2008/09/08 : CIA-RDP08S01350R000100030002-2

Approved For Release 2008/09/08 : CIA-RDP08S01350R000100030002-2

Approved For Release 2008/09/08 : CIA-RDP08S01350R000100030002-2

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Approved For Release 2008/09/08 : CIA-RDP08S01350R000100030002-2

Manufacturing and Construction

A. General

1. Introduction

The U.S.S.R. is an industrial power ranking second only to the United States, even though it lags far behind in total output. Soviet gross national product (GNP) in 1966 was only 47% of that of the United States. Moreover, the rate of growth of Soviet GNP has declined somewhat in recent years, falling from an annual average of 6½% in the 1950's to less than 5% in the first half of the 1960's. Net industrial output between 1950 and 1966 nearly quadrupled—increasing at an average annual rate of 8½%.

The U.S.S.R. possesses large supplies of most of the natural resources needed by an industrial nation. It has coal, petroleum, and water power in abundance, as well as large deposits of iron ore, copper, and most of the leading types of minerals. However, some of these resources are located in severely cold regions of the north, far from the industrial centers, so that their utilization is difficult and extremely costly. FIGURE 1 compares Soviet output of important heavy industry products with U.S. outputs for selected years.

The industrial sector has continued to increase its share in the total structure of the Soviet economy. As depicted graphically in FIGURE 2, the relative importance of industry in the U.S.S.R.'s GNP increased from 31% in 1955 to 37% in 1966. For the same period, the share claimed by construction increased from 8% to 11%.

The high rates of growth of industrial production during the late 1940's and early 1950's were the result of a number of favorable circumstances. First, recovery from wartime disruption made possible rapid industrial growth during the 1950's. Second, gains in productivity—the efficiency with which inputs are used—were high during this period because of improvements in production techniques, training of the

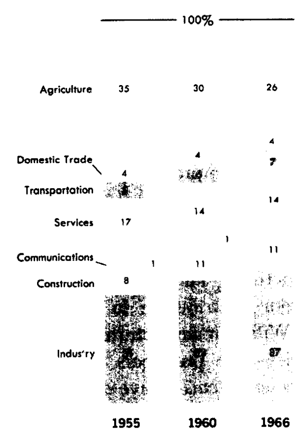

FIGURE 2. ESTIMATED GROSS NATIONAL PRODUCT, BY SECTOR OF ORIGIN

FIGURE 1. COMPARISON OF SOVIET AND U.S. OUTPUT OF KEY HEAVY INDUSTRY PRODUCTS

ITEM	UNIT	U.S.S.R.			U.S.	U.S.S.R. AS PERCENT OF U.S.
		1958	1960	1965	1965	1965
Metals:						
Pig iron and blast furnace ferroalloys.	Million metric tons	39.6	46.8	66.2	80.6	*82.1*
Steel—crude	....*do*	54.9	65.3	91.0	119.0	*76.5*
Primary aluminum	Thousand metric tons	510.0	630.0	1,025.0	2,499.0	*41.0*
Copper	....*do*	406.3	490.0	770.0	1,956.8	*39.3*
Energy:						
Coal of all types	Million metric tons	493.0	510.0	578.0	478.0	*121.0*
Petroleum products	....*do*	92.7	116.1	177.0	423.7	*41.8*
Natural gas	Billion cubic meters	28.0	45.0	128.0	454.0	*28.2*
Electric power	Billion kilowatt hours	235.4	292.3	506.7	1,230.0	*41.2*
Of which, hydro	....*do*	46.5	50.9	81.4	197.0	*41.3*

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labor force, and economies associated with the increasing scale of operation as industry expanded. Third, industrial technology in the U.S.S.R. was far behind the advanced countries in the West and there were rich opportunities for borrowing and catching up. Important gains thus were made in adopting advanced processed technology as new plants were built or reequipped.

A general decline in industrial growth since the late 1950's, attributable primarily to a decline in productivity gains has been cause for official concern. Output of industrial branches of industry has expanded at widely differing rates, but almost all branches have experienced some decline in the rate of growth. The average annual growth rate of consumer soft goods (textiles, clothing, and footwear) experienced a marked decline—from 8½% during 1951-60 to 4% during 1961-66. The decline in the growth of civilian machinery was somewhat less, but still significant—from 11½% to 8½%.

Soviet planners, in spite of overall progress, have not had sufficient resources to meet the competing requirements of defense, industrial growth, scientific achievement, and improvements in consumer welfare. Far from being an affluent society, the U.S.S.R. nonetheless has been able to allocate its resources so that the high priority goals of the economy could be met. The manufacturing and construction industries have made a major contribution to growth of the Soviet economy. Within manufacturing, the machine building industries—the producers of civilian machinery and military end-items—have made especially rapid advances. Soviet planners accord a high priority to machine building to ensure self-sufficiency in military production and in the growth-supporting heavy industries such as iron and steel and electric power.

The U.S.S.R. has developed a high capability to produce not only the industrially important machine tools, but also a highly sophisticated output of military aircraft, guided missiles and space systems, nuclear power reactors, and electronic computers. At present, Soviet production of machine tools, railroad passenger cars, conventional weapons, mainline locomotives, tractors, and grain combines, surpasses U.S. production of each of these commodities. In units of metalcutting machine tools, the U.S.S.R. now outproduces the United States nearly 3 to 1.

In the production of military end-items and the development of advanced weapons systems, the U.S.S.R. has reached perhaps its highest level of performance. At a time when military progress has brought about many new technical problems involving the use of new materials, new processes, new equipment, and new requirements for specialized labor skills, Soviet industry has demonstrated the ability to design and produce advanced weapons systems. Although bomber production is declining, the U.S.S.R. is presently producing surface-to-surface ballistic missiles with ranges up to 6,500 nautical miles, as well as surface-to-air, air-to-surface, and air-to-air missiles. It is estimated that the U.S.S.R. probably has produced hundreds of ICBM's, and several thousand ballistic missiles with ranges less than the ICBM. The U.S.S.R. exports guided missiles to the Warsaw Pact countries, Yugoslavia, Cuba, the Communist countries of the Far East, and some to various non-Communist countries.

The high order of Soviet military production is also evident in the naval construction program, which now is concentrating on the production of nuclear submarines, with and without missile capabilities. Finally, the U.S.S.R. has attained world leadership in producing conventional weapons.

In other branches of manufacturing, the U.S.S.R. lags far behind the West in the use of modern production techniques. Some Soviet manufacturing processes are archaic. Foundry and metalforming production is especially backward; materials handling equipment is lacking in much of Soviet industry; obsolete models often remain in production; spare parts production is a chronic problem; and antiquated machinery often continues in use irrespective of cost.

In spite of attempts on the part of the Soviet leadership to raise the priority of manufactured consumer goods, a wide disparity still exists between industries manufacturing producer goods and those manufacturing consumer goods. The processed food industries are especially backward in terms of quality and variety of product and processing technology. Light industry has a poor record in terms of the goods produced and in manufacturing performance. Production of household appliances is increasing rapidly although output is still far short of demand. Quality of appliances is such that few would be salable in U.S. markets. Production of the new plastics, fibers, and petrochemical products has lagged far behind achievements of the United States, United Kingdom, West Germany, and Japan.

2. Growth of industry

Soviet industrial production during 1959-66 increased at an average annual rate of about 7% (based on valued-added weighted indexes of intermediate and final products), a high rate of growth—even though substantially below the 10% increase achieved during 1950-58. Within the manufacturing industries, the chemical industry increased at the highest average annual rate of growth of 12% and light industry at the lowest rate of 4½%. Rates of growth of industrial production, both Soviet official and U.S. estimated, for

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all of industry and by branch of manufacturing for the period 1959-66 are given below (1958=100):

	Official Soviet gross value index		Estimated value-added index	
	Index	Rate	Index	Rate
Industry	200	9.1	173	7.1
Machine building and metalworking	265	13.1	183	7.8
Chemical industry	277	13.6	248	12.0
Light industry	143	4.6	142	4.5
Food industry	170	6.8	158	5.9

Whereas the official Soviet index usually shows a higher rate of increase than the estimated value-added index, the latter confirms the substantial growth achieved in Soviet industry.*

The rapid growth in industrial production that characterized the 1950's was not maintained during the first half of the 1960's, as many of the advantages for rapid growth began to run out. As the level of technology rose, the potential gains from borrowing tended to diminish. Some slowing of growth occurred because supplies of raw materials in many parts of industry did not keep pace with requirements. Later, although inputs improved, expected gains were partially offset by a drop in productivity. For example, the skills of industrial workers, although considerably higher than in the 1950's, ceased to improve as rapidly as before. Also, the rate of growth of investment in industry during the 1960's was much lower than in the 1950's and could not support as high a rate of growth of industrial output. The average annual rate of growth in industrial investment of almost 12% in 1951-60 fell to 6½% in 1961-66; consequently, plant managers in many cases were obliged to keep obsolescent equipment in operation and thereby further contributed to slowing down the growth of productivity.

Some of the U.S.S.R.'s natural resources of better quality or more favorable location are gradually becoming exhausted, and new industrial growth requires the exploitation of resources further removed from industrial centers. For example, Siberia contains four-fifths of the nation's hydroelectric potential, an equally large share of its timber reserves, three-fourths of the known coal reserves, and two-thirds of the oil reserves. Soviet planners now must turn to these resources despite the difficulties in recruiting labor and the disadvantages of higher transportation costs.

Another deterrent to rapid industrial growth is the expansion of military-space programs that use top-quality materials, complex machinery, and specialized personnel. These resources would otherwise be used in civilian industry and would help to maintain former levels of growth. In addition, Soviet military aid to Vietnam has been increasing.

Even though the U.S.S.R. has not had sufficient resources to meet all of the competing requirements for national defense, industrial growth, scientific achievement, and improvements in consumer welfare, Soviet planners have tried to maintain a careful balance between priority goals and less important sectors of the economy. Thus, the U.S.S.R. has been able, on the whole, to support large military and space programs, to maintain a substantial though lower rate of growth for industry, to modernize and reequip a large share of industry, and gradually to improve consumer welfare.

A number of particular obstacles are now making it difficult for the Soviets to achieve some of their planned growth. A shortage of steel has been limiting industrial expansion to some extent, a problem that the State Planning Committee (*Gosplan*) was seeking to alleviate by boosting sharply investment in the steel industry. Having previously lost status as a result of Khrushchev's high priority chemicals program, the steel industry has risen again on the scale of national priorities under the Brezhnev-Kosygin leadership.

The U.S.S.R. has been unable to move ahead as fast as its planners desire in certain areas of manufacturing which are of benefit primarily to the consumer; for example, in the development of synthetic fibers, plastics, and other synthetic materials; in modernizing the textile industry; and in providing modern equipment for laundry and dry cleaning establishments. A subsidiary of Courtaulds, the United Kingdom's largest textile consortium, contracted in 1967 to supply the U.S.S.R. with plant and machinery for an acrylic fiber factory valued at more than $26 million. This firm supplied five other fiber plants to the U.S.S.R. in previous years. Two large textile plants for spinning and weaving blends of wool and synthetic fiber were being built in 1967 under contracts signed with Italian firms. Commercial laundry equipment is to be produced in the U.S.S.R. under a cooperative agreement with Fisher Bendix of the United Kingdom. Self-service laundries using U.K. and U.S. equipment are already operating in several Soviet cities.

The U.S.S.R. is also looking to Western firms for help in expanding and modernizing its automotive industry. The dawn of the automobile era in the U.S.S.R. has been slow in breaking, but the decision in 1966 to promote production of passenger cars brought the country one step nearer the automotive

* Western economists are generally agreed that the official Soviet index based on gross value of industrial output overstates growth. The estimated index, based on 1960 value-added weights, is an independent measure of Soviet industrial growth. The official Soviet indexes are included, however, to permit future Soviet announcements to be compared with past trends.

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age. A plant to be built in the U.S.S.R. at Tol'yatti (formerly Stavropol) by the Fiat Company of Italy will be capable of producing 600,000 automobiles a year when operating at capacity and will be the single most important addition to the industry as presently constituted. In addition, the French automotive firm, Renault, will assist in the modernization of the Moskvich automotive plant in Moscow. U.S.-built machine tools will be supplied to the plant built by Fiat, as well as to a new automotive plant to be built in the Moscow suburban area that will produce automobiles of the Moskvich type. With the newly built or expanded and modernized facilities, Soviet production of automobiles probably could reach 460,000 by 1970, and 1.1 million by 1975. This would provide the economy with an automobile stock in 1970 equal to that of the United States in 1917, and, on a per capita basis, about 5% of the current U.S. inventory. However, it seems unlikely that the 1970 goal of 700,000 to 800,000 automobiles will be reached before 1972.

In development and production of electronic computers, the U.S.S.R. also has failed to keep pace with developments in the Industrial West. Obviously, this lag has not prevented the U.S.S.R. from achieving spectacular results in its military and space programs. In the area of economic, business, and industrial applications of computers, however, the U.S.S.R. has barely scratched the surface compared with progress in the United States and other non-Communist countries.

The lack of electronic data processing equipment and the rudimentary state of development of this branch of the computer industry are causing the Soviet leadership considerable concern. The directives for the present Five Year Plan (1966-70) place major emphasis on increasing the production of computers, particularly those capable of handling large amounts of data as opposed to earlier emphasis on models designed to perform rapid calculations.

3. Importance of the manufacturing and construction industries

The manufacturing industries have made a major contribution to the growth achieved by the Soviet economy. In 1966, the four major branches of manufacturing—machine building, food, light, and chemical—accounted for approximately 54% of total industrial production. The machine building industries—the producers of civilian machinery and military end-items—have made especially rapid advances. Soviet planners accord a high priority to such production to ensure maximum support for production of military goods and the basic heavy industries such as the iron and steel and electric power industries. The following tabulation compares the relative importance of the branches of manufacturing in 1966, based on estimated value-added data, shown in percent of total:

All industry	*100*
Of which:	
Manufacturing industries	*54*
Machine building and metalworking	*31*
Light industry	*10*
Food industry	*8*
Chemical industry	*5*

The manufacturing sector in 1966 employed about 65% of the industrial workers in Soviet state industry (FIGURE 3). Employment in manufacturing in recent years has increased at the same rate as the economy as a whole. Total employment in Soviet industry increased from approximately 21 million in 1958 to 28 million in 1966, an increase of 35%. During the same period, total employment in manufacturing increased from approximately 12 million to 17½ million, an increase of more than 40%.

Within industry, the size of the labor force varies widely from one manufacturing sector to another. Machine building and metalworking claim a larger labor force than the other three branches of manufacturing combined. The machine building, light, and food industries all are relatively labor intensive whereas the chemical industry tends to be capital intensive.

Construction has contributed enormously to the development of the productive base of the Soviet economy, but on the whole its performance has been below planned levels. Total construction in 1966 was almost 2½ times that in 1955, although the fastest growth occurred during 1956-60, when an annual rate of 13% was achieved. During the early 1960's, the rate of increase dropped sharply, but by 1966 construction had risen to an average annual rate of about 7%. Housing construction has not been adequate to meet the requirements of increasing urbanization and the retirement of old housing in the cities and countryside. In spite of official pledges to alleviate the shortage, annual plans for housing construction have been consistently underfulfilled. There has also been a decline in housing built by individuals because of difficulties in acquiring building sites and building materials.

FIGURE 3. EMPLOYMENT IN MANUFACTURING AND CONSTRUCTION
(Thousand persons)

	1958	1966
All industry*	20,807	28,100
Of which:		
Manufacturing industries**	12,294	17,600
Machine building and metalworking	5,951	9,300
Chemicals	609	1,200
Light industry	3,666	4,600
Food industry	2,068	2,500
Construction	4,442	5,760

* Totals.

** Figures for 1966 are estimated.

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The quality of construction also has been under criticism, and the construction industries collectively have been beset by problems arising from their unwieldy size, inefficiencies in mechanization, insufficient supply of skilled labor, and shortages of building materials. In spite of its numerous difficulties, the industry has registered remarkable growth—especially in the past 10 to 12 years, attributable mainly to increases in the inventory of heavy construction equipment, greater standardization of building designs, and greater use of structural components made of precast reinforced concrete. Growing at an average annual rate of 8½% between 1955 and 1966, the volume of construction installation work increased from 12.8 billion rubles to 31.0 billion rubles. The relative importance of construction in the Soviet GNP is illustrated in FIGURE 2. FIGURE 4 shows some of the major industrial construction projects under way in the U.S.S.R. during 1967.

4. Production

Soviet industrial production is planned and carried out according to priorities set by the Communist Party and state leadership. Traditionally, Soviet policy has favored production of producer goods, military equipment, and—in more recent years—equipment for the space program, all at the expense of consumer goods production. Presently (1967), greater than usual attention is being paid to the production and distribution of consumer goods as planners strive to match the production of goods more closely with consumer's needs and tastes. The production of consumer durables is receiving especially strong and continuing support. FIGURE 54 lists the output of important types of manufactured goods produced in the U.S.S.R.

Even though many of the original Seven Year Plan production goals for 1965 were revised or discarded, fairly rapid growth was achieved by most of the manufacturing industries during the 7-year plan for 1959-65. The machine building industry, according to official pronouncements, overfulfilled its 1965 plan. Even so, the heavy requirements for military and space hardware restricted the ability of the machine building industry to produce important machinery items needed for industrial expansion. The production of metalcutting and metalforming machine tools, trucks, buses, and freight cars increased little or not at all during the period. An additional strain was imposed by the regime's determination to promote unscheduled programs for the consumer. The production of household appliances, particularly refrigerators and washing machines, increased at exceedingly high rates of growth during 1959-65, and the high growth rates are continuing.

The chemical industry exceeded by a considerable margin the average rate of growth of output achieved by total industry, but there were persistent problems and specific shortages of production. Output of plastics, resins, and synthetic fibers reached only a fraction of the goals set by the original ambitious 7-year plan. Production of mineral fertilizers on the other hand was relatively close to the planned level.

Growth of output of the food industry averaged 6% during the 7-year period, even though there were wide fluctuations, caused in large part by adverse weather conditions. On a per capita basis, however, increases in total food consumption at around 2% a year have been low during the 1960's. In 1958, consumer hopes were high for improvements in the quality and variety of food, particularly in the greater availability of meat and dairy products. But because of periodic setbacks in agriculture, which precluded such quality improvements in the food supply, these hopes in the main have not materialized.

The lower growth rate for light industry during 1959-65 was, to some extent, caused by materials shortages, but a more pressing problem occurred in the form of consumer resistance. Goods that were produced but did not sell accumulated in retail and wholesale networks, causing serious inventory problems. These included textiles, clothing, and footwear of poor quality, unattractive design, or shoddy workmanship. To prevent a continuing buildup of surpluses, production goals had to be cut back for a number of individual commodities. Some types or models of light industrial goods were taken out of production altogether, and the introduction of new types of goods to replace them or to otherwise improve the assortment tended to slow down production rates. As a result, production of clothing and some types of textiles increased little during the first half of the 1960's.

5. Investment

Investment in the manufacturing industries has grown as a share of total capital investments in Soviet industry, accounting for almost 40% in 1965 compared with only 30% in 1950. The machine building industry, largest of the manufacturing branches in terms of output and employment, also has consistently received the largest share of investment in manufacturing, amounting to 16% in 1965. Meanwhile the share of the chemical industry has almost trebled since the early 1950's, reaching 11% in 1965. Light industry's share has remained at 3-4%, and the food industry's share has ranged between 8% and 11% since 1950. FIGURE 5 compares the distribution of capital investment in the Soviet manufacturing industries in 1950 and 1965.

Large increases made in investment in the chemical industry since the late 1950's reflect an attempt to overcome the failure of the U.S.S.R. previously to keep pace with the industrial West in the development of chemicals. In spite of their importance to military and industrial production, the Soviet chemical industry had made only the most rudimentary beginnings in the development of the newer plastics and

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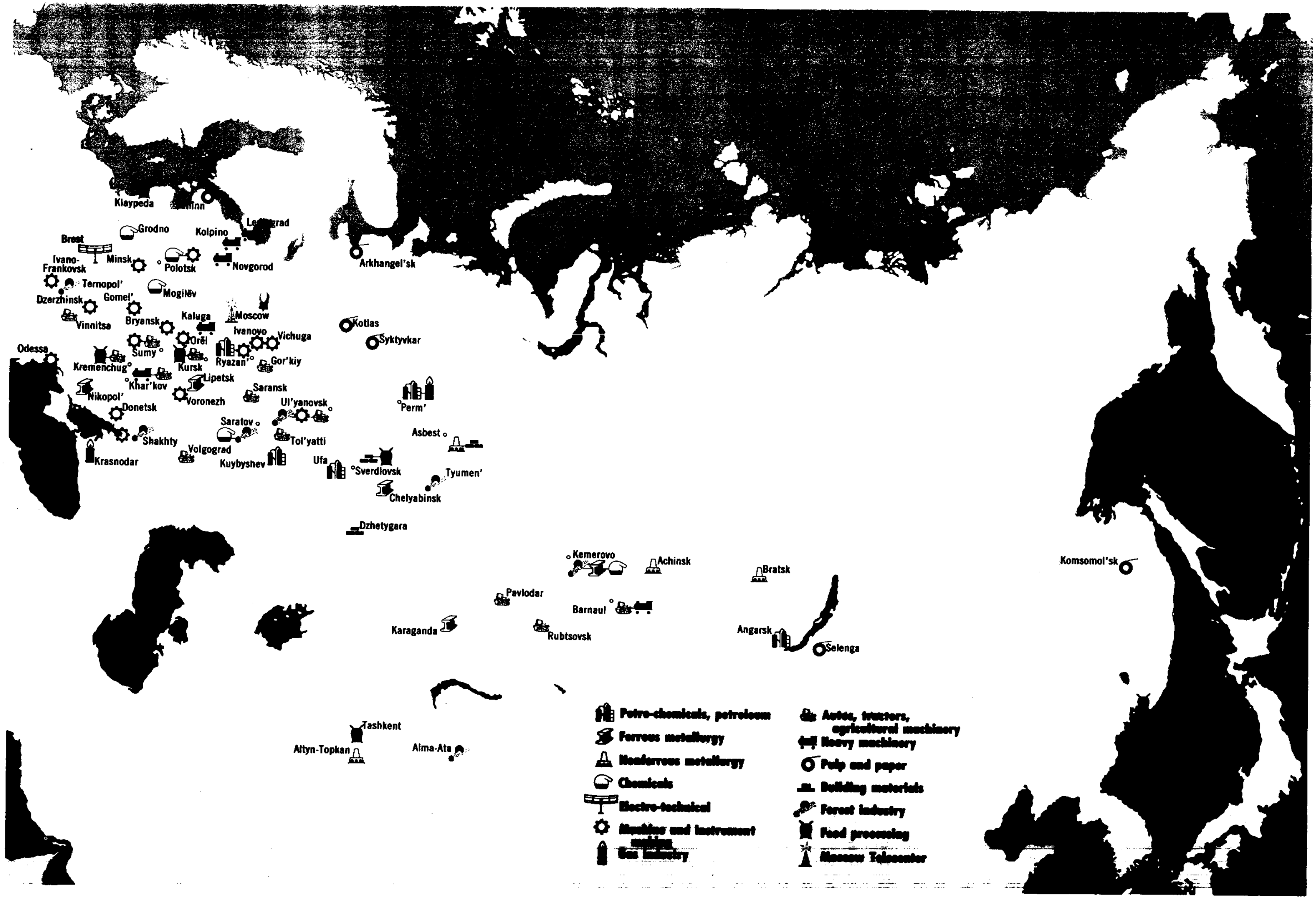

FIGURE 4. MAJOR INDUSTRIAL PROJECTS UNDER CONSTRUCTION IN THE U.S.S.R., 1967

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FIGURE 5. TOTAL CAPITAL INVESTMENT IN MANUFACTURING INDUSTRIES*

	1950		1965	
	Billion rubles	Percent of total	Billion rubles	Percent of total
Industry	4.2	*100*	17.9	*100*
Manufacturing industries	1.3	*31*	6.9	*39*
Machine building	.6	*14*	2.8	*16*
Chemical industry	.2	*5*	1.9	*11*
Food industry	.4	*10*	1.5	*8*
Light industry	.1	*2*	0.7	*4*

* Total capital investment includes both centrally planned and noncentrally planned investments. Data are in constant 1955 planning prices, converted to new (1961) rubles.

synthetic materials used widely abroad. Moreover, in the Industrial West these new materials were responsible for dramatic new developments in production of consumer goods and in many other industrial lines. In 1958, the Soviets initiated a program to develop large-scale production of synthetics, primarily from byproducts of petroleum and natural gas, and plans were made to obtain from the West new technology, prototypes of advanced equipment, and, in some cases, entire plants. In 1963 Khrushchev announced still another new program to increase rapidly the output of chemical fertilizers, synthetic fibers, and plastics. An investment program of about 25 billion rubles was announced for the chemical industry, and another 17 billion rubles for related industries during the remainder of the decade.

By 1965 the chemical industry, in spite of large infusions of capital and labor, had fallen far short of achieving goals set under the ambitious program. Problems in carrying out the program stemmed mainly from the complexity of modern chemical technology—particularly in plastics and synthetic fibers—and the difficulty which Soviet industry experienced in handling the new technology. The industry has had relatively less difficulty with its plans for chemical fertilizers, which involve somewhat simpler production processes, but fertilizer production in 1965 also was below plan. One manifestation of these difficulties was a decline in output relative to fixed capital. Output more than doubled during the period 1959-65, but fixed capital more than tripled.

Overall industrial investment during the 1966-70 period is to rise at an average annual rate of 8-8½%, compared with 7% during 1961-65 (FIGURE 6), but changes have been made in the planned composition of this investment. In particular, Khrushchev's program for "chemicalization" of the U.S.S.R. has been reduced in scale. Investment plans for the consumer industries sector for 1966-70 show that the light and food industries are expected to get a larger share of the total than in the preceding 5-year period when the planned average annual growth rate of about 10% was cut back to about 2½%. The planned increase in investment in machine building of 8½% represents a slight reduction below the rate of increase in the two previous 5-year periods. By accelerating the growth of investments in metals during 1966-70, the present leadership is attempting to correct some of the provisions in earlier plans in which it was erroneously assumed that availability of chemical substitutes would significantly reduce the demand for metals. Present shortages of steel reflect such error of planning.

FIGURE 6. AVERAGE ANNUAL RATES OF GROWTH OF GROSS FIXED INVESTMENT IN INDUSTRY, BY BRANCH
(*Percent*)

	1951–55	1956–60	1961–65	1966–70 PLAN
Total investment in industry	*12½*	*11*	*7*	*8–8½*
Machine building	*12½*	*9½*	*9*	*8½*
Chemicals	*10½*	*27*	*16½*	*11½*
Consumer goods	*12*	*17*	*2½*	*14–15*

6. Management of industry

Before 1957, the Soviet Government administered and directed the operation of enterprises in industries of national importance (which included most of Soviet industry) through a series of ministries organized along functional lines. The activities of all economic enterprises were coordinated through the State Planning Committee (*Gosplan*) and other planning organs. Management of individual enterprises had little authority over product mix, materials used, composition of the labor force, or the use of available capital, and prices and wage rates were fixed at higher administrative levels. Although targets were set for numerous measures of production, plant management was rewarded primarily on the basis of gross output. In 1959-60, the system of bonuses for enterprise managers was revised and the importance of another criterion—cost per ruble value of output—was enhanced. Even so, gross output continued to be the success indicator of overriding importance.

From 1957 through 1965, most industrial enterprises were administered and directed from the center through a system of economic councils (*sovnarkhozy*) organized on a geographical rather than a functional basis. This system never worked smoothly and was revised several times before being abandoned at the end of 1965. On the whole, the operations of enterprises under the *sovnarkhozy* system had not differed significantly from the earlier system of central administration.

In September 1965, the decision was made to reestablish administration of industry along functional rather than geographical lines. By the end of January

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Approved For Release 2008/09/08 : CIA-RDP08S01350R000100030002-2

1966, the administration of industry was being carried out by 23 ministries.* In April 1967, a Ministry of Medical Industries, an All-Union Ministry, was added to the administrative system. A more important administrative change was the approval of a number of measures designed to increase the authority of enterprise managers and to restructure their incentive program to induce them to use their new authority efficiently. These new measures had been tested in more than 400 enterprises in the months preceding the change.

The reform gives enterprise managers greater authority over the size and composition of the labor force, wage and salary payment, and the use of capital. The enterprises are to initiate and finance certain investment projects themselves. Over time, managers are to have greater control over inputs of materials and over the product mix.

Some of the old success criteria—gross value of output, cost per ruble value of output—and a host of minor plan targets have been dropped. Still, irregular supplies of materials, a chronic source of trouble in the past, also has plagued the enterprises working under the new system. Furthermore, there is little indication that enterprise managers have yet gained an appreciable amount of authority over their product mix or materials inputs. Even so, there are official claims that the reform has brought about better use of the capital and other inputs available to the enterprises, and has induced enterprise officials to improve the quality of products and to adhere more faithfully to delivery schedules.

7. Foreign trade

Soviet foreign trade increased from a total value of about 7.8 billion rubles in 1958 to 14.5 billion rubles in 1965—a near doubling during the Seven Year Plan. Trade in manufactured goods has continued to account for 42-46% of total turnover. Manufactured goods as a share of all exports remained around 30% during this period (1959-65), whereas for imports the share of manufactured goods rose from 54% to 62% (in 1962 the share was as high as 67%). FIGURE 7 shows the share of each of the major categories of manufactured goods in total exports and imports in 1965.

In spite of the large volume of output of its manufacturing industries, the U.S.S.R. is a substantial net importer of manufactured goods. Foreign trade data

* Ten of the new ministries, including all those for machine building, are All-Union ministries, and 13 are Union-Republic ministries, i.e., Union ministries with counterpart ministries in each Republic.

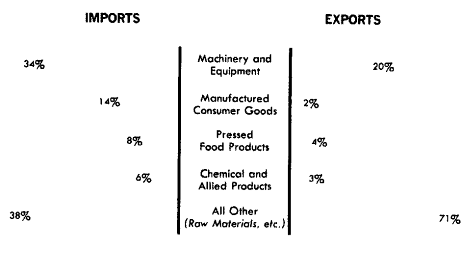

FIGURE 7. PERCENTAGE DISTRIBUTION OF MANUFACTURED GOODS IN FOREIGN TRADE, 1965

for this sector for 1965, expressed in millions of rubles, are as follows:

	EXPORTS	IMPORTS	TRADE DEFICIT
Total, manufactured goods	2,186	4,439	−2,253
Of which:			
Machinery and equipment	1,472	2,419	−947
Chemical and allied products	246	450	−204
Processed food products	299	547	−248
Manufactured consumer goods	169	1,023	−854

In 1965, nearly 58% of Soviet foreign trade was with other Soviet bloc countries, 11% with other socialist countries (Communist China, North Vietnam, North Korea, Cuba, and Yugoslavia), 12% with the developing countries, and 19% with the industrialized countries of the non-Communist world. Trading partners of the latter group in order of importance are the United Kingdom, Japan, West Germany, Italy, and France. Among the developing countries, Finland, India, and the United Arab Republic are the major trading partners. The following tabulation shows Soviet foreign trade with these groups in 1965, in millions of rubles:

All foreign trade	14,598
Soviet bloc countries	8,471
Other socialized countries	1,577
Developing countries	1,744
Industrialized non-Communist countries	2,806

Kosygin, at the 23rd Congress in 1966, recognized that the scientific-technical level of much of today's industrial activity calls for a broadening of economic exchanges among industrialized countries. The U.S.S.R. would like to increase its trade in manufactured goods and to diminish trade in raw materials with eastern Europe because of competing demands and dwindling supplies in central and southern U.S.S.R.

Most of the trade between the U.S.S.R. and the non-Communist industrial countries is centered in western Europe, where restrictions are relatively fewer than in the United States, and where long-term credits are available. Trade between the United States and the Soviet Union still is small, less than one percent

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of total Soviet foreign trade in 1965. Even though the U.S.S.R. desires to expand trade with the United States, and U.S. policy is tending toward an easing of restrictions, obstacles still remain. A fairly wide array of goods still are embargoed by the United States because of "strategic" implications, even though trade controls on many commodities are being relaxed. The U.S.S.R. is willing to expand trade only if the U.S. will import more Soviet goods, but the assortment of Soviet commodities available for export is limited and many items cannot compete in U.S. markets. Soviet needs are largely for U.S. production equipment, especially chemical equipment, but including machinery for reequipping plants of the clothing, textile, and furniture industries, food processing equipment, computers, materials handling equipment, and other items.

Soviet imports of manufactured goods now include ships and marine equipment; railroad rolling stock; mining, metallurgical, and oil equipment; food and light industrial equipment; chemical equipment; and motor vehicles. On the export side, the U.S.S.R. supplies more raw materials (especially to the eastern European Communist countries) and fewer manufactured goods. In 1965, the U.S.S.R. provide an estimated three-fourths of the raw materials used by the eastern European Communist countries including iron ore, oil, and electric power. Presently the supplies of these materials in the central and southern U.S.S.R. are beginning to be depleted and Soviet planners must make available new sources or urge the eastern European Communist countries to begin drawing on supples in the West. The U.S.S.R. is anxious to expand its export of manufactured goods. Exports of machinery in 1965 made up only 20% of total Soviet exports, whereas in East Germany and Czechoslovakia more than half of the exports are machinery. Exports of manufactured goods presently include mainly tractors, trucks and autos, agricultural equipment, construction equipment, machine tools, and various kinds of consumer goods.

Soviet exports to the developing countries since 1955 have included fewer manufactured goods such as iron, steel, and cotton textiles, and more complex items of machinery and equipment, mainly in the form of complete plants delivered under the Soviet aid program. However, the total export to these countries is comparatively small. For example, in 1965 the value of Soviet exports of machinery to the developing countries totaled $360 million, whereas the U.S. supplied $3 billion worth of comparable goods. Major recipients of Soviet exports among the developing countries are India, the United Arab Republic, Afghanistan, and Iraq.

B. Industrial machinery and equipment

1. Agricultural machinery

a. Introduction — The U.S.S.R. is by far the major producer of agricultural machinery among the Communist countries. East Germany, the second largest producer, manufactures only a fraction of the Soviet output of tractor plows, drills, cultivators, mowers, and grain combines. Soviet production of agricultural machinery in 1966 reached a peak value of 1,510 million rubles and included major items in the following numbers:

Tractor drills	219,000
Tractor plows	177,000
Tractor cultivators	208,000
Grain combines	92,000
Windrowers	88,600
Beet harvesting combines	10,500

Production of several major items declined after 1957 as a result of the deemphasis of agricultural machinery supply. In 1960, official attention was again directed toward mechanization of agriculture, and the production of machinery began to increase. In 1966, the value of output of machinery for agriculture exceeded the earlier peak in 1957 by about 60%.

The U.S.S.R. produces a complete line of agricultural machinery, ranging from simple types of plows to complex self-propelled grain combines. A major deficiency that has persisted since World War II is the absence of large-scale production of specialized types of machinery, such as for animal husbandry, poultry-raising, vegetable-growing, fertilizer-spreading, and the handling of harvested grains and other crops. At no time during the postwar period has the U.S.S.R. seriously attempted to fill these gaps through increased production or through imports. Consequently, Soviet agriculture continually suffers from an unbalanced inventory of agricultural machinery.

The design and quality of Soviet agricultural machinery is inferior to that produced in the United States, even though there have been improvements in recent years. A few U.S. agricultural machines have been imported, but Soviet institutes have been slow to adopt the design features of the U.S. machines. Contrary to earlier practice, U.S.-made machines are rarely copied outright. Recently the industry has concentrated on the development of equipment with greater working widths and on equipment designed to work at higher operating speeds. The industry also is developing some special items of equipment; for example, grain combines for front-mounting on a self-propelled chassis, a special type of tractor with the engine in the rear.

The agricultural machine building industry is a major branch of the machine building industry and is one of the largest consumers of metal in the U.S.S.R. Production of agricultural machinery in 1966, based on value, reportedly was nearly four times that of chemical equipment. Soviet agriculture depends almost completely upon domestic production for all types of agricultural machinery. Only small quantities are exported.

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b. PRODUCTION

(1) *Location* — Agricultural machinery production is concentrated in the European part of the U.S.S.R., where 20 of the 27 major producers are located. Major plants producing agricultural machinery are described in FIGURE 55. Some 700 to 800 widely scattered plants produce spare parts for tractors and agricultural machinery. Generally, the agricultural machinery plants are located in or near major agricultural areas. Machinery for growing cotton, for example, is produced at Chirchik and Tashkent in the cotton growing Uzbek S.S.R., while grain combines are produced at Rostov near the fertile Kuban' region and the Ukraine.

(2) *Volume and mix* — Soviet production of agricultural machinery (excluding spare parts) has increased substantially since 1955, albeit at a slower rate in recent years. Yearly percentage increases have been uneven for the industry; production peaks having been reached in 1957 and again in 1966. The following tabulation shows official data on the gross value of output of agricultural machinery (in millions of rubles):

1955	540	1963	1,371
1957	948	1964	1,443
1959	674	1965	1,459
1960	758	1966	1,510
1961	972	1967 Plan	1,687
1962	1,174		

Soviet officials were firmly convinced that the dissolution of the machine-tractor-stations (MTS) in 1958 and the sale of equipment to the collective farms would lessen the need for new equipment; consequently, production was cut back. By 1960, however, it was apparent that agricultural machinery inventories could not be maintained at the reduced rate of deliveries. To alleviate this strain, the goal of the Seven Year Plan for the final six years was raised by 1,289 million rubles. Thereafter, production began to improve rapidly and by the end of 1965 total production for the 7-year period was 60% in excess of the original plan. The production of spare parts, consistently below requirements, has increased in most years at lower rates than the production of complete machines. For example, the production of spare parts for period 1959-65 was 20% above the level originally planned, but complete machines were 60% above plan.

Output of basic types of agricultural machines is shown in FIGURE 8, and recent models of a tractor and a grain combine are shown in FIGURE 9. Important changes in product mix during this period are reflected by the data on production of combines. Tractor-drawn grain combines, once important in agriculture, were produced in small numbers after 1958 and by 1960 production was stopped. The production of combines for harvesting beets increased sharply as the acreage sown to sugar beets increased, and fewer combines for harvesting corn were produced when the acreage devoted to mature corn declined. The increased level of deliveries of mineral fertilizers to Soviet agriculture was accompanied by increases in

FIGURE 8. PRODUCTION OF BASIC TYPES OF AGRICULTURAL MACHINES
(*Thousands of units*)

TYPE	1958	1960	1962	1963	1964	1965	1966
Grain combines	65.0	59.0	79.8	82.9	83.6	85.8	92.0
Self-propelled grain combines	35.2	58.9	79.8	82.9	83.6	85.8	92.0
Beet harvesting combines	7.3	4.7	10.1	15.9	18.3	17.5	10.5
Corn harvesting combines	6.1	3.6	26.9	29.0	9.9	*na*	*na*
Ensilage harvesting combines	38.1	15.0	47.5	58.1	47.0	20.0	*na*
Potato harvesting combines	0.01	0.05	3.0	4.2	4.1	4.9	*na*
Cotton pickers	0.02	3.2	6.1	7.1	7.0	7.7	7.2
Windrowers	96.3	56.9	73.9	89.7	83.9	97.8	88.6
Mineral fertilizer spreaders	*na*	*na*	*na*	*na*	*18.0	*35.0	*61.0
Plows, general-purpose:							
Total tractor-powered	164.0	149.1	140.6	178.5	178.4	165.7	177.0
Tractor-drawn	52.3	57.8	78.7	90.5	94.7	112.3	*na*
Tractor-mounted	111.7	91.3	61.9	88.0	83.7	53.4	*na*
Sowing machines:**							
Total tractor-powered	186.1	111.9	162.5	200.3	235.1	261.7	219.0
Tractor-drawn	163.9	40.8	63.8	95.9	185.9	233.4	*na*
Tractor-mounted	22.2	71.1	98.7	104.4	49.2	28.3	*na*
Cultivators:							
Total tractor-powered	180.3	84.8	122.1	155.4	193.2	206.1	208.0
Tractor-drawn	44.7	1.9	0.6	22.5	70.1	125.7	*na*
Tractor-mounted	135.6	82.9	121.5	132.9	123.1	80.4	*na*
Mowing machines:							
Total tractor-powered	76.5	87.5	97.6	103.5	108.1	121.7	130.0
Tractor-drawn	50.6	43.8	35.1	53.0	62.4	68.1	*na*
Tractor-mounted	25.9	43.7	62.5	50.5	45.7	53.6	*na*

* Deliveries to agriculture.

** Excluding fertilizing-type, the production of which dropped from 32,200 in 1958 to 15,200 in 1959 and 11,100 in 1960. Production has increased in recent years, but data are not available.

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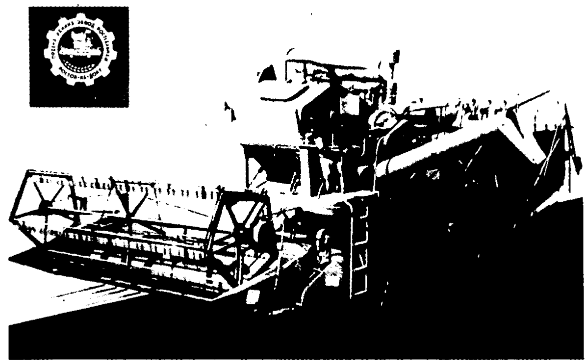

FIGURE 9. MODELS OF SOVIET TRACTORS AND GRAIN COMBINES. (*left*) Belarus MTZ-52 4-wheel drive tractor of 50-hp. (*above*) SK-4 self-propelled grain combine.

the deliveries of mineral fertilizer spreaders—deliveries in 1966 were 3.4 times the level in 1964—but serious shortages still exist. The interest in tractor-mounted machines has declined somewhat in recent years partly because of the trend toward larger and wider machines which are more easily drawn than mounted.

(3) *Facilities* — Many agricultural machinery plants, including tractor plants, were expanded and modernized during the Seven Year Plan, at a reported cost of more than 944 million rubles. By comparison, 1.7 billion rubles is scheduled for investment in these facilities during 1966-70. However, complaints of serious lags in construction continued into early 1967. Despite the installation of a considerable amount of new equipment in agricultural machinery plants the level of mechanization in many areas is low. Many of the automatic lines that have been installed produce items such as nuts, bolts, chain links, and rake teeth, but the transfer of materials between shops and working positions requires much hand labor. During 1966-70, much of the increase in output is to come from increased labor productivity: only 10% of the scheduled increase (including tractors) is to come from new plants, 18% from reconstruction of existing enterprises, and the remaining 72% is to come from increased labor productivity.

The Soviet agricultural machinery industry is making a relatively rapid transition to specialization in the production of parts and end-products, but the progress is not even. For example, 80% or more of the production of such items as grain combines, cotton pickers, tractor plows, tractor drills, and tractor cultivators is carried out in only one or two large, specialized plants each, but the production of many other items (harrows and spare parts, for example) is still scattered among hundreds of small, nonspecialized producers, including many outside the agricultural machinery industry. A major drawback of the nonspecialized producers is their high unit costs of production, which often exceed the selling price of the end-product. A continuing obstacle to increased specialization is the failure of many subcontractors to fulfill production commitments and meet contract deliveries.

(4) *Major problems* — Problems affecting the Soviet agricultural machinery industry have not changed markedly in the past decade and are summarized as follows: 1) Delinquency in deliveries of semifinished materials and components by subcontracting plants to producing plants; 2) shortage of highly skilled design and production engineers; 3) lack of coordination among designers, producers, and users of agricultural machinery; and 4) the slow pace of construction work at producing plants. The industry also is delinquent in the production of an adequate assortment of spare parts.

c. FOREIGN TRADE — Soviet production of agricultural machinery is geared to the domestic market; only a small amount is exported. During 1958-65, about 5% of the grain combines, 4% of the plows, 3% of the drills and grain cleaning machines, and 1% of the cultivators and mowers were exported.

FIGURE 56 shows the value of Soviet exports of agricultural machinery, by country, for the period 1960-65. Communist countries, including Cuba and Yugoslavia, received almost all of the agricultural machinery exported during this period. Exports to Cuba, about half of which were harvesters for sugar beets, increased from a negligible quantity in 1960 to over 8% of total exports of agricultural machinery in 1965. In spite of Soviet efforts to expand trade with developing countries, little progress has been made in establishing permanent and expanding markets for agricultural machinery in these areas. Lower prices have gained a few customers, but inferior quality and poor servicing after sale have tended to offset the advantage of price.

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The value and origin of Soviet agricultural machinery imported in the period 1960-65 is shown in FIGURE 57. Imports during this period came almost entirely from Bulgaria, East Germany, and Czechoslovakia; they comprised in large part, mowers, hammer mills, and ensilage harvesting combines from Bulgaria, and combines (primarily potato), grain-cleaning machines, and milking machines from East Germany. Small-scale imports from the United States, Canada, and West Germany have enabled the U.S.S.R. to keep abreast of technological developments in the production of agricultural machinery.

2. Tractors

a. INTRODUCTION — The U.S.S.R. has a highly developed tractor industry capable of producing on a large scale many different models of tractors. Soviet production reached a level of 354,500 units in 1965, exceeding U.S. production of 272,100 units. During 1961-65, 70% of total production was allocated to agriculture, 24% to other domestic consumers, and 6% was exported.

The tractor industry includes 14 major producing and assembly plants (FIGURE 58). Production is fairly well distributed throughout the major agricultural areas of the European U.S.S.R. and eastward as far as western Siberia. One-third of the tractor output is concentrated in the agriculturally rich Ukrainian S.S.R. New capacity for the production of tractors has been created since the mid-1950's through a considerable expansion of existing plants and through the conversion of other facilities to tractor production. Tractors are now being produced at converted facilities at Bryansk, Didi Lilo (near Tbilisi), Dnepropetrovsk, Kishinev, Leningrad, Petrozavodsk, Taganrog, and Tashkent—all representing new capacity, which accounted for an estimated 16% of total production of tractors in 1965. The Pavlodar Machine Building Plant is in the process of conversion to the production of tractors, and a new plant for producing tractors is under construction at Cheboksary, east of Gor'kiy.

b. ORGANIZATION — The tractor industry is administered and controlled by the Ministry of Tractors and Agricultural Machine Building and its main administrations. The ministry, in cooperation with *Gosplan,* drafts production plans to meet the needs of the collective farms (*kolkhozes*) and state farms *sovkhozes.*

The tractor industry is vertically integrated, i.e., plants produce a large share of their own parts and subassemblies, as well as most spare parts. They depend on other plants primarily for electrical systems, rubber tires, and specialized components and accessories. This system of integrated plants, however, gradually is being replaced by a complex of specialized factories which are to furnish necessary component parts to tractor plants for assembly. Thus three engine plants now are augmenting the supply of engines manufactured by tractor producers, and the Khar'kov Tractor Plant has been able to forego the production of engines for crawler tractors.

c. PRODUCTION — Soviet tractor production in selected years from 1950 onward was as follows, in units:

	CRAWLER	WHEELED	TOTAL
1950	85,100	31,600	116,700
1956	109,200	74,300	183,500
1959	103,800	109,700	213,500
1960	122,000	116,500	238,500
1961	136,600	127,000	263,600
1962	137,700	149,300	287,000
1963	149,200	176,100	325,300
1964	142,700	186,300	329,000
1965	157,000	197,500	354,500

Along with increases in output, there has emerged simultaneously a new pattern of production. All tractors manufactured since 1966 have been diesel-powered, compared with only 62% in 1950. Row-crop tractors, both wheeled and crawler, made up 58% of total output in 1965, compared with only 27% in 1950. Estimated production of tractors by model type is given in FIGURE 10. By 1970 the tractor industry is to be a highly specialized industry capable of producing annually between 600,000 and 625,000 tractors.

Because of shortages of repair parts, substantial numbers of tractors are out of operation. Since the mid-1950's, the industry has been moving toward a solution of the problem of spare parts in its program of greater plant specialization. In 1966-70, there will be a further effort to increase the degree of standardization of parts and specialization of plants, and to increase the amount of mechanization and/or

FIGURE 10. ESTIMATED PRODUCTION OF MAJOR TYPES OF TRACTORS
(*Units*)

TYPE	1963	1964	1965
Crawler:			
DT-54A	49,200	10,400	13,100
T-75/74	47,800	47,900	50,000
DT-75	3,000	34,000	41,000
T-38	7,500	7,500	7,500
TDT-40M/75/60	13,000	13,000	11,700
T-4	0	0	1,000
S-100/T-100M DET-250	24,000	24,000	25,100
Other	4,700	5,900	7,600
Subtotal	149,200	142,700	157,000
Wheeled:			
Belarus	90,400	92,100	100,200
T-28M	10,000	15,200	16,800
DT-20	24,600	25,000	25,300
T-16	8,300	11,700	13,000
T-40A	26,300	29,000	32,500
T-28KhZ	16,400	12,300	6,700
K-700	0	1,000	2,800
Other	100	200	200
Subtotal	176,100	186,500	197,500
Total	325,300	329,200	354,500

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automation. Some attention also has been given to improving parts production at existing facilities through better manufacturing techniques.

d. Raw materials supply — The U.S.S.R. is self-sufficient in raw materials for tractor production; however, the quality of materials—steel, rubber, electrical components, and the like—often is less than satisfactory. Failure to deliver materials on schedule and failure to conform to specifications are a constant source of irritation to the industry.

e. Technology — The tractor industry already has achieved a fairly high degree of mechanization and some automation in the production processes. Greater specialization of production and standardization of parts will make possible still more extensive use of automation. Tractor plants have been equipped with some automatic lines for several years—for example, lines for machining engine block and cylinder heads. However, reluctance of industry officials to invest in new machine tools has hampered the phasing into production of some of the new tractor models. Moreover, the machine tool industry has been unable to furnish all of the necessary equipment on schedule and thus has caused serious delays.

In design, construction, and performance, Soviet-built tractors are inferior to those produced in the United States. Soviet tractors, both the newer and the older models, tend to be heavy in relation to the power of the engines. Structural defects, which are not uncommon, often can be traced to the quality of steel or the precision of the machining in the production of parts. Engineers and designers are working to improve the basic models to obtain tractors of greater power and dependability.

The inventory of tractors in Soviet agriculture at the beginning of 1966 was 1,613,200 units, about two-thirds of which were row-crop tractors. Row-crop models, now favored over the general-purpose crawler types, comprise about two-thirds of the inventory. Some crawler tractors, chiefly the T-38M, are suitable for row-crop cultivation, but few tractors of this type are allocated to agriculture. The goals of the present plan, 1966-70, are to provide the agricultural sector with 1,790,000 new tractors, of which 1,010,000 are to be row-crop tractors.

The U.S.S.R., under the jurisdiction of the state monopoly, Avtoeksport, exports a sizable number of tractors and imports relatively few in spite of recurrent shortages in the domestic economy. About 6% of all Soviet tractors produced in 1965 were exported, mainly to other Communist countries and to India. The following tabulation shows Soviet exports of tractors and spare parts in recent years (value figures are in thousands of foreign exchange rubles):

Year	Number of units	Value of tractors	Value of spare parts
1962	12,400	43,491	29,403
1963	23,100	74,689	39,428
1964	21,000	68,663	42,366
1965	21,920	65,920	48,370

3. Machine tools

a. Introduction — The U.S.S.R. continues to lead the world in the output of machine tools.* In 1966, it produced more machine tools than the rest of the Communist countries combined. The U.S.S.R. has exceeded the United States in the output of metalcutting machine tools since 1954, but fell behind in metalforming machine tools in 1963, and may have lost its lead for these types in 1966. The Soviet machine tool inventory at present is larger and younger than that of the United States, however, the technical quality of the U.S. inventory is superior. Machine tools built in the United States are generally more complex, more highly automated, and more productive than are their Soviet counterparts.

The Soviet machine tool industry holds a high priority because of its importance to the maintenance of a high rate of growth of industrial production. For example, machine tools account for more than 30% of the total capital stock of the Soviet motor vehicle industry. In 1965, the machine tool industry accounted for about 2% of the gross value of output of the machine building and metalworking industries.

Despite a large physical output of machine tools—191,000 metalcutting and 38,300 metalforming tools in 1966—the U.S.S.R. has been and remains a net importer of machine tools. Imports have been highly selective, however, consisting primarily of special types which are not produced in sufficient quantities in the U.S.S.R.

The recently formed Ministry of Machine Tool Building and Tool Industry administers 280 machine tool plants, which in 1965 produced 78% of the total Soviet output of machine tools. Of these plants, 89 specialize in the production of metalcutting machine tools. Figure 59 lists major producers of machine tools. The Ministry also controls 12 scientific research institutes and their 13 affiliates, nine design-technological institutes, three designing institutes, and 38 specialized design bureaus. These bureaus and institutes employ about 40,000 people.

The specialization of the plants of the Soviet machine tool industry, combined with a high degree of standardization of machine tool components and a limited number of models, permits mass production of the more popular models and the use of conveyor lines for machining parts and assembling finished machines.

* In this subsection, machine tools are classified as either metalcutting or metalforming (woodworking machine tools are not included). Metalcutting machine tools are designed to remove metal in the form of chips, turnings, and borings, and include honing machines, lapping machines, grinders, and electro-erosion and ultrasonic machines. Metalforming machine tools are designed to press, forge, emboss, hammer, extrude, blank, spin, shear, or bend metal into shape.

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b. Production and plans

(1) *Production* — The 191,000 metalcutting machine tools produced in 1966 represented an increase of 3% over 1965, and the 38,300 metalforming machine tools, an increase of 10% over 1965. The Seven Year Plan (1959-65) production goals—planned to reach 190,000 to 200,000 units for metalcutting and 36,200 units for metalforming machine tools in 1965—were not fulfilled. The failure to meet these goals is the result of the greater emphasis on quality rather than quantity since 1962 and because of continued lags in the construction program. Production of machine tools since 1958 and plans for 1970 are set forth in Figure 60.

Although the level of output of general-purpose metalcutting machine tools is probably adequate, considerable improvement is still necessary in the assortment of product. The machine tool industry has not been able to produce a sufficient number of high-precision and specialized machines to satisfy the needs of other sectors of Soviet industry. To compensate for shortages, the U.S.S.R. has imported the highly specialized machine tools that it needs from other Communist countries and from the industrial non-Communist world. The planned expansion of the Soviet automobile industry, for example, requires substantial imports of specialized equipment. Given time and the necessary priorities, the Soviet machine building industry is capable of producing the highly productive specialized machine tools required for mass production of motor vehicles. However, the present accelerated program for expanding the production of passenger cars can be carried out economically and effectively only by importing many of these tools.

Efforts since 1962 to improve the product mix in machine tools have not been very successful. The mix still is heavily weighted toward the less productive, general-purpose types of machine tools. Figure 11 shows the mass production of lathes in the U.S.S.R. The following tabulation compares the percentage distribution of different types of machine tools in the United States and in the U.S.S.R. in 1965; it also illustrates the imbalance in the U.S.S.R. which favors the less productive metalcutting machine tools, such as lathes and drilling machines:

	United States	U.S.S.R.
Center lathes	*15.4*	*29.5*
Automatic and semi-automatic lathes	*5.1*	*2.5*
Milling machines	*22.5*	*12.2*
Boring machines	*2.7*	*1.6*
Grinding machines	*22.8*	*6.6*
Drilling machines	*7.9*	*15.2*
Other	*23.6*	*32.4*
	100.0	*100.0*

Where applicable, the substitution of metalforming for metalcutting techniques generally results in higher production rates, lower labor requirements, less metal waste, and a product with improved structural characteristics. Even so, in the U.S.S.R. the share of metalforming machine tools, which amounted to 16% in 1958, had declined by 1% by 1965. The causes of underfulfillment of plans in the metalforming machine tool industry are not evident. Except for the production of spectacularly large pieces of equipment, such as powerful forging and extrusion presses used primarily for military purposes, the metalforming branch of the industry receives relatively little pub-

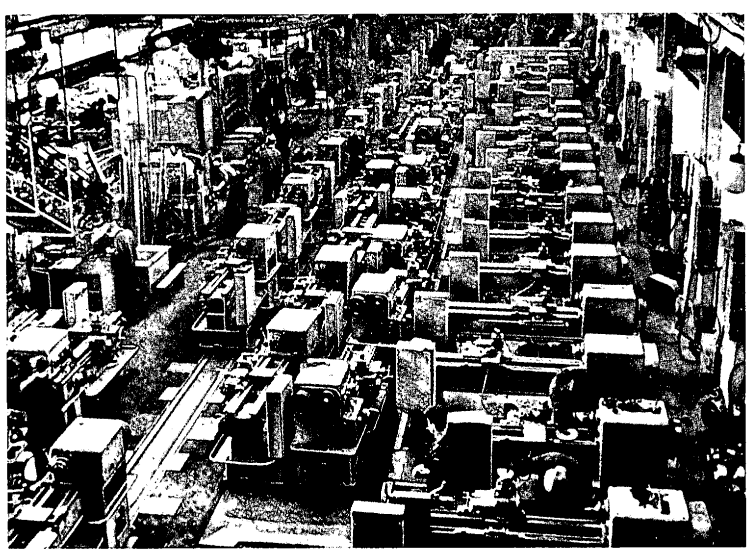

Figure 11. Soviet mass production of lathes

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licity. The metalforming machine tool industry, traditionally small compared with metalcutting, expanded little in capacity during 1959-65 and received far less emphasis and priority from Soviet planners.

The Seven Year Plan goal for the building of automatic transfer machine tool lines was not fulfilled either. Between 250 and 270 automatic and semiautomatic lines were to have been built in 1965, but only 213 were completed—fewer than the 230 built in 1964. A shortage of plant capacity for this special kind of production appears to have been a limiting factor. Only three plants in the U.S.S.R. are specialized producers of automatic lines, and these are known to have little available floor space for expanding production or to engage in other types of production. Figure 12 shows one of the transfer machines in a large automatic transfer machine tool line for the production of cylinder heads for diesel engines for tractors.

(2) *Plans* — The U.S.S.R. has announced its plan to produce 220,000 to 230,000 metalcutting and 50,000 to 52,000 metalforming machine tools annually by 1970. The goal for metalcutting machine tools implies an average annual growth rate of 3.5% to 4.4%, a rate similar to that realized during the previous 7-year period. Even though output in 1966 increased by only about 3%, the goal is still likely to be reached—particularly if investment in new plant construction is doubled, as official statements indicate.

The 1966-70 plan calls for increased output of the so-called "highly productive" types of machine tools—electro-discharge (EDM), electro-erosion, and electrochemical (ECM) machines. As presently planned, enough of these types of machines are to be in operation to perform 10% of all metalcutting operations by 1970. The U.S.S.R. has done independent and highly competent developmental work on EDM, but may be giving it a higher priority than it deserves relative to its ultimate contribution. Probably less than 10% of all metalcutting operations are as suitable for ECM and EDM technique as for conventional metalcutting methods.

Production of metalforming machine tools is to increase at 8.2% a year during 1966-70, a much higher rate than the 3.9% achieved during 1959-65. However, output increased 10.8% in 1966 over 1965, an indication that the 1970 target may be realistic. If achieved, the 1970 plan would increase the share of metalforming machine tools in the total machine tool product mix from 15.7% to 18.5%, a moderate improvement in the mix. However, it is far behind the United States, where metalforming machine tools make up about 38% of total metalworking machines. New capacity must be created in the metalforming machine tool industry if the 1970 goal is to be reached. Construction of a large new facility is underway in Tiraspol and investment funds for the construction of plants to produce metalforming machine tools, according to some officials, are to double by 1970.

Generally, Soviet metalforming machine tools embody a lower level of technology than metalcutting machine tools, particularly in the degree of automation and precision. During the Seven Year Plan, most research and development had been directed towards introducing new models and processes which directly benefit the aerospace industries, and the development of the highly productive, automated stamping and drawing presses which could support the consumer goods industries was neglected. Although Soviet officials have announced their intention to boost production of precision forging presses, casting machines, and high-speed stamping and drawing presses

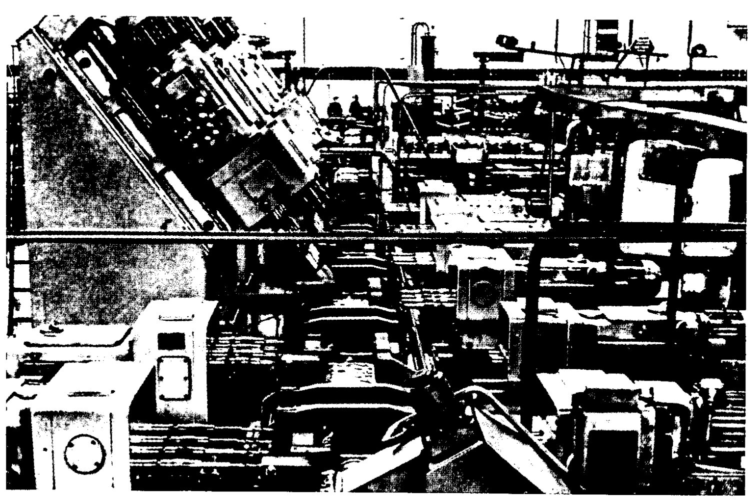

Figure 12. Transfer machine in an automatic line for production of cylinder heads for tractor diesels

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during the present Five Year Plan (1966-70), it is not yet clear to what extent these tools will be used for the production of consumers goods.

The present 5-year plan calls for a doubling of the production of automatic and semi-automatic machine tool lines over the 1965 level, which would amount to 426 lines in 1970, and which implies an annual rate of growth of almost 15%. To meet such an ambitious target, a considerable increase in productive capacity will be required. The Moscow Ordzhonikidze Machine Tool Plant, the U.S.S.R.'s leading producer of automatic lines, is being enlarged, and a plant for producing automatic lines is being built in Kostroma.

U.S. producers of automatic lines typically use the "building block" method—a system of assembling standardized power heads and other components with specially designed transfer mechanisms. In contrast, most Soviet automatic lines have been designed individually, a process that is expensive and time-consuming. The U.S.S.R. is introducing the building block method during the 1966-70 plan. To the extent practicable, the Soviets propose to use the modular or building block technique in the production of individual metalcutting and metalforming machine tools in addition to automatic transfer machines. The Soviet approach involves establishing a number of basic model designs within each machine tool category, as well as a limited series of standardized variants of each particular model. Initially, modular components will be developed to obtain several different configurations within a particular model with most subassemblies, such as base, gear box, and bed, common to all variants. Eventually, industry officials hope to develop standardized components common to several models and even categories of machine tools.

(3) *Investment* — Investment during 1959-65 in the machine tool industry was confined largely to the reconstruction of existing plants. Rebuilding programs usually provided for some increase in floor space, modernization of old shops, and often for a full complement of new machinery. However, reconstruction during this period was chronically behind schedule. Of the 25 high priority, controlled-environment shops, only 11 have been completed. A new shop to produce vertical turret lathes has been under construction for several years at the Moscow *Krasnyy Proletariy* Plant and still was not in operation in 1967. A new plant to produce horizontal boring machines that was begun in Ivanovo before the 7-year plan was not operating at full capacity as of mid-1967.

The 25 controlled-environment shops being built at various machine tool plants are designed to control temperature, humidity, air contamination, and vibration, which Soviet engineers consider important for increasing the output of precision machine tools. U.S. specialists who have visited these plants stated that these conditions are not needed except for producing machines of extremely high precision.

The planned expansion during 1966-70 is to be achieved by building several new plants, by completion of projects under construction, and by further modernization of plants. The new plant at Gomel, which produces standardized machine tool components, was completed in early 1966. The capacity of the plants in Vitebsk, Minsk, Kirovakan, Yerevan and Khar'kov are to be expanded. The Tiraspol "Kirov" Machine Building Plant, when present expansion is complete, will be one of the largest Soviet producers of casting machines and forging presses.

(4) *Distribution and inventory* — Although little is known about the distribution of the machine tools, inventory figures within Soviet industry and agriculture reflect a use pattern. The inventory of metalcutting machine tools in 1962 was distributed about as follows (in thousand units):

Industry		1,714
Of which:		
Machine building	1,100	
Other industry	614	
Nonindustrial		728
Of which:		
Agricultural equipment repair	400	
Other	328	
Total		2,442

(5) *Foreign trade* — Soviet efforts to market machine tools in the Industrial West and in the developing countries have not been very successful. Only about 1,100 metalcutting machine tools were exported to non-Communist countries in 1965, including those sold as parts of complete plants. Some of the machine tools sold in the Industrial West are "forced sales," that is, trading partners are forced to buy them in order to sell other products to the U.S.S.R. Easy credit terms often are extended the developing countries to encourage purchases of machine tools. Even though the U.S.S.R. probably will continue to export some machine tools to non-Communist countries in the years ahead, it cannot compete effectively in world markets until the industry is able to provide service facilities, to increase the availability of spare parts, and to make further improvements in quality.

(6) *Quality* — The Soviet machine tool industry has raised the quality of its product considerably since the early 1950's. Its machine tools at that time contained serious faults in design and workmanship which made them far less productive, less durable, and less precise than their Western counterparts. Now this gap is being narrowed. The quality of Soviet machine tools is considered by U.S. technicians to be adequate, even though somewhat below the level of quality of comparable products in the United States and western Europe. However, quality varies from plant to plant. For example, the Odessa Radial Drill Plant, which is crowded and poorly organized, produces machines that often are defective, whereas the

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Yegorevsk Komsomolets Machine Tool Plant, which is clean, modern, and well-equipped, is noted for high quality in its gear cutting machinery.

The improvement in quality of machine tools is an important objective of the 1966-70 plan. The industry is striving to develop further the technology for building machine tools and to increase their precision and lengthen their service life. Soviet officials are aware that even though their machine tools meet world standards of productivity, they are below standard in precision and durability. Machine tools for plants tend to abbreviate some of the manufacturing processes, and to use low-quality bearings, electrical components, and other components. Soviet officials plan to produce machine tools during 1966-70 that will compare in service life to those produced in the West, i.e., tools that will remain in operation for 10 to 15 years before requiring general overhaul.

4. Electric power equipment

a. Introduction — The production of electric power equipment has received high priority for many years in the Soviet manufacturing industry. This subsection discusses only the major types of equipment which account for most of the value of the industry's output. The output of major types of electric power equipment produced during the Seven Year Plan (1959-65) and the estimated planned output for 1970 are shown in Figure 13.

Plants producing electric power equipment have steadily improved automation and mechanization of production processes. Major types of equipment are produced in specialized plants and the concept of plant specialization is being extended to producers of auxiliary equipment and semifinished products. Important producers of major types of electric power equipment are described in detail in Figure 61.

The current 5-year plan calls for the annual production of 22,000-24,000 megawatts of capacity in turbines by 1970, which will require an average annual growth rate of about 10% during the period. Although specific goals for equipment other than turbines have not been announced, the output of the other main types of equipment has been estimated from the product mix in the past, e.g., tons of boiler capacity per kilowatt of steam turbine capacity. The average annual growth rates required to attain the estimated 1970 output of these other types of equipment are slightly lower than the growth rates achieved during the 1959-65 period.

Several plants in the electric power equipment industry are now operating under the new economic system, which uses profitability as the main criterion for success. All plants in the industry are to be converted to the new system by 1968.

b. Technology — Manufacturing methods and techniques are generally similar to those used in the United States and other highly industrialized countries. Soviet technology lags behind the United States in the production of all types of electric power equipment except hydraulic turbines and high voltage transmission equipment. In the latter two fields, the U.S.S.R. employs the most advanced technology in the world. The major technological deficiencies in the electric equipment industry are the failure to develop satisfactory equipment for operation at supercritical steam parameters* and the lack of adequate testing facilities for large turbines and generators.

In 1960, the U.S.S.R. built its first 300 megawatt generating unit (consisting of boiler, turbine, and generator) designed to operate at supercritical steam parameters. Since then, all generating units of 300 megawatts and higher have been designed to operate at supercritical parameters. By the end of 1966, however, none of the 21 units installed had operated at rated capacity because of recurrent breakdowns caused primarily by defects in the boiler tubing and in the welded joints. The successful application of supercritical technology is dependent on the development of heat-resistant steel alloys, high-quality fabrication of alloys, and sophisticated welding techniques. So-

* Steam conditions with pressures above 3,206 pounds per square inch and temperatures above 705° Fahrenheit, the point at which water flashes into dry steam without boiling.

Figure 13. PRODUCTION OF ELECTRIC POWER EQUIPMENT

COMMODITY	UNIT OF MEASUREMENT	1958	1959	1960	1961	1962	1963	1964	1965	1966	1970 PLAN
Turbines*............	Thousand megawatts..	6.6	7.6	9.2	10.7	11.9	11.9	13.3	14.6	**15.2	22–24
Generators for turbines.	....*do*..............	5.2	6.5	7.9	9.4	11.0	11.8	12.8	14.4	**13.4	***20–22
Boilers...............	Thousands of tons of steam per hour.	40.0	41.7	50.3	57.8	66.4	71.0	78.5	82.0	**89.6	***123–134
Transformers..........	Thousand megavolt-amperes.	30.5	40.5	49.4	64.1	75.7	83.9	88.9	95.3	*na*	***132–145
Electric motors, AC over 100 kw.	Thousand megawatts..	3.3	3.7	4.1	4.4	5.2	5.8	5.6	5.3	5.5	*na*
Electric motors, from 0.25 to 100 kw.	....*do*..............	10.4	12.3	13.5	15.6	17.4	18.9	20.5	21.6	22.6	*na*

* As much as 5% of the production of turbines consists of turbines for purposes other than electrical power production, e.g., marine propulsion and driving mechanical equipment.

** Preliminary figures.

*** Estimates based on announced plan for turbines.

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viet manufacturers have not yet successfully applied the necessary technology to the production of electric power equipment, but the industry is concentrating on the development of supercritical technology and may be successful in applying it within a few years. The use of equipment designed to operate at supercritical steam parameters is important to the U.S.S.R. because of the economies in operation it affords through increased efficiency and savings in fuel. Partly as a result of difficulties encountered with equipment designed to operate at supercritical steam parameters, Soviet equipment manufacturers now plan to build a 500-megawatt turbine for operation at subcritical steam parameters in low-cost fuel areas such as eastern Siberia.

Lack of adequate testing facilities at producing plants has caused numerous operational problems and has necessitated costly and time-consuming adjustments of equipment after delivery. These problems have been compounded by the Soviet practice of beginning serial production of new generating units before prototypes have proved reliable. Some minor additions to testing facilities were installed during the 1959-65 period. In 1966, a test bed for turbines as large as 1,000 megawatts was under construction at the Leningrad Metal Plant and a test stand for 1,000 megawatt generators was planned at the Elektrosila Plant in Leningrad.

Improvements in the efficiency of electric power equipment have been hindered by several other factors, including shortages of synthetic insulation materials for large generators, the substitution of aluminum for copper in transformers and in electric wire and cable, and the use of hot-rolled rather than cold-rolled steel in Soviet transformers.

c. Turbines — The U.S.S.R. is the world's second largest producer of turbines. In 1966, Soviet output of 15.2 thousand megawatts was exceeded only by U.S. output of 18.6 thousand megawatts.* The production of turbines is concentrated in a few specialized plants in the European U.S.S.R. and in the Urals. The Leningrad Metal Plant is the oldest and largest producer of turbines in the Soviet Union. The second major producer is the Khar'kov Turbine Plant *imeni* S. M. Kirov.

Soviet production of turbines increased at an average annual rate of 12% during 1959-65, even though there was a marked decline in the growth rate during the latter half of the period. The product mix of turbines varies in accordance with the demands of domestic construction projects and export commitments. The following tabulation for 1958-63, the latest period for which data are available, shows the production of individual types of turbines (in thousand megawatts):

Year	Steam and gas turbines	Hydraulic turbines
1958	5.4	1.2
1959	6.2	1.4
1960	7.5	1.7
1961	8.4	2.3
1962	9.3	2.6
1963	10.1	1.8

Most of the increase in output during the 7-year plan period was achieved by increasing the individual capacities of the turbines produced, which did not require significant expansion of production facilities. Steam turbines of 150 and 200 megawatt capacity were installed for the first time in the early years of the 7-year plan. The first 300 megawatt steam turbine was produced in 1960 and began operating in 1963. By the end of 1966, the U.S.S.R. had installed 21 units of 300 megawatt capacity, 54 units of 200 megawatt capacity, and 62 units of 150 megawatt capacity. About 130 large generating units are to be installed during 1966-70, including three units of 800 megawatt capacity, four units of 500 megawatt capacity, and about 70 units of 300 megawatt capacity.

The first 500-megawatt single-shaft steam turbine and the first 800-megawatt double-shaft steam turbine were produced in 1966 and are to begin operating before the end of the 1966-70 plan. As a further step in production of larger turbines, the U.S.S.R. is presently designing an 800-megawatt single-shaft steam turbine and a steam turbine of 1,200 megawatt capacity. The following tabulation shows the initial year of production for various sizes of steam turbines (in megawatts):

Year	Capacity of unit	Year	Capacity of unit
1923	2	1958	200
1925	10	1960	300
1938	100	1965	500
1952	150	1966	800

The U.S.S.R. produces the largest and most technically advanced hydraulic turbine in the world. Two units of 508 megawatt capacity were to be installed in 1967, and eight more are to be produced by 1970. Soviet engineers are planning even larger units, however, and have begun preliminary design work on hydraulic turbines of 540 megawatt capacity.

Small gas turbines of 6 megawatt and 12 megawatt capacity have been produced for gas pipeline compressor stations and mechanical drives. In 1960, a prototype 25-megawatt gas turbine was built for electric power production and was subsequently installed in a thermal powerplant in Kiev. Testing of this turbine has uncovered design deficiencies and the unit still has not operated at its rated capacity. An even larger gas turbine of 100-megawatt capacity is scheduled for completion in 1967.

* The U.S. figure includes turbines with a capacity of 4,000 kw. and larger. Soviet statistics presumably include turbines of all capacities. The comparison between the United States and the U.S.S.R. thus is biased in favor of the U.S.S.R.

Approved For Release 2008/09/08 : CIA-RDP08S01350R000100030002-2

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d. Generators — Output of generators grew at an average annual rate of 15.7% during 1959-65, and amounted to 14,400 megawatts in 1965. However, preliminary data indicate that production declined to 13,400 megawatts in 1966.

Generators are produced in four major plants—the Elektrosila Plant in Leningrad, the Heavy Electrical Equipment Plant in Khar'kov, the Turbogenerator Plant in Novosibirsk, and the Ural Electrical Apparatus Plant in Sverdlovsk. Little expansion of production facilities was reported during the 7-year plan period (1959-65), and no major expansion is planned during 1966-70. Most of the increase in output of generators has been achieved by increasing unit capacity rather than expansion of production facilities. Increases in the capacities of generators have paralleled increases in the capacities of turbines. Mechanization of operations in the producing plants was increased during the 7-year plan and is continuing.

e. Boilers — The total capacity of boilers produced in the U.S.S.R. in 1966 was 89,600 tons of steam per hour, an increase of 9.3% over that produced in 1965. During 1959-65, production of boilers rose at an average annual rate of 10.8%. Three plants, located in Taganrog, Podol'sk, and Barnaul, produce most of the medium- and large-capacity boilers (Figure 61).

The U.S.S.R. has produced boilers with an output of 950 tons of steam per hour for use with 300 megawatt turbines, boilers of 1,600 tons of steam per hour for 500 megawatt turbines, and a boiler of 2,500 tons of steam per hour for an 800-megawatt turbine. Designs are now being worked out for larger boilers for turbines of more than 1,000 megawatts. In recent years, large boilers of more than 40 tons of steam per hour have accounted for more than 60% of the boiler capacity produced, as is shown in Figure 14.

Boilers are produced in a few specialized plants, but these plants are dependent on many suppliers for components such as feed water pumps, blowers, and preheaters. Serious problems in installation and operation, caused by delayed shipments and defective materials received from suppliers, have led to plans to shift production of these components to specialized manufacturing facilities. Such specialization is intended to reduce the cost and to improve the quality of auxiliary equipment.

Figure 14. TOTAL CAPACITY OF BOILERS PRODUCED
(Thousands of tons of steam per hour)

YEAR	LARGE BOILERS (more than 40 tons/hour)	MEDIUM BOILERS (10–40 tons/hour)	SMALL BOILERS (less than 10 tons/hour)
1958........	22.0	2.7	15.3
1959........	22.8	3.3	15.6
1960........	30.8	3.7	15.8
1961........	37.1	3.1	17.6
1962........	44.0	3.7	18.7
1963........	*47.7	*3.8	*19.5
1964........	*53.5	*4.1	*20.9
1965........	*56.7	*4.1	*21.2
1966........	*62.9	*4.3	*22.4

* Estimated.

f. Electric motors and transformers — In 1965, Soviet production of electric motors amounted to 26,900 megawatts. Electric motors are produced at a large number of plants, but major producers are the Dinamo Electrical Equipment Plant in Moscow, the Khar'kov Electrical Machinery Plant, and the Baku Electrical Machinery Plant.

More than 80% of the capacity of electric motors produced is in motors of less than 100 kilowatts capacity that are designed for a wide variety of uses. The 10% average annual rate of growth in production of electric motors during the 7-year plan period was achieved mainly by opening up new production facilities and by modernizing existing production lines.

Production of transformers grew at an average annual rate of 17.7% during 1959-65, and amounted to 95,300 megavolt-amperes in 1965. The largest single producer is the Zaporozh'ye Transformer Plant, which manufactures almost one-half of all Soviet-made transformers.

The two major goals in the production of transformers during the 7-year plan were the manufacture of large power transformers for high voltage transmission over long distances and the building of small- and medium-sized transformers and transformer substations for the rural electrification program. To achieve the first goal, the Zaporozh'ye Transformer Plant has steadily increased the unit sizes of its transformers, and in 1966 it built a 417-megavolt-ampere unit intended for use in the prototype 750-kilovolt transmission line being erected in 1967 from Konakovo to Moscow. Preliminary design work was started on 1,500 kilovolt transmission lines to be used to transmit electric power from Siberia to the European part of the U.S.S.R. The growth in output of small- and medium-sized transformers has been achieved by the opening of new production facilities in many locations throughout the U.S.S.R.

g. Electric wire and cable — The U.S.S.R. produces all types of power and communications wire and cable needed by a modern industrialized economy, including insulated power cable, weatherproof cable, and coaxial cable. However, some wire and cable are also imported from various European countries. The value of Soviet wire and cable of all types produced in 1965 is estimated at $2.2 billion, which is about three times the estimated value of production in 1958. Electric power wire and cable probably represent about two-thirds of the total. The increase in output has been achieved through the construction of new production facilities and further mechanization of older plants.

The largest producers are the Moscow Cable Plant, the Northern Cable Plant in Leningrad, and the Kama

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Cable Plant at Perm, all of which are in the western part of the U.S.S.R., near the major power-consuming areas. There are also several large producers serving local needs in the eastern part of the U.S.S.R.

h. FOREIGN TRADE — The U.S.S.R. is a major exporter of electric power generating and transmission equipment to other Communist countries and to some less developed countries in the non-Communist world, notably India and the U.A.R. Soviet generating sets with a total combined capacity of nearly 20,000 megawatts are either in operation, under construction, or planned for installation in 125 thermal powerplants in 18 countries. Almost 9,000 megawatts of capacity in hydraulic generating sets will have been installed in hydroelectric powerplants outside the U.S.S.R. by 1970.

The Aswan High Dam project in the U.A.R. is probably the best known example of Soviet assistance to another country in the development of electric power facilities. The U.S.S.R. will have delivered twelve 175-megawatt hydraulic generating sets to this project by 1970. Three units were delivered in 1966, four more were to be delivered in 1967, and the rest by 1970. The U.S.S.R. also will deliver six 170-megawatt hydraulic generating sets to the Iron Gates Hydroelectric Power project, which is being erected by Rumania and Yugoslavia on the Danube. It will also furnish design data and technical supervision for production of six more units by Rumania and Yugoslavia for the same project. Five 120-megawatt hydraulic generating sets were delivered to the Bhakra Hydroelectric Powerplant in India during 1964-65, as well as a number of smaller units to other hydroelectric powerplants. India received almost 1,000 megawatts of capacity in thermal and hydroelectric powerplants from the U.S.S.R. in 1964, and 600 megawatts of capacity in 1965.

The eastern European Communist countries have been the major buyers of Soviet thermal generating sets. Poland received seven 200-megawatt thermal generating sets from 1962 to 1965, and is to receive four more during 1966-70. Bulgaria is to receive four 200 megawatt sets and a number of smaller units by 1970. Rumania is also to receive at least two of the 200 megawatt sets. East Germany is planning to purchase six 200-megawatt units and six 300 megawatt units from the U.S.S.R. for the Boxberg powerplant, which is to be completed by 1974. Two 200-megawatt units were also built for Yugoslavia in 1966, and three more are to be built by 1970. In addition, the U.S.S.R. has built a number of smaller units for some of the developing countries, including India, Iran, Indonesia, Cuba, the U.A.R., and several others.

The U.S.S.R. exports transmission equipment to a number of the developing countries, including North Vietnam, Mongolia, Nepal, Cambodia, and the U.A.R. The U.S.S.R. is helping the U.A.R. to build a complete transmission system, including transformer substations and two 500-kv. transmission circuits of 1,575 km. length, from Aswan to Cairo.

5. Machinery for extraction of fuels

a. COAL MINING MACHINERY

(1) *Introduction* — The U.S.S.R. produces almost all of the mining machinery and equipment needed by the Soviet coal mining industry, the largest of its kind in the world. Coal mining machinery is produced in about 50 plants, 40 of which specialize in underground equipment.* Underground mining now accounts for three-fourths of all the coal produced in the U.S.S.R. By 1970, however, only 72% of the coal produced will come from underground mines as strip mining is increased. Major plants producing underground coal mining machinery are listed in FIGURE 62.

The 40 plants that produce underground mining equipment make over 1,000 different type-sizes of machines and equipment, including a full complement of development and production equipment. This proliferation of types and sizes has resulted from the effort to mechanize all phases of coal mining and to develop equipment specifically for the many different coal fields of the U.S.S.R. Soviet engineers have shown great capability in designing special equipment. However, the machines are not dependable in operation: frequent breakdowns are caused by the poor quality of components, and the lack of spare parts may cause long periods of idleness.

The production of underground coal mining equipment is fairly well dispersed throughout the European U.S.S.R., the Urals, western Siberia, and Kazakhstan. In general, there is an important coal mining machinery plant or group of plants near every major coal basin in the country. These plants, however, do not produce a full complement of machinery to make each basin self-sufficient in equipment. Instead, each plant tends to specialize in the production of certain end-items that are distributed throughout the coal mining industry. The largest single concentration of plants is found in the Ukrainian S.S.R., and includes major plants in Gorlovka, Khar'kov, Donetsk, and Lugansk.

(2) *Production* — The total amount of coal mining machinery produced in the U.S.S.R. is not known, data having been published only for selected types of equipment. The Seven Year Plan provided for a general increase of 75% to 80%, but the plan probably was not fulfilled. For example, the production of combines in 1965 was only 998 units, whereas the plan called for 1,260 units. FIGURE 63 shows the production of selected types of coal mining equipment for the years 1960-65, and FIGURE 64 shows the inven-

* The rest are heavy machine building plants that produce limited quantities of coal mining equipment—power shovels, draglines, heavy-duty dump trucks, etc.—for strip mining. This subsection is limited mainly to underground coal mining machinery and equipment.

Approved For Release 2008/09/08 : CIA-RDP08S01350R000100030002-2

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tory of major types of underground machinery and equipment.

The industry in recent years has been handicapped by the lack of investment capital for the building of new facilities and the modernization of plants. At the same time, plant managers have been called on to increase the service life and reliability of their machines and to reduce costs. The poor quality of component parts supplied to the mining machinery plants is a chronic source of trouble. Such items as safety valves, electrical switchgears and parts, and oil pump springs reportedly have been defective. These and other deficiencies account for the frequent breakdowns, long periods of idleness, and the high cost of repairs which have been characteristic of Soviet coal mining machinery in underground mines.

The 5-year plan for 1966-70 calls for increases in strip mining. Large new strip pits will require machinery of a size hitherto unknown in the U.S.S.R. The industry is experienced in the technology of underground mining but not in the design and manufacture of equipment for strip mining. Only since the late 1950's has the industry produced giant-sized power shovels, draglines, bucket wheel excavators, large dump trucks, and tractor-trailer units. Reportedly it takes up to 10 years to design, test, and produce the extra large excavators used in overburden removal, i.e., the clearing away of top layers of rock and dirt. For example, the design for one such machine, an 80-cubic meter bucket 100-meter boom walking dragline, was scheduled for completion in 1964, but construction of this machine is not to be finished until 1970. The manufacture of medium-sized draglines (14 and 15 cubic meter buckets and 75 to 90 meter booms) was started at the Ural Heavy Machine Building Plant *imeni* Ordzhonikidze (UZTM) at Sverdlovsk in 1960, and by 1964 output had reached the level of four units per year. In 1962, UZTM built a 25-cubic meter dragline; a second one was scheduled for completion in 1965. No information is available about the performance of these machines.

(3) *Technology* — In general, the level of technology of the Soviet coal mining machinery industry is below that of its counterparts in the United States and western Europe. Manufacturing methods and techniques in many of the plants are outdated and labor-consuming. The capacity for forging and heat-treating special parts in many plants is inadequate. Automatic control and signaling devices are in short supply and of poor quality. Even though work has continued since the early 1950's on developing an integrated unit for automated longwall mining, the best unit in operation in 1966, the OMKT, still requires a crew of men at the coal face to operate and service the equipment. In contrast, during 1961 the United Kingdom installed 2 ROLF (remotely operated longwall face) complexes in which the whole unit is controlled by one man at a control panel away from the coal face.

A number of Soviet research and design institutes are involved with the development of coal mining machinery. The largest general mining institute is the "A.A. Skochinsky" Mining Institute at Lyubertsy, near Moscow. The institute is administered by the Ministry of the Coal Industry, its work directed by the Department of Earth Sciences of the Academy of Sciences. The State Planning, Design, and Experimental Institute for Coal Mining Machinery (*Giprouglemash*) designs new equipment and builds prototypes at the Malakhov Experimental Plant, bench tests them, and then sends them to various mines for field testing. Other research and design institutes are located near most of the major coal fields. Research and development on a lesser scale also is conducted at some of the manufacturing plants listed in Figure 62. Design and development of strip mining equipment is conducted at the heavy machinery plant where the unit is to be constructed.

(4) *Foreign trade* — In 1965, Soviet export of combines and coal and rock loaders in terms of value was almost three times that of 1960. Czechoslovakia was the biggest importer of Soviet coal mining machinery during 1960-65. Even though the U.S.S.R. has advertised mechanized support systems and development combines in Western trade journals, none are known to have been exported to western Europe since 1959. A breakdown of Soviet exports in this class by types and destination is shown in Figure 65. Figure 66 shows the total of such exports and their value for the years 1960-65.

Soviet foreign trade data include little information about imports of coal mining machinery. Some equipment was imported from France and probably from West Germany in the early 1960's. In 1961, the U.S.S.R. imported from the United States five continuous miners, seven shuttle cars, seven roof bolting drill units, five extendable belt conveyors, and a supply of spare parts for all machines. The total value of this import was about $1.9 million, of which $350,000 was for spare parts. Early in 1967, it was announced that the U.S.S.R. had signed an agreement with East Germany for the purchase of 10 complete strip mining installations, consisting of bucket wheel excavators, loader-transfer conveyors, and belt conveyor systems. Delivery is to be completed by 1970. Orders for large amounts of conveyor belting were placed with producers in the United Kingdom and in Hungary, probably for installation in new strip pits.

The U.S.S.R. also imports mining equipment from Czechoslovakia. By early 1967, some 20 Czechoslovak strip mining machines and about 30 km. of belt conveyors had been imported by the U.S.S.R. In late 1966, the U.S.S.R. contracted to purchase from Czechoslovakia $14 million worth of machinery and equipment for the Stoylen strip pit in the R.S.F.S.R., including the largest Czechoslovak bucket wheel excavator, 6.8 km. of belt conveyors, a loader-transfer

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Approved For Release 2008/09/08 : CIA-RDP08S01350R000100030002-2

conveyor, mobile repair shops, and auxiliary equipment.

b. Petroleum machinery and equipment

(1) *Oilfield equipment*

(a) introduction — Oilfield equipment in the U.S.S.R. includes both surface and subsurface installations utilized in the drilling and equipping of oil and gas wells. Major types of oilfield equipment are produced at 44 plants. Total production doubled during 1959-65, and is expected to almost double again during 1966-70. During the present 5-year plan, about 2,800 new types of equipment are to be introduced for the first time and many obsolete types discontinued. Emphasis is being placed on the development and serial production of deep drilling rigs (3,000-6,000 meter depths), both conventional and offshore types; more powerful mud pumps (10.2-20.4 pounds per square inch [psi]); higher quality drill pipe and drilling bits; high pressure well-head assemblies and blow-out preventors (13.6-68.0 psi); multizone downhole completion equipment; surface and submersible pumps; automatic control systems for wells, pipelines and refineries; large diameter linepipe for oil and gas transmissions systems; and pipeline turbines, compressors, and pumping stations.

Soviet oilfield equipment is generally inferior to equipment manufactured in industrialized countries of the West. Soviet equipment tends to be bulky and heavy, frequently built of low-quality materials, and does not perform uniformly well under diverse operating conditions. Transportation of such heavy and oversized equipment poses a serious problem when drilling occurs in wilderness or unmapped territory. The industry plans to modernize and improve the quality of extraction equipment, a program that will require considerable time and substantial investment.

(b) location — Before World War II, most oilfield equipment was produced in the major oil-producing regions of Azerbaydzhan (Baku) and Groznyy. As the center of oil production shifted to the Urals-Volga area, the center of manufacture of oilfield equipment also shifted to this area, even though Baku continued to specialize in the output of particular types of equipment. Major plants which manufacture oilfield equipment are listed in Figure 67.

(c) production of major items

1) Rigs — The U.S.S.R. produces types of drilling rigs similar to those used in the United States, including portable and semiportable light-, medium-, and heavy-duty models. Production of Soviet rigs of the heavy-duty, semiportable type amounted to about 350 units in 1958 and increased to 520 units in 1965. The output of portable rigs approximated 2,000 units in 1965, but only about one-half were used in the oil and gas industries.

In many respects Soviet rigs are inferior to their U.S. counterparts. They are heavier, require a longer time to assemble and dismantle, and perform less efficiently. Durability of many parts is poor, and spare parts are in short supply. In recent years, however, Soviet rigs of advanced design with automatic controls have been seen in operation by industry specialists from the West. Such improvements are vital to raising the efficiency of drilling operations.

The need to drill to greater depths will require certain improvements in rig design and drilling technology. These include stronger derricks and substructures, more powerful drawworks and hoists, mud pumps with greater circulation capabilities, drill pipe of lighter weight and higher quality, improved turbodrilling techniques, and greater use of rotary drilling. The U.S.S.R. was scheduled to receive a mobile offshore drilling platform from the Netherlands during 1967. This unit, valued at $10 million, would enable the Soviets to drill in water up to 60 meters deep and to drill to depths of 6,000 meters. It will supplement the single Soviet mobile platform in use in the Caspian Sea that can drill to a depth of 3,000 meters in water up to 18 meters deep.

In 1965, imports of 33 complete drilling rig assemblies (valued at about $10.8 million) from Rumania constituted the largest import item of oilfield equipment. No heavy-duty rigs were exported from the U.S.S.R. in 1965, but 269 core drilling rigs valued at about $4 million were exported. These rigs are used for drilling shallow exploratory wells to a depth of 1,000 meters and were shipped primarily to other Communist countries and to the less developed countries.

2) Turbodrills — Approximately 80% of oil and gas well drilling in the U.S.S.R. in 1965 was achieved by use of the turbodrill.* Soviet production of turbodrills doubled between 1958 and 1965, as shown in the following tabulation:

1958	4,213	1962	7,656
1959	4,898	1963	8,038
1960	6,222	1964	8,280
1961	6,752	1965	8,439

The turbodrill has an extremely high rate of penetration (more than twice that of rotary methods) in shallow, extremely hard, rock formations that are less than 2,500 meters in depth. Below 2,500 meters, the turbodrill is much less efficient owing to the limitations of supporting equipment. The weight of Soviet drill pipe (which is heavier and about 1½ times as large in diameter as U.S. pipe) and the inadequate capacity of Soviet mud pumps accelerate bit failure and reduce penetration rates. The net effect—especially below 2,500 meters—is that less time is spent in drilling and more time is spent in replacing worn-out bits.

* Turbodrilling differs from rotary drilling in that only the lower section of drill pipe containing the turbodrill itself rotates, whereas in rotary drilling the entire length of pipe is rotated from the surface.

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Attempts to modify the turbodrill technique have led the Soviets to reduce the diameter and weight of the drill pipe, and the size of the bit, in order to extend the useful depth of operation. The need to drill to greater depths also has revived interest in rotary drilling technology.

3) Electrodrills — Production of the electrodrill began in the U.S.S.R. in 1956, but its use has increased slowly in spite of claims that it is superior to the turbodrill and can operate satisfactorily at depths of 4,000 to 5,000 meters. In 1963, only 25 electrodrills were in operation. This number had increased to only 116 by the end of 1965, although 500 were planned for that year.

The electrodrill method has been plagued by difficulties in transmitting electricity to the drill at the bottom of the well. Criticism of design and charges of shoddy workmanship have been leveled at the Kharkov Electrical Machinery Plant, which produced the electrodrill. Until some of the problems are solved, only small increases in use of the electrodrill are likely during 1966-70.

4) Bits — Soviet production of drill bits in 1965 reached about 900,000, of which at least 95% were cone-type bits. Diamond and jet bits used for coring purposes accounted for most of the remainder. Recent attempts of the U.S.S.R. to buy diamond bits from France may indicate that the quantity or quality of Soviet bits is inadequate. The present Soviet tri-cone standard bit has been compared with U.S. bits under similar conditions, and has been found to be only about one-third as efficient. In wells deeper than 2,000 meters, Soviet tri-cone bits wear out rapidly because of the excessive weight of the drill pipe, increased bottom-hole temperature, and bearing failure. Consequently, the effective speed of Soviet drilling (meters per rig per month) is only about one-half that possible with U.S. bits. Attempts are being made, however, to improve the quality of Soviet bits. A net importer of drill bits, the U.S.S.R. imported 20,300 tri-cone bits in 1965 (primarily from Rumania), and exported about 9,200.

5) Pumps — Soviet oilfield pumps are generally of lower quality than comparable Western types and are severely limited with respect to filtering, desanding, and dewaxing devices. They include both rod-type models activated by a pump jack at the surface and the downhole electric vortex-type similar to the Reda pumps manufactured in the United States. Western observers indicate that the Soviet version of the Reda pump is about as good as the U.S. model. However, this type of pump accounts for only a small percentage of total pump production in the U.S.S.R.

The production of pumps fluctuated during the 7-year plan. Production in 1965 was only about 5% above that of 1958. The output of deep well plunger pumps was as follows, in thousands of units:

1958	88.0	1962	77.0
1959	95.3	1963	88.7
1960	81.8	1964	90.4
1961	80.3	1965	92.8

The increase in output during the 7-year plan lagged behind domestic needs, and many new wells have been forced to remain shut-in because of the lack of lifting equipment.

The quality of Soviet mud pumps has become a limiting factor in turbodrilling efficiency. Frequent breakdowns and the lack of spare parts have been the basic difficulties in operation of the present models. Equally serious is the inability of Soviet manufacturers to mass-produce pumps capable of generating more than 2,250 psi, in comparison with U.S. types, which deliver 3,000-3,750 psi. Greater mud pump capacity will be necessary to improve bit life and drilling effectiveness.

6) Blow-out Preventors — Although serial production of a universal type blow-out preventor at the Leytenant Shmidt Works in Baku was reported in 1966, this equipment is not universally available where it is needed. Not only have several recent drilling disasters been attributed to the lack of this item, but the shortage has caused the cessation of development drilling in several high-pressure oil and gas deposits located in Krasnodar Kray, the Ukraine, and in Central Asia. The industry is stepping up efforts to obtain blow-out preventors abroad, and imports rose from 157 units in 1964 to 226 in 1965.

7) Well Completion and Serving Equipment — Well completion and servicing equipment comprises a wide assortment, ranging from small tools to large tractor-mounted units.

Production of oilfield casing and drill pipe reportedly is adequate. However, shortages have occurred as a result of diversion to other, less essential uses, such as shallow-water well casing. Casing and drill pipe are produced at the same plants and are of identical quality and weight, the only major difference being that tool joints are added to the ends of the casing for drilling purposes. Although Soviet casing and drill pipe is heavier than that of the United States, it is rated at only 70 psi compared with 110 psi for the U.S. product.

High-pressure well head fittings and complete oil well surface installations ("Christmas trees") with 3,000 to 15,000 psi ratings are in very short supply. Lack of this equipment caused the cessation of development drilling in several high-pressure fields. Pressures over 10,000 psi in oil and gas fields are rarely encountered, but high quality is essential when such pressures are attained. U.S. manufacturers produce well head assemblies rated up to 20,000 psi, and are testing equipment for possible 30,000 psi.

Production of well head assemblies in the U.S.S.R. is estimated at 3,000 to 6,000 units per year, all be-

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lieved to have less than 5,000 psi rating and to be of inferior design. The industry is attempting to develop well head assemblies capable of operating at pressures of 7,500 to 10,000 psi. For present needs, however, the U.S.S.R. is attempting to buy 220 well head assemblies rated at 5,000 to 15,000 psi from the United Kingdom and France. Underwater well head assemblies for diverless completion are also the subject of Soviet-French technical discussions, possibly for future offshore operations in the Caspian Sea.

(d) FOREIGN TRADE — Since 1964, the U.S.S.R. has been a net importer of oilfield equipment. As it became necessary to increase drilling to find new oil and gas fields during the latter part of the Seven Year Plan (1959-65), imports of oilfield equipment, primarily from Rumania, increased rapidly and the former position of the U.S.S.R. as a net exporter of such equipment was reversed. In 1960, about 60% of total Soviet exports of oilfield equipment were sent to other Communist countries; by 1965 this share had risen to about 80%. Concomitantly, shipments of Soviet oilfield equipment to the less developed non-Communist countries, mostly in connection with technical assistance programs, declined from about 37% of the total in 1960 to about 17% in 1965. Soviet trade in oilfield equipment, in quantity and value terms, is shown in FIGURE 68.

(2) *Refinery equipment*

(a) PRODUCTION AND DEMAND — Production of refinery equipment almost doubled during the 7-year plan; the 1970 plan calls for its output to increase by 50% to 70% above the level of 1965, as the following tabulation shows (in thousands of metric tons*):

1958	71	1964	140
1960	93	1965	140
1962	121	1966	147
1963	115	1970 Plan	210-240

In fact, the plan for installation of new refining capacity during 1959-65 was not fulfilled, despite the growth in output of equipment. A total crude charge capacity of 250-260 million tons was to be in operation by 1965, but actual capacity approximated 225 million tons.

The 1970 plan calls for the crude oil charge capacity to reach 310-330 million tons a year. Special emphasis is placed on the construction of secondary processing facilities—catalytic cracking, catalytic reforming, hydrocracking, hydrogen treating—to increase the quantity and upgrade the quality of distillates. Such a program will require a significant effort by the petroleum equipment industry to produce modern types of processing units. If past difficulties in moving from an established line of output to one of new and more advanced design continue, the U.S.S.R. may have to purchase modern refinery equipment and technology from the industrialized countries of the West in order to meet its 1970 goals.

* Metric tons are used throughout this section.

(b) FOREIGN TRADE — The U.S.S.R. was a net importer of refinery equipment during the entire period of the 7-year plan. The value of imports has risen since 1960, probably as a result of inability of the domestic equipment industry to meet the demands of the refinery construction programs. Rumania and Czechoslovakia are the major suppliers of this equipment. Rumania supplied about one-half of the 26 million rubles worth of equipment imported in 1965. Trade in refinery equipment by the U.S.S.R. during 1959-65 was as follows (in thousands of foreign exchange rubles):

	IMPORT	EXPORT
1959	3,070	846
1960	1,171	192
1961	9,833	444
1962	18,349	808
1963	20,300	641
1964	20,242	1,068
1965	26,226	284

6. Chemical equipment

a. INTRODUCTION — The U.S.S.R. is a relatively large producer of chemical equipment,* producing about as much as the eastern European Communist countries combined. Nevertheless, output is insufficient to meet the requirements of the growing domestic chemical industry, and substantial quantities of this equipment are imported. Output of chemical equipment in 1965, valued at 386 million rubles, accounted for less than 1% of the total output of the machine building and metalworking sector.

During the current 5-year plan, output of chemical equipment is scheduled approximately to double, reaching a value level of 780-830 million rubles in 1970. Specialization is to be emphasized both in the production of standard components and in the production of complete technological lines for manufacture of specific chemical products. The manufacture of equipment of large capacity also is being stressed. The product mix planned for 1970 continues to reflect high priorities for agricultural chemicals, plastics, fibers, and synthetic rubber. The plan also emphasizes the need for equipment to produce petrochemical raw materials and polymeric end-items.

b. ORGANIZATION AND LOCATION — The U.S.S.R. did not have a unified industry for the manufacture of chemical equipment until the establishment of the State Committee for Chemical and Petroleum Machine Building in May 1963. In October 1965, the State Committee was changed to an All-Union Ministry, comprising some 25 to 30 plants that produce chemical equipment. Chemical equipment also is produced

* Including a wide range of heterogeneous items such as filters, centrifuges, heat exchangers, evaporators, columns, driers, reactors, and autoclaves for use in chemical processes.

Approved For Release 2008/09/08 : CIA-RDP08S01350R000100030002-2

Approved For Release 2008/09/08 : CIA-RDP08S01350R000100030002-2

at some 200 plants in other branches of machine building, although the output of chemical equipment from these plants is below that of the specialized plants. Almost two-thirds of the total output of Soviet chemical equipment is produced in the R.S.F.S.R.; most of the remainder is produced in the Ukraine. The principal plants producing chemical equipment are listed in FIGURE 69. Information is incomplete on Soviet plans for construction of chemical equipment plants during 1966-70. Many of the existing plants are to be expanded or modernized; new plants are to be built at Perm and Poltava; and a number of general machine building plants may be converted to the production of chemical equipment.

c. PRODUCTION

(1) *Volume* — The value of chemical equipment produced in 1965—386 million rubles—represented an increase of 245% over the level of 1958. Annual increases in production thus averaged about 19% in 1959-65, but the pattern of growth was uneven, the largest rates of increase having occurred in 1959-60. Soviet production of chemical equipment* since 1958 and the plan for 1970 are shown in the following tabulation, in millions of rubles:

YEAR	VALUE OF OUTPUT	YEAR	VALUE OF OUTPUT
1958	112	1963	289
1959	173	1964	344
1960	226	1965	386
1961	243	1966	417
1962	266	1970 Plan	780-830

Output in 1965 overfulfilled the original 7-year goal of 350-370 million rubles, but was below the revised target of 450 million rubles announced in 1963 and the goal of 420 million rubles set after Khrushchev was replaced. Shortcomings in the quality of chemical equipment have frequently delayed the operation of new chemical plants and necessitated larger expenditures to remedy deficits resulting from faulty design and manufacture. In many cases equipment has failed to reach its planned level of productivity.

(2) *Difficulties* — Numerous difficulties hampered efforts to expand the production and improve the quality of chemical equipment in the U.S.S.R. during the 1959-65 period. An inadequate supply of labor existed at most levels, engineers, designers, and technicians being in particularly short supply. Shortages of materials and equipment were evident in the construction and operation of chemical machine building plants. There was a substantial underfulfillment of the plan to introduce new chemical machine building capacity. Delays in production were caused by shortages of materials such as clad steel, plastic-coated metal sheets and pipes, and acid resistant materials. The supply organizations failed to assure prompt delivery of completed items to the chemical industry. Furthermore, the chemical industry frequently canceled orders for machinery and equipment that already was in production or had been completed. Not only was this practice costly, but it delayed the production of other equipment that was needed.

d. FOREIGN TRADE — The volume of chemical equipment imported by the U.S.S.R. from other Communist countries and from the non-Communist world increased substantially during the 7-year plan. The value of total imports in 1965 was more than four times the level in 1958, as FIGURE 70 shows. Chemical equipment imported from the West, which accounted for only 38% in 1958, increased to 53% of the total by 1965. Most of the chemical equipment imported from other Communist countries has come from Czechoslovakia and East Germany.

The U.S.S.R. has continued to export some chemical equipment in spite of pressing domestic needs. Exports are mainly in the form of complete plants shipped to other Communist countries, and, to a lesser extent to the developing countries. Generally these plants were for the production of basic chemicals and chemical products. Comprehensive data on exports of Soviet chemical equipment are not available.

7. Locomotives and railroad cars

a. INTRODUCTION — Although the railroad is the principal means of transportation in the U.S.S.R., domestic production of railroad transport equipment is inadequate for the basic requirements of the country, and much railroad equipment must be imported. In the post-World War II period, the U.S.S.R. consistently has been a net importer of railroad equipment from the eastern European Communist countries.

The Soviet locomotive and railroad car industry has 14 major plants—six for the production of locomotives, four for freight cars, three for passenger cars and permanently coupled passenger train sets, and one for suburban and subway cars. Details on the major plants are given in FIGURE 71. In general, these plants are vertically integrated, although in the past few years the industry has tended toward specialization in the production of some of the components.

b. PRODUCTION

(1) *Locomotives* — By 1959, the U.S.S.R., with a production of some 1,400 locomotives, was producing more locomotives of all types than the United States. Production continued to grow rapidly through 1961, when slightly over 2,000 units were manufactured, but output then leveled off at about 2,100 units annually in the period 1962-66. Since 1958, diesel locomotives consistently have accounted for about 70% of annual Soviet production of locomotives. FIGURE 15 shows production of mainline locomotives in the U.S.S.R. in 1959-66.

The last Soviet steam locomotive was produced in 1956, and railroads are converting rapidly to the

* Soviet data on the value of output of chemical equipment excludes pumps and compressors.

Approved For Release 2008/09/08 : CIA-RDP08S01350R000100030002-2

Approved For Release 2008/09/08 : CIA-RDP08S01350R000100030002-2

FIGURE 15. PRODUCTION OF MAINLINE LOCOMOTIVES, BY TYPE
(*Units*)

YEAR	DIESEL SECTIONS	ELECTRIC
1959	1,002	435
1960	1,303	396
1961	1,455	557
1962	1,483	617
1963	1,519	643
1964	1,484	638
1965	1,485	641
1966	1,529	600

use of diesel and electric locomotives. The U.S.S.R. plans to use electric locomotives in preference to diesels on lines with heavy freight density and steep grades, as well as on sections with commuter traffic. The large volume of investment in permanent installations required by electrification, however, is not justified on lines with light traffic, and the pace of electrification is slowing somewhat. The rate at which the U.S.S.R. is switching from steam to diesel and electric traction is shown by the following tabulation:

TYPE OF LOCOMOTIVE	PERCENT OF FREIGHT TRAFFIC HANDLED	
	1960	1966
Steam	*56.8*	*11.2*
Diesel	*21.4*	*46.8*
Electric	*21.8*	*42.0*

(a) DIESEL — The TE-3 diesel-electric freight locomotive is the predominant source of Soviet railroad motive power. The TE-3 sections, each of 2,000 h.p., generally are coupled in pairs with multiple unit control. A variant of the TE-3—the TE-7—is used for passenger trains. Industry officials, however, want to phase out production of both the TE-3 and the TE-7 as soon as possible and replace them with more powerful units capable of higher speeds. Such a locomotive is the 2TE-10L, a 2-section locomotive of 6,000 hp., which has been in series production since 1965. Other mainline diesel locomotives produced in 1966 were the TEP-10L, the TEP-10, the TEP-60, and the M-62. The latter unit apparently was manufactured solely for export to the east European Communist countries. FIGURE 16 shows typical models of locomotives—diesel and electric—built in the U.S.S.R. FIGURE 72 shows the characteristics of the major locomotives.

Current emphasis in the production of diesel-electric locomotives is directed toward the building of a 3,000-hp. freight unit, the TE-40. This locomotive uses a 4-cycle, 16-cylinder engine, the D-70. Progress has been slow, however, and it is unlikely that production of the TE-3 will be stopped completely before the TE-40 or a comparable unit is brought into series production. The 2 TE-10L probably also will be replaced by the TE-40.

FIGURE 16. MODELS OF MAINLINE LOCOMOTIVES. (*top*) Diesel-electric locomotive, TE-3. (*bottom*) Electric locomotive, VL-60.

Recently the U.S.S.R. started small-scale production of diesel-powered locomotives with hydraulic transmissions. About 150 of these locomotives are now in service, and more are being built. Soviet planners presently favor the extensive use of the diesel-hydraulic locomotive because of the lighter weight of the hydraulic transmission compared with the electrical transmission system, and because of the saving of copper that results from eliminating the generator and traction motors. Transportation officials, on the other hand, prefer the diesel-electric locomotives because they are more reliable in service. Experimental gas turbine locomotives also have been built and tested in regular service, but their production in the near future is unlikely.

(b) ELECTRIC — The VL-8 is the principal direct current locomotive in the U.S.S.R., and the VL-60 is the principal alternating current locomotive. As is the case with diesel locomotives, electric locomotives presently in extensive use fail to satisfy fully the Soviet requirements for motive power. Thus, more powerful units are being phased into production. The VL-10, a more powerful version of the VL-8, was reported to be in serial production in early 1967, and production of the VL-80, the most powerful electric locomotive, probably has grown significantly in recent years. In fact, the aggregative electric tractive power produced in 1966 increased in the face of a decline in the number of locomotives produced. More efficient alternating current locomotives, the VL-60K and the VL-80K, both of which are produced with

Approved For Release 2008/09/08 : CIA-RDP08S01350R000100030002-2

Approved For Release 2008/09/08 : CIA-RDP08S01350R000100030002-2

FIGURE 17. PRODUCTION OF FREIGHT AND PASSENGER CARS
(*Units*)

YEAR	FREIGHT	PASSENGER
1959	38,600	1,790
1960	36,400	1,656
1961	35,000	1,748
1962	35,700	1,727
1963	37,200	1,986
1964	39,500	2,018
1965	39,600	1,991

silicon rectifiers, have also been brought into serial production.

(2) *Freight cars* — Following World War II, the rebuilding of the inventory of Soviet freight cars received high priority. The main plants for the production of freight cars were restored, and in 1950 the industry reached a peak output of 50,000 cars. Except for a decline during the Korean war, production continued through 1965 at a rate of about 35,000 to 40,000 cars a year (FIGURE 17). The present inventory of freight cars in the U.S.S.R. is slightly more than one million. Production of mainline freight cars is extensive. There are 12 railway institutes concerned with the design of rolling stock and track structures. These institutes work with designers and engineers of the producing plants in the development and adaptation of new equipment. For especially important projects, the Institute of Complex Transport Problems works with the All-Union Scientific Research Institute of Railroad Transport to establish the desired technical characteristics of the new equipment. A plant is then designated to draw up detailed plans and specifications and, after these are accepted, a prototype is produced. Finally, after a period of testing is successfully completed, the new model is placed in series or individual production.

c. FOREIGN TRADE

(1) *Imports* — To supplement its domestic production, the U.S.S.R. has imported locomotives and railroad cars from the eastern European Communist countries regularly since 1946. Large numbers of switching and industrial locomotives have been imported, and imports of high-speed electric locomotives for passenger trains have been increasing. About 800 such units were purchased from Czechoslovakia in the period 1958-65, and some 1,000 additional locomotives are to be received in 1966-70. Imports of railroad passenger cars, mainly from East Germany, Hungary, and Poland, rose to a high of 1,545 units in 1964, then fell to 1,084 in 1965, reflecting the growth in domestic production. Freight car imports remained relatively steady through 1964 and 1965. FIGURE 18 shows Soviet imports and exports of railroad equipment.

(2) *Exports* — Because of domestic requirements, Soviet exports of new rolling stock have been small, with scarcely any exports of freight or passenger cars being reported. In the period 1959-65, 1,850 mainline locomotives were exported, of which 92% were surplus steam locomotives. In 1965, no steam or electric locomotives were exported, but 88 diesel-electric locomotives were exported, chiefly to Cuba and Hungary. Hungary was the main recipient, having purchased 52 M-62 units.

8. Metallurgical equipment

a. GENERAL — The metallurgical equipment* industry of the U.S.S.R. increased its output by 38% during the Seven Year Plan (1959-65), and reached a level of 252,200 tons in 1966. Even so the industry has not been able to meet the full requirements of the Soviet iron and steel industry; it has been particularly deficient in producing equipment embodying the latest technological developments in use in the West. Production perennially falls short of assigned goals, and the level of equipment technology in most sectors of the iron and steel industry lags behind that of Western producers. The role assumed by the U.S.S.R. as a major supplier of metallurgical equipment to other Communist countries and to the developing countries has further hampered its ability to satisfy the

* Including rolling mills; mechanical equipment for coke ovens, blast furnaces, open hearth furnaces, oxygen converters, and electric furnaces; mixers; and some types of materials-handling equipment such as charging machines. The category excludes blowers, compressors, power equipment, specialized electrical machinery, equipment for oxygen generating plants, and agglomerating and ore concentrating equipment.

FIGURE 18. EXPORTS AND IMPORTS OF RAILROAD EQUIPMENT

	1959	1960	1961	1962	1963	1964	1965
Exports:							
Locomotives							
Mainline Steam	950	60	20	75	409	180	......
Mainline Electric	......	......	......	10	19	12	......
Diesel	......	......	......	......	13	13	88
Imports:							
Locomotives							
Diesel	52	122	147	142	186	146	180
Mainline Electric	43	109	102	102	157	166	186
Freight cars	2,225	2,228	2,722	2,998	3,564	3,571	3,129
Passenger cars	1,490	1,471	1,377	1,370	1,501	1,545	1,084

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requirement of its own iron and steel industry. The U.S.S.R. has relied increasingly on imports of metallurgical equipment to offset the heavy export program. Czechoslovakia and East Germany, for example, have provided the U.S.S.R. with increasing amounts of rolling mill equipment, although of less complex types than that now produced in the U.S.S.R. In order to procure the more advanced types of equipment now being used in the iron and steel industries of the West, the U.S.S.R. is stepping up its efforts to buy from Western firms. The most notable acquisition to date has been a complete oxygen converter plant from Austria. The U.S.S.R. continues to demonstrate strong interest in purchasing large continuous cold rolling mills and related finishing equipment, such as heat treatment facilities and continuous galvanizing and tinning lines—the types of equipment in which the U.S.S.R. is most deficient. Soviet efforts to buy such equipment have not yet been successful.

b. Structure of the industry — The Soviet metallurgical equipment industry consists of a diversified group of machine building plants, of which only a few are engaged solely in the production of metallurgical equipment. The major producers of this equipment are heavy machine building plants with casting, forging, metalworking, and materials-handling facilities of adequate size for the manufacture of large and heavy products. Eight of these plants account for much of the production of metallurgical equipment, including virtually all of the production of rolling mill equipment (Figure 73). Dozens of other industrial plants produce various types of metallurgical equipment, including cranes, ladles, charging machines, and other materials-handling equipment, and components for rolling mills, steelmaking furnaces, blast furnaces, and coke batteries.

Most of the plants of the metallurgical equipment industry, including the major producers, are subordinate to the Ministry of Heavy, Power, and Transport Machine Building. The remaining plants of the industry, usually producers of specialized components, are subordinate to other ministries, including those for Medium Machine Building and General Machine Building. All of the metallurgical equipment plants, however, are subject to a considerable degree of centralized control by the State Institute for the Design and Planning of Metallurgical Plants (GIPROMEZ). GIPROMEZ determines the requirements of the Soviet steel industry, and thus establishes the basis for production plans for metallurgical equipment. *Gosplan* and the Ministry of Ferrous Metallurgy issue directives concerning assignments for production of metallurgical equipment.

Research and design activities for the metallurgical equipment industry are carried on by numerous organizations under the coordination of GIPROMEZ and its affiliates at republic and local levels. Three major research and design institutes are located in Moscow: The All-Union Scientific Research and Planning-Design Institute of Metallurgical Machine Building (VNIIETMash), the Central Scientific Research Institute of Technology and Machine Building (TsNIITMash), and the Central Scientific Research Institute of Ferrous Metallurgy (TsNIIChERMET).

c. Production — In 1966, the U.S.S.R. produced 252,000 tons of metallurgical equipment. Rolling mills and related finishing equipment—the major component of the total—accounted for about 50% of the total weight of metallurgical equipment produced in 1961-65.

Aggregate production of metallurgical equipment during the 7-year plan amounted to 1.6 million tons, a level about 6% below the planned output of 1.7 million tons. Production of rolling mill equipment for the plan period totaled 0.8 million tons, far short of the planned level of 1.0 to 1.1 million tons. In 1965, the final year of the plan, Soviet production of rolling mill equipment amounted to 111,200 tons, only about one-half of the goal of 200,000-220,000 tons originally set for that year. Although aggregate production of the other types of metallurgical equipment apparently exceeded the planned tonnage, production of some items, particularly those involving new technology, fell below planned levels. Production during 1961-66 is shown in the following tabulation, in tons:

	Total metallurgical equipment	Of which, rolling mill equipment
1961	213,300	102,100
1962	240,100	121,200
1963	235,600	112,200
1964	240,600	112,200
1965	242,300	111,200
1966	252,200	*n a*

Failure to achieve output goals was caused in part by delay in providing production capacity needed to meet the increasing demands for metallurgical equipment and other types of industrial machinery. Some progress was made in modernizing production facilities, but in general the construction of new facilities was behind schedule throughout the industry during 1959-65.

Other factors contributed to the shortfall in quantity and assortment in planned production of metallurgical equipment. For example, new construction at some of the steel plants often was behind schedule and the placing of orders for equipment failed to coincide with the planning of production schedules. The production of new equipment in some cases could not be undertaken at all because new technological designs were inadequately or incorrectly drawn.

The various difficulties in the design, manufacture, and installation of metallurgical equipment were responsible for the failure of the steel industry to add new productive capacity as planned. Plans for retirement of obsolete and obsolescent equipment were deferred because it was needed to maintain planned levels of output of iron and steel during 1959-65. Equally damaging was the failure of the industry to

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install additional types of rolling and finishing facilities required for the diversification of steel products. Moreover, programs for the adoption of new technology in steelmaking, such as continuous casting and the use of oxygen converters, were only partially implemented.

d. TECHNOLOGY — Soviet capability to produce efficient metallurgical equipment is demonstrated in the advanced design and technology of its new blast furnaces. During 1959-65, the metallurgical equipment industry produced components for blast furnaces with working volumes of 2,000 and 2,300 cubic meters and rated annual capacities of one million tons and more of pig iron. Several furnaces with volumes of 2,700 cubic meters—greater than the largest now in use anywhere else—are scheduled for construction by 1970. The new Soviet blast furnaces will incorporate high top pressure and other advanced technology, and probably will be unsurpassed in design efficiency by furnaces operating anywhere else in the world. In many cases, however, the Soviet blast furnaces have not achieved the production rates expected, even after lengthy periods of operation.

During the 7-year plan, the U.S.S.R. lagged behind Western producers technologically in the manufacture of equipment for steelmaking. Elsewhere in the world modern producers had been switching almost completely from the open-hearth furnace to the oxygen converter, but the U.S.S.R. continued to install equipment for the older method. About two dozen open hearth furnaces (500-ton and 600-ton) were constructed during 1959-65, and in 1962 the U.S.S.R. completed a 900-ton unit with a rated annual capacity of about 700,000 tons of steel, the largest of its kind in the world.

The U.S.S.R. had experimented earlier with the use of small-scale oxygen converters and had undertaken a program to adopt this new process but was unable to solve various technical problems in the design and construction of large-scale converters of 100-ton and 250-ton capacities. These difficulties led to the Soviet decision in December 1962 to purchase a *Linz-Donawitz* (L-D) oxygen converter plant from the Austrians, who developed the process. Installation of this equipment at the Novo Lipetsk Metallurgical Plant was completed in December 1966. The complete plant includes three 100-ton vessels having an aggregate annual capacity of 2 million tons, and an oxygen generating plant. Meanwhile, by the end of the 7-year plan, the U.S.S.R. had managed to install several 100-ton converters produced domestically, but total production of 5 million tons of crude steel by this method in 1965 was only about one-fourth of the planned amount.

The U.S.S.R. also has lagged in its program for construction of large electric furnaces. The largest electric furnaces constructed during the period 1959-66 were 100-ton units, and although the designing of 180-ton and 250-ton furnaces was undertaken as early as 1956, none has yet been produced. In the United States, electric furnaces of 180-ton capacity have been in use for a number of years.

The U.S.S.R. has also lagged in the development of specialized furnaces for vacuum melting of steel, particularly in the manufacture of consumable-electrode, vacuum-arc furnaces. Some progress has been made in the development of electron-beam furnaces, but, for the most part, the U.S.S.R. has relied heavily on East Germany for this advanced technical equipment. The U.S.S.R. is recognized as a world leader, however, in the development of electro-slag remelting, which is an alternative to vacuum melting for the production of high-quality steels. The U.S.S.R. has patterned its rolling mill equipment primarily on designs developed in the United States and other non-Communist countries. Thus, rolling mills built in the U.S.S.R. in recent years generally conform to modern standards for rolling speed, weight of starting material, and the use of continuous lines for rolling and finishing processes. Long leadtimes characterize the Soviet industry, however, and the process of design, construction, and installation of many of the new rolling mills—particularly large, multistand sheet and strip mills—requires up to five and in some cases ten years to complete, as compared to two or three years in the United States. Such delays have resulted in the commissioning of rolling mills that were obsolescent in some respects and required early modernization.

The U.S.S.R. has demonstrated technical ability in the design and construction of large primary rolling mills, particularly blooming and slabbing mills and continuous billet mills. The industry has produced 1,300-mm. blooming mills, reportedly having annual capacities of 6 million tons. The U.S.S.R. also has produced 2,500-mm. and 1,700-mm. continuous wide strip mills, each having a designed annual capacity of 3.5 million tons. The strip mills, however, are not as well equipped as Western-built mills with automatic gage controls and other process control features. Moreover, only three such mills were installed during the 7-year plan, and none since 1960. In the design and manufacture of cold-rolling mills and continuous electrolytic galvanizing and tinning lines, progress has been even slower, as evidenced by the substantial shortfall in planned output for 1965 of various types of flat-rolled steel, including cold-rolled sheet, tin plate, galvanized sheet, and transformer sheet.

With respect to pipe and tube rolling mills, the industry has designed and manufactured a wide range of equipment, enabling the U.S.S.R. to become the world's largest producer of steel pipes and tubes. Difficulties have been encountered, however, in the manufacture of specialty mills and of auxiliary equipment for heat treatment and finishing operations. Reliance is being placed on imports of pipe and tube mill equipment to compensate for such deficiencies.

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The U.S.S.R. has gained recognition as a world leader in the development of continuous casting techniques, but application of the process is lagging far behind plan. At least 15 units were in operation at the end of 1966, generally small-scale units for the casting of billets and blooms. One impressive, large-scale unit for the casting of slabs has been constructed at Novo Lipetsk, but the delay in installing complementary strip rolling equipment is hampering efforts to operate this facility at its designed capacity of over 2 million tons of slabs per annum. In the United States, where acceptance of the new process has been slower, the tonnage of steel handled by continuous casting methods in 1966 is estimated to have been about equal to the 1-2 million tons of output in the U.S.S.R., and a number of new units are to be activated in the near future.

e. FOREIGN TRADE — The U.S.S.R. traditionally has been a net exporter of metallurgical equipment, but in recent years imports have increased steadily and may have exceeded exports in 1964 and 1965. Data on annual exports of metallurgical equipment are incomplete; however, between 1956 and 1965, the U.S.S.R. exported an estimated 559,000 tons of metallurgical equipment, more than 80% of which was in the form of complete plants shipped under technical assistance programs. Of the remainder, more than half consisted of replacement rolls for rolling mills. Imports, consisting principally of rolling mill equipment, were about two-thirds the size of exports for the same period. Soviet trade in metallurgical equipment during 1961-65 is shown in the following tabulation, in tons:

	EXPORTS UNDER TECHNICAL ASSISTANCE PROGRAMS*	OTHER EXPORTS	TOTAL EXPORTS	IMPORTS
1961	46,400	9,573	55,973	26,700
1962	46,400	11,341	57,741	35,325
1963	46,400	12,164	58,564	49,000
1964	46,400	14,319	60,719	62,902
1965	46,400	10,678	57,078	61,622

* Average annual shipments.

Most of the metallurgical equipment exported by the U.S.S.R. is shipped to Communist countries (FIGURE 74). Steel plants which have been equipped wholly or in part by the U.S.S.R. include the Hunedoara Metallurgical Combine in Rumania; the Lenin Metallurgical Plant in Nowa Huta, Poland; the Danube Metallurgical Combine in Dunaujvaros, Hungary; the Lenin Metallurgical Plant in Dimitrovo, Bulgaria; steel plants in Anshan, Wuhan, and Paotow in Communist China; and the Songjin, Hwanghae, and Kangson plants in North Korea. Since 1963, the U.S.S.R. has supplied equipment for new plants under construction at Galati in Rumania, at Kremikovtsi in Bulgaria, and at Kosice in Czechoslovakia. In addition, equipment has been shipped to Yugoslavia for the expansion of the Zelezara Metallurgical Combine in Zenica. The U.S.S.R. also has assisted Cuba in the expansion of its largest steel mill, scheduled for completion in 1968.

Significant quantities of metallurgical equipment have been exported to the less developed countries. An important recipient is the Bhilai Steel Plant in India, which by the end of 1961 had an annual ingot capacity of 2.5 million tons, achieved entirely with Soviet equipment and technical assistance. The U.S.S.R. also has supplied several large rolling mills for the Helwan Steel Plant in the U.A.R., and has equipped a small rolling mill and wire products plant in Ceylon. Work on a Soviet project to construct a steel plant in Indonesia was interrupted in 1966, and apparently postponed indefinitely because of economic difficulties in that country. Finland has been another recipient of Soviet equipment, including components for a blast furnace and a small oxygen converter shop.

Among steel mills in the less developed countries currently receiving Soviet equipment and technical assistance, the most important is the Bokaro Steel Plant in India, which is to have an initial ingot capacity of 1.7 million tons. This plant requires equipment of advanced types not fully mastered by the U.S.S.R., including oxygen converters for steelmaking and continuous cold rolling mills and related finishing equipment for the flat rolled steel products. Other steel plants are to be built with Soviet assistance in Algeria and Iran, and at Madras in India.

Soviet imports of metallurgical equipment (FIGURE 75) have been obtained primarily from Communist countries, mainly Czechoslovakia and East Germany. Czechoslovakia has supplied blooming mills, billet mills, and auxiliary equipment for rolling mills; East Germany has supplied bar and merchant mills, wire-drawing equipment, and a wide variety of auxiliary equipment for rolling mills, such as shears, levelers, roller tables, gears, and spindles. East Germany has supplied a number of electron beam furnaces for the vacuum melting of high-quality steel and other metals. Since 1963, the U.S.S.R. has imported from Hungary equipment for the modernization and enlargement of pipe mills and from Poland small quantities of rolling mill equipment.

Only one major equipment order has been placed with a Western country—the complete L-D oxygen converter plant with Austria discussed above—but the U.S.S.R. has been seeking for at least 7 years to obtain additional equipment from other suppliers in the West. Particular interest has been shown in continuous cold-rolling mills, silicon steel electrical sheet processing lines, continuous electrolytic tinning and galvanizing lines, and heat-treatment facilities. Acquisition of these types of equipment would enable the U.S.S.R. to expand output of steel products in short supply, such as cold-rolled sheet, high-quality transformer sheet, tinplate, and galvanized sheet. The U.S.S.R. also would benefit from the technical study of imported equipment, enabling it to improve its own

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capabilities for the manufacture of metallurgical equipment.

9. Construction equipment*

a. Introduction — The U.S.S.R. produces a large assortment of construction equipment and ranks second only to the United States in volume of output, yet the needs of the Soviet construction industry in terms of quantity, quality and assortment are not met. Increases in production of construction equipment, especially earthmoving equipment, are not sufficient to keep pace with the growth of construction activity. Much of the equipment is underpowered and is susceptible to frequent failure in service.

b. Production

(1) *Volume* — During the recently completed 7-year plan (1959-65), the construction equipment industry made substantial gains in the annual output of the principal types of equipment. The value of aggregate output increased by about 85% during the period. Nevertheless, it is believed that the industry failed to achieve in 1965 the production rates which were initially scheduled in the draft plan. The output of selected, important types of construction equipment is shown in Figure 76. These data indicate that during the 7-year period, the average annual rate of growth in production of excavators was about 11%, bulldozers about 9%, motor graders 7%, scrapers 15% and cranes about 4%.

In 1966 the output of construction equipment increased by 11.6%, compared with the planned increase for that year of 9.5%. An increase of 9.4% is planned for 1967. Although the production plan for 1966 was overfulfilled in aggregate terms, the product mix continued to be unsatisfactory. Among deficiencies of particular concern to the Ministry of Construction, Road, and Communal Machine Building is the relatively small output of very heavy self-propelled cranes able to assemble apartment houses from individual rooms prefabricated of concrete and masonry. The continuing absense of scrapers of 25 cubic meter capacity and tractors of 300 hp. and more to draw them, as well as such powerful tractors to mount bulldozers and scarifiers, is holding back desired increases in labor productivity in construction. A further limitation is the continuing inability of the U.S.S.R. to develop and bring into series production a family of large high-powered wheel-type tractors for mounting bulldozers, loaders, and the like.

(2) *Quality* — The Soviet construction equipment industry recognizes that in respect to productivity, reliability, and service-life, its products are inferior to the best foreign models. Soviet equipment tends to have lower power-weight ratios than foreign equipment because the assortment of available engines is limited and contains few large engines. Moreover, the limited selection of ferrous metals available to Soviet machine builders requires the use of heavier sections of lower tensile strength steels than would be used in machines produced in the Industrial West. The unreliability and relatively poor quality of Soviet construction equipment stems in large part from poor manufacturing practices—e.g., failure to surface-harden wearing parts, to provide adequate grease seals, to avoid stress concentrations in structural members, etc. These problems are exacerbated by the difficult operating conditions to which Soviet equipment is subjected. Preventive maintenance schedules are not adhered to, and operators disregard their instructions. The extreme cold of the Arctic and the extremely dusty conditions of the desert regions are both hard on engines, compressors, and other mechanisms incorporating gears and bearings.

(3) *Product assortment* — The assortment of earthmoving equipment produced in the U.S.S.R. is overweight in excavators and deficient in high-speed wheel-type scrapers. As a consequence, labor productivity in the construction industry is low. Moreover, most of the excavators are small to be compatible with the small dump trucks (3.7-ton average size) available. The U.S.S.R. has not yet organized large-scale production of the large diesel engines, power-shift transmissions, electric wheel drives, large wheel and tire assemblies, and hydraulic control equipment necessary for a family of high-speed earthmoving machines, although development of such machinery has been in process for years.

The Soviet assortment of tower cranes and high-lift mobile cranes is quite large. The current trend toward prefabrication of larger sections of buildings made of concrete (e.g., the prefabrication of whole rooms and apartments) requires the production of many heavy-lift cranes, presently produced in small numbers.

Although the U.S.S.R. has traditionally favored the production of tractors of the tracklaying types, these have been developed primarily for agricultural use. Their deployment in construction work has been limited by their small size. Only in the last few years has the U.S.S.R. produced tracklaying tractors with more than 100 hp. and these (140, 180, and 250 hp.) are in limited production. The most powerful wheel-type tractor currently adaptable to construction work is the K-700, the 220 hp. four-wheel drive tractor recently put into series production at the "Kirov" plant in Leningrad. This tractor was designed for use in agriculture, and although variants for use in construction are being developed they are not yet available to industry.

* The construction equipment industry, commonly referred to in the U.S.S.R. as the construction and road machine building industry, manufactures multibucket and single bucket excavators, graders, scrapers, bulldozers, cranes, loaders, concrete and asphalt mixing and paving equipment, road rollers, other equipment, and spare parts for construction equipment. It is also responsible for the production of construction materials equipment.

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c. TRADE—The U.S.S.R. is a net exporter of earth-moving equipment, excavators and construction cranes, but it is a net importer of machinery for manufacturing building materials. The value of Soviet trade in two principal categories of construction equipment for selected years during 1957-65 is shown in FIGURE 77. The foreign customers for Soviet construction equipment are the other Communist countries and some of the less developed countries. The industrialized countries of the West do not buy Soviet construction equipment. The U.S.S.R. imports construction equipment and machinery for manufacturing building materials principally from East Germany, Hungary, Poland and Czechoslovakia. Small amounts have also been obtained from Austria, West Germany, Canada, and Sweden. In 1965, the U.S.S.R. received about three-fourths of its imports of construction equipment and about two-thirds of its imports of equipment for manufacturing building materials from East Germany.

10. Electronic computers

a. GENERAL — The computer industry has rapidly become one of the most significant industries in the U.S.S.R. The computer has become a dynamic force in almost every aspect of human endeavor in industrialized countries within the last 10 years, and Soviet computer developments have immediate significance for almost every aspect of Soviet life, particularly in such critical areas as space exploration, antiballistic missile systems, and economic management. Although Soviet officials are convinced of the value of computers, they have yet to commit the resources required for a major entry into the computer age. The exact status of the Soviet computer industry is unclear, but, in many respects it is probably at the level of computer development of the United States in the late 1950's. Much information about Soviet computers is closely guarded because of strategic implications. Almost nothing is known about their special-purpose, military computers (not further considered in this subsection).

b. PRODUCTION — The production of digital computers in the U.S.S.R., established on a commercial scale in 1956, has grown rapidly but is neither adequate for internal demand nor impressive by U.S. standards. By the end of 1966, the U.S.S.R. had produced an estimated 3,500 or more digital computers. In 1966 alone, value of production of computer and data processing equipment came to more than $250 million. Production has been increasing by almost 30% annually in recent years, and present plans call for continued large increases in output, although no quantitative goals have been announced. Soviet production of computers for nonmilitary purposes is far short of demand at present, and is not likely to satisfy requirements in the foreseeable future. The United States, in sharp contrast, had produced more than 35,000 digital computers by the end of 1966, and in 1966 alone produced more than $2.5 billion worth of computer and data processing equipment.

c. PRODUCTION FACILITIES — Facilities for the production of computers have been expanded rapidly in recent years, both by the expansion of existing plants and the building of new ones. More than 30 producing plants were known to be associated with the production of computers in 1966, most of which had not been producing computers 10 years earlier. Major producers include the Moscow and Penza Computer and Analytical Machine (SAM) plants, the Minsk Computer Plant, the Yerevan Computer Plant, and the Sigma Complex (a group of small plants in Lithuania). The labor force at each of these facilities ranges between 2,000 and 8,000 employees. Other major plants are located in Kazan, Kiev, Leningrad, Severodonetsk, and Ulyanovsk. Many specialized one-of-a-kind computers have been built by the research departments of institutes and industrial organizations for specific applications. A number of facilities associated with computer production probably have yet to be identified.

d. TYPES OF COMPUTERS — Although most Soviet computers now being produced are better designed for computational work than for the processing of large volumes of data, the newly emerging models incorporate features that enhance their ability to handle data. In operating characteristics the equipment is roughly similar to that available in the United States during the late 1950's and the early 1960's, except that Soviet equipment is somewhat less capable of handling large quantities of data. The most powerful Soviet computers known are the M-220, the Ural-16, and the BESM-6, the latter two being somewhat similar to the IBM 7030 Stretch and the U.K.'s Atlas. The most common general purpose computers are the medium-sized Minsk machines (analogous to the IBM 1400 series), and the smaller models of the Ural line. FIGURE 19 shows typical models of Soviet digital computers.

Process control computers include the large KVM-1, the medium-sized Dnepr and VNIIEM series, and the small UM-1 and UM-1 NKH models. Scientific and engineering computers include the medium-sized Razdan series and two small models, the Promin and Nairi. Analog computer types are numerous, particularly the MN series. Many one-of-a-kind computers are built for scientific work, process control, or plant automation. Large systems of computers occasionally are built on an experimental basis by linking together a few smaller, serially produced machines. A great many small, punched-card, unit record-type systems, such as the EV-80, have been built. Much peripheral equipment of slow speed and limited capability also is produced, but magnetic disk memories and mass storage devices are not yet in series production. Because they lack good quality peripheral equipment such as printers, card readers, card punches, tape and tape-handling equipment, disc memories, and mass-storage devices, Soviet computers can neither process large amounts of data economically nor retrieve them quickly.

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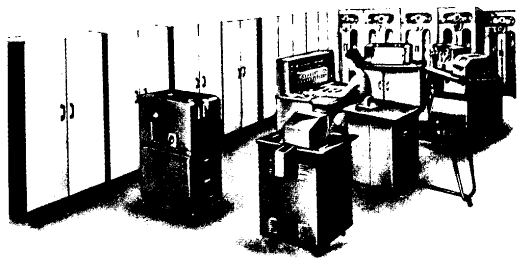

FIGURE 19. MODELS OF SOVIET COMPUTERS. (*left*) BESM-6 digital computer. (*above*) Minsk-22 digital computer.

e. TECHNOLOGY — The U.S.S.R. lags behind the West by 1 to 5 years in computer technology. However, in computer theory and logic design, the U.S.S.R. is almost on a par with the United States. Currently produced Soviet computers are transistorized, but they were made with vacuum tubes as recently as 1963. The more-advanced integrated circuit components used in the West are not used in any of the known Soviet models. Computers are produced by the combined efforts of a number of design institutes and producing plants, sometimes without effective coordination or standardization of parts and components, so that production processes are inefficient and workmanship often poor.

Programing techniques are in the early stages of development. Until recently, most programing was done in very low level languages because older Soviet machines could neither recognize alphanumeric notation, nor store a large amount of data internally. Standardized utility programs and shared applications programs usable on more than one type of computer are not yet generally available. However, Algol, Fortran, and other more-advanced programing languages have recently been introduced, and the sharing of programs among users has started.

f. ADMINISTRATION — Administration of the Soviet computer industry has been dispersed among the many organizations involved in the design and production of computers, but is finally becoming centralized. The industry at present is controlled by the Ministry of the Radio Industry, by the Ministry of Instrument Building, Means of Automation, and Control Systems, and by several coordinating committees at the national level, whereas before the reorganization of 1965, operational control of the industry was divided among several regional economic councils (*sovnarkhozy*). The design bureaus connected with computer factories, research institutes, or other industry organizations, design and construct prototypes which are submitted to an All-Union acceptance committee composed of the end-users and representatives of the producing plants. The Ministry of the Radio Industry or the Ministry of Instrument Building, Means of Automation, and Control Systems (if the computer is a process control type) selects a plant under its jurisdiction to produce the computer in series, and controls its production until phaseout. Computers are sold outright to the organizations that use them, and the manufacturer assumes no responsibility for them after installation. In the United States, the computer usually is leased from the manufacturer, who is responsible for maintenance of the computer until it is retired. The Ministries recently have issued directives to extend the responsibility of the manufacturer, but implementation of these directives may take several years.

g. APPLICATION — Of the 3,500 digital computers believed to have been produced in the U.S.S.R. by the end of 1966, the existence of only about 500 individual computers has been definitely established. Certain applications in military and aerospace programs, about which the U.S.S.R. witholds information, probably account for much of the total. Typical applications are traffic control for railroads and steamship lines, planning and control of large construction projects (using the U.S.-developed PERT system), and production planning, process control, and business data handling within industrial enterprises. The newest and most powerful models are usually assigned to research institutes.

The most ambitious application of computers presently envisioned by the Soviet Government is a nationwide network of computer centers which will process all economic data, consolidate it at various administrative levels, and array it for use at the national level in making rational economic plans. The completion of this network will require many years, not only because of the time it will take to produce the large number of computers required but also because of the requirement for a large amount of communications equipment to link computer centers.

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h. APPLICATION LIMITATIONS — The use of computers in the U.S.S.R. is not nearly as extensive as in the United States, and some computers that are misapplied stand idle. Relatively few computers have been allocated for the needs of commerce, banking, or enterprise management. Where computers are in use in the U.S.S.R., applications often are elementary, none being as advanced, for example, as the process control systems employed by U.S. oil refineries or as the management information systems employed by U.S. automobile companies. Efficiency in the use of computers in the U.S.S.R. is limited by the fact that producers offer only computer hardware, leaving the end-user to provide his own maintenance and programing support.

i. TRADE — Soviet trade in computers is relatively limited, but both imports from the West and intra-Soviet bloc trade are increasing. Imports from the non-Communist countries are significant in spite of trade controls on advanced computers capable of military or other strategic applications. In 1966, the U.S.S.R. imported data processing equipment valued at $4,000,000 from the non-Communist countries, principally from the United Kingdom, France, Italy, West Germany, Japan, and the United States. The U.S.S.R. is also interested in importing peripheral equipment, advanced computers, certain components, and production technology from the Industrial West. Exports to other Communist countries also are increasing despite the inability of the Soviet computer industry to satisfy domestic needs.

C. Vehicles

1. Introduction

The U.S.S.R. ranks seventh in world production of motor vehicles, with an output in 1965 of 616,300 units, about 62% of which were trucks. However, the current Five Year Plan (1966-70) calls for a dramatic increase in passenger car output. The products of the Soviet motor vehicle industry include passenger cars, trucks, truck-tractors, trailers, buses, motorcycles, motor scooters, specialized vehicles, and a wide range of military vehicles. Employment in the industry during 1962 is estimated to have been about 220,000 workers. There is little reason to believe that employment increased much between 1962 and 1965, but a considerable augmentation of the labor force is expected during 1966-70.

To raise output of motor vehicles in accordance with the current 5-year plan, one new truck plant was being constructed at Frunze and one at Yerevan, both to be in production by the end of 1967. A third is to be built at Chita. Production of the Moskvich passenger car at the MZMA plant in Moscow is to be greatly expanded, and an additional Moskvich plant of equal capacity is to be constructed in the Moscow area. A passenger car plant has been under construction at Izhevsk, at which the assembly of Moskviches began in December 1966. Another new passenger car plant is to be built at Tol'yatti* (formerly Stavropol near Kuybyshev) with the assistance of FIAT of Italy. The Tol'yatti plant, valued at about $800 million, is to have a capacity of 2,000 vehicles per day. Moreover, a number of factories which formerly produced other types of machinery have been converted to production of motor vehicles. Included in the plans for modernizing the industry is a program to increase standardization and unification of parts and products and to provide for greater specialization of production among the various plants. Substantial increases in labor productivity are expected to result from this program.

Although production of motor vehicles is increasing and their quality improving, the needs of the civilian economy are not completely satisfied. The existing assortment of types of vehicles provides insufficient numbers of light and heavy trucks. Moreover, the serious and persistent shortages of spare parts keeps many vehicles out of service. Peacetime military requirements for motor vehicles probably are being satisfied.

2. Civilian vehicles

a. ECONOMICS OF THE INDUSTRY

(1) *Production* — Since 1961, production of motor vehicles (excluding special-purpose military vehicles) has increased at an average annual rate of about 3.5%. According to the 1966-70 plan, production in 1970 is supposed to total 1,360,000-1,510,000 motor vehicles, of which 600,000-650,000 are to be trucks, 700,000-800,000 are to be passenger cars, and 60,000 are to be buses. It is doubtful that these plans will be fulfilled by 1970. Soviet production of motor vehicles since 1960 has been as follows (in units rounded to the nearest hundred):

YEAR	TRUCKS	PASSENGER CARS	BUSES	TOTAL
1960	362,000	138,800	22,800	523,600
1961	381,600	148,900	24,800	555,300
1962	382,400	165,800	29,200	577,400
1963	382,200	173,100	31,700	587,000
1964	385,000	185,200	32,900	603,100
1965	379,600	201,200	35,500	616,300
1966 (Prelim.)	406,500	230,000	38,500	675,000

The product mix of the Soviet motor vehicle industry includes relatively small shares of very heavy or very light trucks. Some adjustment in the asortment has been achieved since 1959 (as shown below). Nevertheless, although the number of very light trucks produced annually will be increased, the production of heavy trucks will be favored even more, and the production of medium-heavy trucks (5-ton class) will be greatly favored. These trends are reflected in the plan to increase the average carrying capacity per

* Named for Palmiro Togliati, Secretary General of the Communist Party of Italy, who died in the U.S.S.R. in 1965.

Approved For Release 2008/09/08 : CIA-RDP08S01350R000100030002-2

Approved For Release 2008/09/08 : CIA-RDP08S01350R000100030002-2

vehicle from 3.7 tons in 1965 to 4.9 tons in 1970. The following tabulation shows the assortment of civilian motor vehicles in 1965 compared with that of 1959, in percent of total:

	1959	1965
Up to 2 tons	*1.0*	*6.8*
From 2 to 5 tons	*92.0*	*78.1*
Over 5 tons	*5.2*	*9.5*
Heavy dump trucks	*0.1*	*0.4*
Truck tractors	*1.7*	*5.2*
Total	*100.0*	*100.0*

The program for eliminating presently obsolete models of motor vehicles from production should be completed by 1970. The newly designed models now in production and those scheduled for 1967-70 are similar to U.S. vehicles in their power-to-weight ratios. Recent models of civilian motor vehicles built in the U.S.S.R. are shown in FIGURE 20.

In addition, the U.S.S.R. has developed and placed in limited serial production 8 x 8 cross-country vehicles at the motor vehicle plants at Minsk and Moscow. These vehicles have been seen transporting missiles in the annual May Day parade in Moscow.

Motor vehicle production in 1966 included 753,000 motorcycles and motor scooters, and a small number of motor bicycles. Nonwheeled vehicles produced in small numbers include power sleds and special-purpose tracked vehicles for use on adverse terrain and snow.

(2) *Raw materials* — The U.S.S.R. enjoys a high degree of self-sufficiency in the supply of raw materials for its motor vehicle industry, natural rubber being the only major item which must be imported; however, the Soviet synthetic rubber industry is capable of satisfying automotive requirements for rubber. The projected rapid increase in passenger car production will require the enlargement of the capacity of the Soviet facilities for cold-rolling steel strip and sheet. Raw materials are usually allocated to the industry in sufficient amounts, but poor distribution has sometimes resulted in temporary shortages and in reduced production.

(3) *Components and subassemblies* — The production of vehicle components, subassemblies, and accessories is divided among the primary automotive producers and supporting plants. The Gor'kiy Motor Vehicle Plant and the Motor Vehicle Plant *imeni* Likhachev in Moscow account for a large percentage of the total. In general, the primary producers make their own major subassemblies—i.e., differentials, steering gears, engines, and transmissions. In addition, the primary producers also make a few parts and components, such as pistons, fuel pumps, and oil filters. Other parts and components, however, such as bearings, carburators, electrical systems, shock absorbers and tires, are supplied by specialized plants.

Lagging production of parts and components continues to be a chronic problem for the industry. Deficiencies in the supply of parts and components have occasionally delayed the production of new vehicles and continually idle a large part of the vehicle park. During the 7-year plan (1959-65), much emphasis was given to the need to expand the spare parts industry, but with unsatisfactory results because of poor planning and shortages of plant equipment and raw materials. Morever, the low prices established for spare parts deter the primary plants from producing more than needed for vehicle production. The spare parts problem has been greatly aggravated by the appearance of new models. The present 5-year plan calls for a renewed effort to improve production and supply of parts for vehicles by building new plants and converting others to specialized production.

(4) *Mechanization and automation* — The Soviet automotive industry has attained a high degree of mechanization. Automation is less-advanced, but some automatic transfer machine tool lines are in operation, principally for the manufacture of engine blocks and pistons. It is planned eventually to achieve automatic production of all engine blocks, heads, and gear cases, and probably pistons. In addition, partial automation is being applied to the production of other components—crankshafts, connecting rods, rear axle housings, and springs.

Many of the machine tools in service are worn or obsolescent. This situation sometimes necessitates the excessive use of manual operations to complete the work. A large number of the machine tools in the motor vehicle industry are used for the manufacture of tools, dies, and instruments which could be manufactured more economically in specialized plants. The Soviet machine tool industry is not yet capable of supplying sufficient specialized equipment to the motor vehicle industry, except at the expense of sectors of the economy which have a higher priority.

(5) *Supply and use* — By January 1967, the U.S.S.R. had an estimated total inventory of 5,050,000 motor vehicles, comprising 3,753,000 trucks and jeeps, 1,096,400 passenger cars, and 200,600 buses. The total includes some 400,000 to 500,000 trucks of all types which are in military service. The great majority of trucks are designed for short-haul operations, with relatively small numbers suitable for long hauls. The structure of the civilian truck park according to cargo capacity in 1962, compared with the Soviet plan for optimum distribution, is as follows (in percent of total):

	ACTUAL	OPTIMUM
Up to 1.5 tons	*8*	*30*
From 2 to 5 tons	*90*	*60*
Over 5 tons	*2*	*10*
Total	*100*	*100*

Over 70% of the trucks in use in 1962 had standard platform bodies, 20% were dump trucks, 9% had panel or tank bodies, and 1% were tractors for semitrailers. The structure of the 1965 vehicle park

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FIGURE 20. RECENT MODELS OF SOVIET MOTOR VEHICLES. (*a*) ZIL-130 truck. (*b*) Moskvitch passenger car. (*c*) Zaporozhets passenger car. (*d*) FIAT 124 passenger car.

is not known, but the distribution by cargo capacity of output of 1959 and 1965 (discussed above under Production) indicates that an effort is being made to bring the vehicle park into balance with the announced optimum. Continued production of trucks with four- and six-wheel drive for increased mobility on unimproved roads can be expected.

Vehicles are distributed as directed by the state. Industry and agriculture are the principal recipients of new vehicles, while the armed forces receive annually up to 75,000 vehicles of various types. The U.S.S.R. exports small numbers of both trucks and passenger cars. About 25% of passenger car production is sold for private use.

The U.S.S.R. makes little use of trucks for intercity transport, relying on the railroads for long-haul common carrier service. The average haul-distance of motor transport has risen slowly from 11.9 km. in 1958 to 13.24 km. in 1965, and 13.3 km. in 1966. Freight carried by motor transport increased from about 6.5 billion tons in 1958 to more than 10.8 billion tons in 1965 and nearly 11.6 billion in 1966.

(6) *Foreign trade* — Soviet exports of trucks are small compared to total production. On the other hand, a large share of the production of passenger cars is exported: for example, 24% in 1965. Values for exports of motor vehicles for 1964 and 1965, by type, are shown in FIGURE 21.

East Germany and Finland were the largest buyers of Soviet passenger cars in 1965. Cuba became a major importer in 1961: in that year, Cuba received about 37% of Soviet truck exports and about 46% of Soviet bus exports. Although its share of total Soviet exports of trucks has since declined, and in 1966 amounted to about 18%, the value of Soviet vehicles and parts imported by Cuba in 1966 was greater than in 1961. Soviet motorcycle exports are received mainly by Bulgaria. Motor vehicle exports by type and destination for the period 1963-65 are shown in FIGURE 78. The U.S.S.R. imports few ve-

FIGURE 21. EXPORTS* OF SOVIET MOTOR VEHICLES AND PARTS, BY TYPE
(*Units, and thousands of foreign exchange rubles*)

	1964		1965	
	Quantity	Value	Quantity	Value
Trucks	21,200	72,524	15,100	52,548
Passenger cars	44,500	46,555	48,600	51,579
Buses	742	2,046	597	2,779
Trailers	5,317	8,067	4,758	6,851
Special motor vehicles**	1,358	9,506	854	6,749
Sets of parts for assembly of complete trucks	......	....	175	122
Sets of parts for assembly of complete passenger cars	1,280	423	2,096	798
Motorcycles	23,500	5,496	20,900	4,897
Spare parts for trucks, passenger cars, and trolley buses	......	77,829	......	72,359
Spare parts for motorcycles	......	1,935	......	1,597
Total	......	224,381	......	200,279

* The data probably understate exports because they are believed to exclude military shipments, economic aid programs, and gifts.

** Mostly tank trucks but some vehicles for snow removal, mobile machine shops, and other purposes.

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Approved For Release 2008/09/08 : CIA-RDP08S01350R000100030002-2

Approved For Release 2008/09/08 : CIA-RDP08S01350R000100030002-2

hicles, mainly special types from Hungary and Czechoslovakia. In 1965, it imported about 1,619 trucks, 1,490 passenger cars, and 602 buses.

b. Principal producers — Details of Soviet motor vehicle manufacturers and assemblers are given in Figure 79. Seven of these plants were converted to the production of motor vehicles during the 7-year plan.

The Gor'kiy Motor Vehicle Plant (GAZ) is the country's largest producer of vehicles. Medium trucks are the most important product. Also built at this plant are two models of passenger car, the Volga and the M-13 Chayka, and several military vehicles. Some of the truck chassis produced there are made into truck-tractors; others are fitted with bus bodies by plants at Kurgan and Pavlovo, with panel truck bodies at the Tartu (Estonian S.S.R.) Repair Plant No. 3, or with dump bodies at the Saransk Truck Plant, southeast of Gor'kiy. The Gor'kiy Plant is highly integrated, manufacturing its own major components and subassemblies, but depends on other plants for specialized parts. It also may still supply some components and subassembies to the Ul'yanovsk Motor Vehicle Plant for the manufacture of light trucks derived from GAZ-type vehicles. The present 5-year plan calls for spending 125 million rubles on further expansion of the Gor'kiy Plant. Production is to be increased 1.5 times by 1970, compared with 1965.

The Motor Vehicle Plant *imeni* Likhachev (ZIL) in Moscow is second to the Gor'kiy Plant in number of vehicles produced but first in terms of total value of output. It builds a few passenger cars but concentrates mainly on production of medium trucks. Chassis are supplied to other plants for completion as buses, fire trucks, truck cranes, special-purpose vans, and other vehicles. Large numbers of chassis are sent to the Mytishchi Machine Building Plant, where dump-truck bodies are mounted.

Buses are assembled at several plants. The Pavlovo Bus Plant *imeni* Zhdanov (PAZ) is closely allied with the Gor'kiy plant, from which it receives chassis for buses, vans, and ambulances. The Kurgan Autobus (KUAZ), similarly allied to the Gor'kiy plant, is scheduled to become the largest bus plant in the U.S.S.R. The Likino Bus Plant (LIAZ), established in 1960 to take over bus production from the Likhachev plant in Moscow, is producing a 60-passenger bus, and was preparing to manufacture a 110-passenger bus in 1967. The L'vov Bus Plant (LAZ) mounts bus bodies on chassis received from the Likhachev plant. During the 1966-70 plan, the bus plants located in L'vov, Likino, and Pavlovo are each to increase bus production to 10,000 to 12,000 annually. The Riga Bus Plant (RAF) in Latvia builds two small buses (10- and 9-passenger) on Volga chassis received from the Gor'kiy plant.

Several plants both inside and outside the motor vehicle industry are engaged in making or modifying bodies, trailers, and vehicles for special industrial or agricultural use. These plants have small capacities, and their operations in this field are intermittent.

In June 1965, according to an official announcement, there were 637 plants throughout the U.S.S.R. producing spare parts for motor vehicles. This number reportedly comprises 118 main plants, 121 specialized plants, and 398 cooperating plants. The following are among the most important manufacturers of motor vehicle components:

Alma Ata:	
Alma Ata Foundry and Engineering Plant.	Piston pins.
Baku Motor Vehicle Parts Plant	Shock absorbers and reduction gears.
Kiev:	
Kiev Parts Plant *imeni* Lepse	Aluminum pistons.
Kirov:	
Kirov Tire Plant (*K'ShZ*)	Tires.
Kuybyshev:	
Katek Plant	Carburetors, voltage regulators, distributors, generators, starters.
Leningrad:	
Leningrad Carburetor Plant (*LKZ*) ...	Carburetors.
Melitopol Engine Plant	Gasoline engines.
Melitopol Motor Vehicle Spare Parts Plant.	
Moscow:	
Automobile and Tractor Electrical Equipment Plant (*ATE*-1).	Automotive electrical systems.
Automobile and Tractor Electrical Equipment Plant (*ATE*-2).	*Do.*
Moscow Carburetor Plant (*MKZ*)	Carburetors, fuel pumps, filters.
Moscow Tire Plant (*MShZ*)	Tires.
Podol'sk Automobile Plant (*PAZ*)	Batteries.
Ul'yanovsk:	
Ul'yanovsk Small Displacement Engine Plant.	Pistons.
Yaroslavl':	
Yaroslavl' Tire Plant (*YaShZ*)	Tires.
Yaroslavl' Diesel Engine Plant	Diesel engines.
Zavolzh'ye:	
Zavolzh'ye Engine Plant	Aluminum engines, clutch housing.

3. Specialized military vehicles

a. Production — The U.S.S.R., with well-developed military vehicle production facilities, is currently producing relatively large quantities of tanks, armored personnel carriers, tracked prime movers, and special-purpose vehicles. Limited quantities of light assault guns are also produced.

The U.S.S.R. has always given considerable attention to military vehicle development, with particular emphasis on armored combat vehicles. Since World War II, the U.S.S.R. has placed high priority on the development and production of personnel carriers, prime movers, and specialized military vehicles. This effort originally was directed toward remedying

Approved For Release 2008/09/08 : CIA-RDP08S01350R000100030002-2

Approved For Release 2008/09/08 : CIA-RDP08S01350R000100030002-2

gaps in the vehicle inventory which had become evident during the war. More recently, the emphasis on military vehicle production has resulted from the recognized need for mobility and the protection of troops in either a nuclear or nonnuclear battle. Soviet military literature refers frequently to the importance of armored vehicles, and of mobile support vehicles and personnel carriers. The U.S.S.R. is producing these vehicles in quantities sufficient for its peacetime army, as well as for export to other Communist and non-Communist countries. Estimates of production of military vehicles are shown in FIGURE 22.

Soviet military vehicles are characterized by simplicity and ruggedness of design, features which contribute to the ease of manufacture, operation, and maintenance. Soviet tanks are well armored and have heavy armament, good cross-country mobility, and extensive operational range.

The Soviet practice of utilizing a few basic chasssis for the production of different types of military vehicles also contributes to efficiency of production and maintenance. Thus, medium and heavy tank chassis are used or have been used as assault gun mounts, mounts for single-round free rocket launchers, and for prime movers. A single type of tracked amphibious chassis is used for the light amphibious tank, the armored personnel carrier, and a single-round free rocket launcher. Some armored cars, personnel carriers, and wheeled amphibious vehicles use the same standard truck chassis.

FIGURE 22. ESTIMATED PRODUCTION OF MILITARY VEHICLES
(*Units*)

ITEM	1964	1965	1966
Tanks:			
T–55 medium	1,500	1,500	1,500
T–62 medium	1,000	1,000	1,000
PT–76 light, amphibious	400	400	400
Self-propelled weapons* ASU–85	95	95	95
Tracked prime movers:			
Light AT–L (modified)	1,000	900	500
Medium AT–S59	1,100	1,200	1,200
Heavy AT–T	400	400	400
Armored AT–P	1,200	1,200	1,200
Specialized military vehicles:			
MAV–46 amphibious jeep	1,000	1,000	1,000
GAZ–47 tracked amphibious troop/cargo carrier	400	400	400
BAV–485, 6 x 6 amphibious truck	700	700	700
K–61 tracked amphibious ferry	1,000	1,000	1,000
BTR–50p tracked amphibious armored personnel carrier and modifications	2,000	2,000	500
BTR–60p, 8 x 8 wheeled amphibious armored personnel carrier and modifications	2,000	2,500	2,500
BRDM amphibious armored scout car and modifications	2,000	2,000	2,000
BRDM launch vehicle for antitank missiles	900	900	900
BRDM with turret	*none*	*none*	550

* Production of self-propelled AA guns is shown in Subsection G.

Discussions in Soviet literature on military organization and tactics suggest that the U.S.S.R. is concentrating on production of medium tanks. The importance of the medium tank is highlighted by its constant modification and improvement. Between 1949 and 1959, the T-54 was modified by the installation of a gyro-stabilized gun with bore evacuator, at least two variants of turrets, and infrared night-viewing and night-fighting devices. By 1959, the T-55 medium tank had been developed; it incorporated all the modifications of the T-54 and had a more powerful engine. Shortly thereafter, the U.S.S.R. began producing the T-62, the chief innovation of which was the introduction of a smooth-bore 115-mm gun. This, it is believed, will be followed by a T-62 modification incorporating a rifled gun to overcome some of the professed disadvantages of the smooth-bore, and subsequently by a missile-firing tank.

Although some heavy tanks were produced in 1962, production is believed to have terminated during the year. Estimates of past production show that the U.S.S.R. has a sufficient number of heavy tanks to provide for current requirements and for reserves. There is no indication of Soviet development of new heavy tanks.

Production of the light amphibious tank is expected to continue for at least two more years (through 1969). This tank may possibly appear in a modified version, mounting a higher caliber gun. The modified version probably will be produced for a short period at a low rate.

Production of older-style tank-like assault guns using medium and heavy tank chassis has ceased. The trend has been toward manufacture of armored air-transportable guns such as the ASU-85 and the previous model, the ASU-57. However, the U.S.S.R. may, in line with its mobility concept, produce a self-propelled artillery piece incorporating the 115-mm gun. Production of self-propelled antiaircraft guns is discussed below under Arms and Ammunition.

In the field of armored cars and personnel carriers, the U.S.S.R. has experimented with both wheeled and tracked models. At first the trend was toward tracked vehicles, but in 1961 and 1962 new wheeled vehicles were produced. These basic armored personnel carriers were further modified by adding overhead cover and, on one model, by mounting a turret armed with a 23-mm gun as primary armament and a 7.62-mm or larger caliber machinegun as secondary armament. The basic armored scout car also has been produced in other variants—first as a launch vehicle for antitank missiles and later mounting a gun turret. If the present trend continues, it is believed that the U.S.S.R. will develop and issue an all-purpose armored infantry combat vehicle which would replace the light amphibious tank and possibly some of the armored personnel carriers.

Approved For Release 2008/09/08 : CIA-RDP08S01350R000100030002-2

Approved For Release 2008/09/08 : CIA-RDP08S01350R000100030002-2

Because the U.S.S.R. had experienced a shortage of prime movers during World War II, the development and production of a family of prime movers became one of the primary objectives in the postwar period. Models now in production include light, medium, and heavy prime movers. A fourth version is an armored light prime mover. In addition to towing artillery, these vehicles are used to mount ditching machines, bulldozer blades, and radar vans, and are also used to tow equipment such as generators. Production of current models is likely to continue for some time, although there probably will be modifications and improvements.

b. PRINCIPAL PRODUCERS — The U.S.S.R., unlike many advanced industrial nations, has no facilities which can be called tank arsenals. Instead, military vehicles are made in plants which produce a variety of other items, such as railroad cars, locomotives, and tractors. The major tank plant and largest producer of medium tanks is the Ural Railroad Car Plant, No. 183 in Nizhniy Tagil. Other medium tank plants are located at Khar'kov and Omsk. Heavy tanks have been built in Chelyabinsk, but production apparently ceased in late 1962. The light amphibious tank is believed to be produced at the Volgograd Tractor Plant. Armored personnel carriers are produced in Leningrad and probably in Kutaisi. Prime movers are made in Gor'kiy, Khar'kov, Kurgan, and Yaroslavl'. Amphibious trucks are produced in various truck plants, principally in Gor'kiy and the Moscow area. FIGURE 80 lists major producers of specialized military vehicles.

The tank and assault gun plants are characterized by a high degree of self-sufficiency. Except for engines, guns, and electrical equipment, most of the major components are produced by the plants themselves. Moreover, supporting factories are generally located in the same economic region as the plants they supply—an important factor in view of the transportation difficulties in the country.

Production methods during World War II were geared to high volume output, and quality was necessarily sacrificed. Peacetime production, however, has been marked by significant improvements in quality. Production techniques such as electroslag welding are being used to reduce the need for large castings. The U.S.S.R. is also making greater use of alloy steels and other quality materials. Workmanship has improved as production processes have become more specialized.

D. Aircraft production

1. General

The aircraft industry of the U.S.S.R. is second in size only to that of the United States. It comprises some 23 airframe plants,* 11 engine plants, a considerably larger number of plants that produce components and accessories, and various research and development facilities. The Soviet aircraft industry is a high-priority industry which claims a large investment in production and research, and the number of engineering and technical personnel employed constitute a significant group in the nation's supply of skilled labor. Employment in the industry is estimated at 0.8 to 1.0 million.

The production capacity of the industry is estimated at about 123 million pounds of airframe weight per year.** This figure represents a theoretical upper limit of production capability which, although unlikely of achievement in practice, is useful for purposes of comparison. Considering estimated airframe weight produced versus estimated theoretical capacity, production was at its peak in the early mid-1950's while the large bomber programs were underway. Production as a percentage of theoretical capacity ranges from 15% in 1946 to 52% in 1955 and about 25% in 1966. This is not a unique situation inasmuch as the aircraft industries in the United States and the United Kingdom are currently well under their theoretical capacity. Moreover, the weight of the average airframe produced by the industry has increased greatly in the last several years. During the next few years average airframe weight is expected to increase still further with such aircraft as the large transports CLASSIC, COCK, and Tu-154, and the FIDDLER jet fighter becoming increasingly important in production.

As a result of its priority status, the industry has no apparent long-range bottlenecks. The facilities which produce airframes, engines, and components are believed to be sufficiently balanced so that engines and components would be available to support a maximum production effort in the airframe plants.

Production increases for the aircraft industry are only a partial indication of the progress made during the past decade. The industry has been able not

* A former aircraft producer, Kuybyshev Airframe Plant 1, is no longer included. It has not produced aircraft since 1959 and is believed to be engaged in the space program.

** Since the number of aircraft which can be produced within a given floorspace varies with the weight of the aircraft, airframe weight is the most significant common denominator of aircraft production and capacity. Airframe weight is defined as the weight of an empty aircraft less the weight of those items (engines, for example) not normally fabricated by the airframe manufacturer. Airframe weight accounts for roughly two-thirds of the weight of an empty aircraft. Capacity in terms of airframe pounds is derived by multiplying estimated floorspace by an estimate of the number of pounds of airframes per square foot which could be produced, assuming maximum effort. Intelligence information on airframe plant floorspace is superior to that of the other factors which may be used to calculate capacity.

Approved For Release 2008/09/08 : CIA-RDP08S01350R000100030002-2

Approved For Release 2008/09/08 : CIA-RDP08S01350R000100030002-2

only to fulfill civilian and military requirements at home, but has been able also to sell military aircraft abroad to both Communist and non-Communist countries. Moreover, the industry is striving for improved quality of the aircraft being produced. For example, the fighters produced now are far superior in performance capability to the FAGOT/FRESCO types produced in the early 1950's.

Airframe plants in the U.S.S.R. are smaller than their counterparts in the United States and have an average of about 2.2 million square feet of floorspace. Unlike plants in the United States, Soviet airframe plants are made up of a large number of separate buildings for forge and foundry shops, assembly, warehouse buildings, and auxiliary structures, all within a fenced area. However, most have high-bay structures for final assembly and usually a test and flyaway airfield.

Production buildup from the time an order is placed until full production is achieved involves primarily the effort devoted to duplicating the development tooling, acquiring materials, scheduling the production of lead items, and the phasing-in of production. The plant director (appointed by MAP—Ministry of Aviation Industry) is administratively responsible for the operation of the plant, but he closely follows official rules of operation established to regulate materials, labor, capital, and management.

Soviet officials use technical standards in production as a basis for determining manufacturing techniques, worker productivity, quality control, standards, and plant layout. Plant programs for standardization in the aviation industry are the responsibility of the Scientific Research Institute of Aviation Technology and Organization for Production (NIAT). In addition, NIAT actually designs advanced equipment used for the manufacture of aircraft at series plants. Thus NIAT is capable of exerting considerable influence on plant directors regarding the adoption of new or improved production technology and equipment.

The Soviets rely on extensive use of financial incentives in the series production plants, as well as in all aspects of research and development, as a means of increasing the productivity (qualitative and quantitative) of the workers. In recent years, particular emphasis has been applied to financial incentives to stimulate the development and adoption of new and improved forms of production technology, i.e., the qualitative aspect.

The Soviet aircraft industry is beginning to introduce some of the more advanced production techniques, such as the use of heavy presses, modern methods of welding, bonding and brazing, precision forging, and advanced extrusion methods including that of low-alloy steel and titanium. Improvements also have been made in metal removal techniques with the use of numerically controlled machine tools and certain nonconventional processes such as ultrasonic machining and electroerosion. The U.S.S.R. is supporting a devolopment program for metallic and nonmetallic materials of higher strength and greater heat resistance.

Until the mid-1950's, the Soviet aircraft industry tended to use simplified designs for ease of production and maintenance. Now the emphasis has shifted to technological advancement, and models of aircraft now in the development stage will require the use of newer technologies when they enter series production. However, it is believed that the simplest construction methods are still being followed wherever possible. In this way, requirements for highly skilled workers and special-purpose machine tools are kept to a minimum. This does not mean that the Soviets will not abandon proven technology for new technology if the advantages in cost and performance are sufficiently great. There is also a tendency to emphasize the importance of standardization of parts in aircraft production.

Even though Soviet production technology is less advanced than that of the United States, the industry has demonstrated the capability to design modern aircraft and to develop advanced weapons systems. Soviet producers of aircraft tend to emphasize functional quality, i.e., only those parts that demand close tolerances and exacting workmanship are given special attention. Parts and components not considered critical to performance generally are below U.S. standards of quality.

Most of the expansion (nearly three-fourths) of the airframe industry has occurred since 1956, and by mid-1966 there had been no indication of slackened effort. In fact, the most rapid rate of increase in floorspace has been evident since 1964. Not all of the increase is related to aircraft production however; some is now being used for missile work. For example, the Ulan Ude Plant 99, Komsomolsk Plant 126, and Arsenyev Plant 116 are believed to be engaged also in aerodynamic missile production in addition to the building of aircraft. Space devoted to missile work is believed to be small, however, compared to that for aircraft production.

Since World War II most of the Soviet airframe and engine plants have had some capacity devoted to the manufacture of consumer goods, production of which helps to provide stability for the labor force of the aircraft industry, an industry noted for wide fluctuations in output.

The U.S.S.R. has achieved a highly developed manufacturing technology capable of supporting the development and production of advanced air-breathing propulsion systems for aerodynamic vehicles. Initiative and native ingenuity, said to have been lacking in the past, are being shown as the Soviets are challenged to acquire optimum engine/airframe combinations. For the next generation of operational aircraft, designed for supersonic cruise or extended Mach 2.5 – 3.0 capabilities, distinct, new engine

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designs will be mandatory. Not only must the engine be carefully sized but its operating characteristics must be closely tailored for the intended mission and airframe configuration. Responding to the challenge, supersonic cruise and V/STOL engines, as well as an SST engine, are currently under development. Efforts also continue in the development and refinement of powerplants for subsonic transports and helicopters. Although the policy of mass production at minimum cost continues to prevail and the rate of engine production in relation to the number installed remains higher than is considered economical, Soviet engine technology can be expected to provide suitable engines for the new generation of aircraft.

2. Administration

The Soviet aircraft industry is controlled by the Ministry of Aviation Industry (MAP), which is administratively and functionally responsible to the Council of Ministers. MAP exercises complete centralized authority over all production facilities, aeronautical research and development units, flight test centers, and certain specialized metallurgical, instrument, and electronic equipment plants. MAP has controlled the aircraft industry since World War II, except for a brief period in 1953 when it was incorporated into the Ministry of Defense Industry, and for a longer period—late 1957 to early 1965—when there was a general decentralization of administration and control. During the latter period, all series production facilities were administered on a territorial basis by local economic councils or *sovnarkhozes*. Responsibility for research and development facilities during this period was assigned to the newly created State Committee of Aviation Technology (GKAT). GKAT, although not administratively in control of series production, was in charge of technical planning, which included the type and degree of product specialization at the series production plants, assignment of production programs to specific plants, planning and approval of factory equipment and expansion programs, providing technical guidance, and setting product design standards. These responsibilities of the regional *sovnarkhozes* and GKAT ended in March 1965 with the reestablishment of MAP.

3. Production

(For assistance in NATO code identification in the following discussion, sketches of some Soviet aircraft—ground attack, reconnaissance, helicopters, and transport/utility types—are given in FIGURE 123.)

Soviet production of aircraft since World War II has been characterized by a decline in numbers and a substantial increase in the airframe weight. Since 1963, production has been below 2,000 aircraft a year; in 1966 estimated production was only half that in 1957. FIGURE 81 shows estimated output of Soviet aircraft by type, and FIGURE 23 shows estimated output by model.

A number of factors have contributed to the downward trend in the number of aircraft produced. The long service life of many of the aircraft produced in earlier years has made fewer replacements necessary. The U.S.S.R. has imported many of the light aircraft it needs from the eastern European Communist countries, and the use of new weapons systems has reduced the need for certain kinds of combat aircraft. The high cost and longer leadtime needed to develop and build modern aircraft result in the production of fewer units, but with improved capabilities and greater efficiency, fewer are needed. FIGURE 82 shows the cumulative totals (estimated) of certain types of aircraft no longer in production. Airframe plants are described in FIGURE 83 and locations are plotted on the map, FIGURE 24. FIGURE 84 gives information on the Soviet aircraft engine plants.

a. BOMBERS — During 1966, Soviet bombers were being produced in these three models: The BEAR (Tu-95), a turboprop heavy bomber; the BLINDER, a jet-medium bomber; and the BREWER (Yak-28), a light bomber. During the 5-year period ending with 1966, production of bombers averaged about 100 units a year, compared with the estimated output of 1,750 bombers in 1946 and over 1,300 in 1952 and in 1953. In 1955, nine plants were engaged in bomber production, whereas in 1966, only three plants produced bombers. The BEAR aircraft now being produced are reconnaissance aircraft rather than bomb-carrying types.

Light bombers have accounted for slightly over two-thirds of all bomber production since 1946. At the end of World War II, the U.S.S.R. was producing five different piston engine bombers in this category: BOB (Il-4), BUCK (Pe-2), ER-2, BEAST (Il-10), and BAT (Tu-2). The BEAGLE (Il-28) jet light bomber which entered production in 1949 provided significant improvements in performance capability and was produced in large numbers. Four aircraft plants produced an estimated total of 5,200 planes of the BEAGLE type, representing nearly one-half of all light bomber production. Production of a second jet light bomber, BOSUN (Tu-14), began in 1950, but only a limited number was produced. Output of the BREWER, successor to the BEAGLE, began in 1960 at Irkutsk Plant 39. More than 300 planes of the BREWER type, including the trainer variant, MAESTRO (U-Yak-28), are believed to have been produced. Models "A", "B", and "C" of the BREWER have been identified.

In the medium bomber category, the Tupolev-designed BULL (Tu-4), which was similar to the U.S. B-29, was produced from 1947 to 1953, with an estimated cumulative output of nearly 1,800 aircraft. Assembly of the Tupolev-designed BADGER (Tu-16), a jet-medium bomber, began in 1953 and ended in

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FIGURE 23. ESTIMATED PRODUCTION OF AIRCRAFT, BY MODEL*

TYPE	CUMULATIVE PRODUCTION THRU 1961	1962	1963	1964	1965	1966	TOTAL
Bombers:							
BEAR	110	12	12	12	12	12	170
BLINDER	25	25	45	40	45	45	225
BREWER**	55	30	35	105	60	40	325
MAIL	....	....	....	....	5	10	15
Fighters:							
FISHPOT	855	240	15	0	0	0	1,100
FITTER	360	160	155	190	145	180	1,200
FISHBED	700	400	480	550	600	600	3,325
FIREBAR	....	....	40	150	160	180	530
FIDDLER	....	....	....	....	10	40	50
Transports:							
COLT	3,075	100	0	0	20	105	3,300
CLEAT	21	6	5	2	1	0	35
COOT	210	85	55	50	45	45	490
CUB	205	135	155	165	150	80	890
COKE	5	10	35	35	60	130	270
COOKPOT	22	25	20	20	30	3	120
CRUSTY	....	....	....	2	1	8	11
CLOD	....	....	....	5	20	75	100
CLASSIC	....	2	1	0	0	6	9
COCK	....	....	....	1	1	2	4
Trainers:							
MAX	8,200	200	0	0	0	0	8,400
MONGOL	....	5	15	40	50	50	160
Reconnaissance:							
MANGROVE	165	50	5	0	0	0	220
MANDRAKE	....	10	20	35	15	0	80
Helicopters:							
HOUND	2,150	325	300	295	225	130	3,425
HARE	1,680	170	0	0	0	0	1,850
HEN	550	120	0	0	0	0	670
HOOK	120	80	80	70	75	70	500
HIP	....	....	....	5	5	30	40
HARKE	....	....	....	1	5	5	10

* To preclude misinterpretation of the degree of accuracy feasible, estimates of selected aircraft and totals are rounded; as a result the totals may not equal the sum of their components.

** Includes the trainer variant—MAESTRO.

1959. A total of about 1,500 was produced. The BADGER program at Kazan Plant 22, Kuybyshev Plant 1, and Voronezh Plant 64 was very successful, and a substantial modification program has been continued. A large number of BADGERS have been equipped with air-to-surface missiles, several reconnaissance variants have been developed, and a few have been modified for use in anti-submarine warfare (ASW).

A follow-on jet medium bomber, the BLINDER, also designed by Tupolev, entered prototype production at Kazan Plant 22 in 1957-58, and was put in operation in 1962. About 225 are believed to have been assembled by the end of 1966. Output of the BLINDER has been smaller than anticipated; the program apparently has run into difficulty. Both the BLINDER "A" (the bomb-carrying version), and BLINDER "B"—which will be equipped with the air-to-surface missile KITCHEN—are believed to be in production. Probably only a relatively small number of the "B" model had been produced as of the end of 1966; by that time, increased effort was being placed on the "B" model.

The U.S.S.R. has produced two heavy bombers: the BISON jet heavy bomber designed by Myasishchev and the BEAR turboprop bomber designed by Tupolev. The roll-out of the prototype of the BISON at Moscow Plant 23 occurred in 1953, and the aircraft was produced until 1961. A prototype of the BOUNDER was observed first at Moscow Plant 23 in August 1958, and was displayed at the Tushino Air Show in 1961. Two prototypes of this aircraft have been produced, but there is no evidence that it is to enter series production.

Series production of the BEAR began at Kuybyshev Plant 18 in 1955, and an estimated total of 170 aircraft, including three prototypes, were produced through 1966. Five BEAR models ("A" through "E") have been identified to date. The "D" and "E"

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FIGURE 24. LOCATION OF AIRFRAME PLANTS, U.S.S.R.

variants are reconnaissance aircraft, first noted in 1965. Information about the production of the BEAR was relatively limited in the mid-1960's, and estimating total production is difficult. Most of the BEARS produced in the past few years have been in the model "D".

b. FIGHTERS — The Soviet aircraft industry has produced an impressive number of jet fighter aircraft since 1948. Peak production occurred during 1951-53, at the time of the Korean war, when more than 4,000 fighter aircraft a year were built; then production declined. In the late 1950's, as production of a new generation of fighters was introduced, output dropped from 1,700 in 1957 to only 400 in 1959. Although production has remained relatively low, it reached 1,000 in 1966. As output varied, the number of airframe plants directly involved in fighter production has changed correspondingly. In 1949, eight airframe plants totaling more than 13.4 million square feet of floorspace (about 40% of the total) were used for series production of fighters. In 1959, only three plants with 6.5 million square feet (15% of the total) were used, and in 1966, five plants were producing jet fighter aircraft in series, utilizing about 14 million square feet of floorspace (about 25% of the total).

Historically, the U.S.S.R. has concentrated on the productio[n] of interceptors FARMER (MiG-19) FISHBED (MiG-21) and FISHPOT (Su-9)—all relatively inexpensive aircraft capable of high acceleration, speed, and altitude. However, these fighters have armament and fire-control systems of limited range compared with the more sophisticated aircraft of the West. Design changes have involved mainly the use of aerodynamic systems with off-the-shelf radar and weapons packaging as opposed to the more revolutionary weapons systems developed by Western industries.

Future fighter designs will incorporate advanced weapons systems. The current FIDDLER program and the postulated future designs involve aircraft with longer ranges, higher speeds, and complementary missile systems. Much greater cost and effort go into research and development and in series production of these types of fighters. Aircraft operating in the high Mach 2.5—Mach 3 range will require advanced technology such as titanium airframe structuring, and aircraft operating in the attack mission will probably employ terrain-avoidance radar and other advancements. Furthermore, production of these more advanced types of aircraft will require a relatively greater amount of floorspace.

Since 1947, when the U.S.S.R. began to convert from fighters powered by piston engines to those powered by jet engines four different Soviet Design

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Bureaus (OKB's) have contributed to the major fighter programs. The Mikoyan OKB, during the 1950-58 period, had a near monopoly in fighter design. Mikoyan's FAGOT (MiG-15), FRESCO (MiG-17), and FARMER (MiG-19) accounted for about 26,500 of the total estimated 28,000 jet fighters produced in this period, the first generation of jet fighters. The only other series of jet fighters at this time were the FLORA (Yak-23) and FLASHLIGHT (Yak-25) designed by the Yakovlev OKB. However, since series production of the new generation fighters began in 1957-59, other designers have also achieved impressive results. A discussion of fighter production by designer follows below.

The FISHBED, the successor to the FAGOT-FRESCO-FARMER series of the Mikoyan OKB, and the most successful design of the new generation types, accounts for one-half, or more than 3,300, of the aircraft produced since the transitional period of 1957-59. The FISHBED is a single-place, single engine, turbojet fighter of the delta-wing type, designed for high-altitude intercept and ground attack. There are two basic versions of the FISHBED: The clear-air-mass interceptor "C" and "E", about 1,000 of which were produced before phaseout in 1964, and the all-weather interceptor "D" and "F" now in production at two airframe plants, the Moscow Airframe Plant 30 and Gor'kiy Airframe Plant 21. Some 2,200 "D" and "F" models have been built since the beginning of series production in 1962 and 1965 respectively. The FISHBED "D" total includes the export version—the MiG-21-FL, a considerable number of which have been exported. A two-seat trainer variant, the MONGOL (MiG-21), has evolved in parallel design to the other variants. MONGOL "A" equates with the FISHBED "D" (and earlier FISHBEDS) and the MONGOL "B" equates with the FISHBED "F". The MONGOL has been produced primarily at Tbilisi Airframe Plant 31, although a few trainers have been produced at Moscow Airframe Plant 30. By mid-1967, an estimated 160 MONGOLS had been produced.

The Sukhoy OKB, with the successful design of the FITTER/FISHPOT, ranks second among the design bureaus and accounts for 2,300 or about 30% of the fighters produced since 1957. The development of the FITTER (Su-7), a swept-wing parallel to the delta-wing FISHPOT, probably began in 1952. Both were designed as single-place interceptors in the Mach-2 range. The FITTER, however, has been recast for use in ground support, with a secondary role in interception. The FITTER entered series production in 1957 at Komsomolsk Airframe Plant 126, where some 1,200 are believed to have been produced through 1966. FITTERS have been exported to the U.A.R., Syria, and Iraq, and may also go to India.

The Yakovlev OKB, third in terms of production since 1957, is now producing the FIREBAR/BREWER. The FIREBAR, a two-place turbojet fighter with twin engines and swept wings, is designed to counter manned bombers at low altitudes. It is the end result of an evolutionary progression from the FLASHLIGHT fighter through the reconnaissance aircraft MANGROVE (Yak-27), and the light tactical bomber, BREWER. The production of FIREBAR, the first Soviet fighter to enter series production in this decade, began at Novosibirsk Airframe Plant 153 in 1963, with an estimated total output of 530 aircraft by the end of 1966. Tupolev, although one of the most important designers in the Soviet Union, only recently entered the fighter field with the FIDDLER. This is a two-place, twin engined turbojet fighter of swept-wing configuration and is the largest fighter the Soviets have produced. It is thought to have been developed as a specialized response to the stand-off manned bomber threat and ranks as an extended range interceptor, capable of loiter missions 500 nautical miles from base. The FIDDLER is believed to have entered series production in 1965 at Voronezh Airframe Plant 64, with an estimated 50 aircraft produced through December 1966.

The U.S.S.R. is known to be developing fighters with improved performance characteristics. The Mikoyan designed aircraft, the E-266, set three world records for speed in March 1965. This aircraft is not known to be in series production, but development may be complete and series production could begin during 1968-69. Other designers probably are also developing new fighters, and it is likely that the U.S.S.R. will continue to stress production of fighter aircraft.

c. TRANSPORTS — Transport aircraft are produced in the U.S.S.R. to fill military and civil requirements at home and also to sell abroad. Because of the increased size and complexity of the more modern transport aircraft, the industry presently produces fewer transports than were produced during the late 1950's, when production of high-performance aircraft began. In 1966 the industry produced about 450 transports, compared with 800 in 1957. Five of the types produced in 1966 were designed for civil use and two were for military use. One of the military types is believed to be phasing out, and two new models are believed to be in or near the stage of prototype production. The industry is also developing a supersonic transport (SST). The COCK (An-22), only recently in series production, presently is the world's largest aircraft. Six airframe plants, representing about 20% of the industry's production capability, are devoted to building transports.

The U.S.S.R. has emphasized production of turboprop rather than jet transports since the start of production of high-performance transports in 1956. Of the total number of transports produced so far, about 2,000 are turboprops and about 350 are jet transports. Production of the turboprop aircraft since the late 1950's has been relatively stable, with a range of output of 200 to 250 aircraft a year. Civil jet

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transports will likely increase in importance by 1970 as newer jets come into production.

Since the mid-1950's, the U.S.S.R. has been expanding and modernizing the air transport system. Before this time, Soviet production of transport aircraft was neglected in favor of military aircraft. Only four plants produced the light transports CAB (Li-2), COACH (Il-12), and CRATE (Il-14), and the small transport COLT (An-2). Despite limited floorspace, considerable numbers of these transports were produced. The development of the new high-performance transports brought into production during 1956-57 five new transports. These are described below.

(1) *The* CAMEL (*Tu-104*) — The first of the new generation transports to enter production was Tupolev's twin-engine medium jet, CAMEL, the only turbo jet among the group. By 1960 about 200 CAMELS had been produced at three plants—Kharkov Plant 135, Omsk Plant 166, and Kazan Plant 22.

(2) *The* CUB (*AN-12*) — Production of the CUB, a large military assault turboprop transport, was begun at Irkutsk Plant 39 in 1957. Later it was produced also at Tashkent Plant 84 and Voronezh Plant 64. By the end of 1966, about 900 CUBS had been produced. Production was phased out at Plant 39 in 1961, at Plant 64 in early 1966, and may be phasing out at Plant 84. CUB is primarily a military aircraft, but about 75 are known to be in service in *Aeroflot*, the civil transport service, and 80 have been exported.

(3) *The* CAT (*AN-10*) — More than 100 CATS, the civil counterpart of the CUB, were produced during 1958-60 at Voronezh Plant 64.

(4) *The* CAMP (*AN-8*) — The twin-engine military aircraft, CAMP, another Antonov turboprop, was produced during 1958-61 at Tashkent Plant 84.

(5) *The* COOT (Il-18) — The four-engine turboprop COOT, designed by Ilyushin, entered production in 1957 at Moscow Plant 30; it proved to be one of the most successful of the Soviet transports. By the end of 1966, about 500 had been produced, about 85 of which were exported. The latest model to enter production is the long-range version, Il-18D, which carries 122 passengers. Production in the future may include an ASW version of the Il-18, called the MAY.

Since 1957 the U.S.S.R. has produced about 35 CLEAT (Tu-114), an adaptation of the Tupolev-designed heavy bomber built for carrying 220 passengers in tourist-class fashion on long-distances flights. In 1960-61 two more civil transports entered series production: the short-haul turbroprops, COKE (An-24) designed by Antonov, and the turbofan, COOKPOT (Tu-124). The COKE, an aircraft similar in appearance to the Fokker F-27, began in late 1961 what appears to be a long and successful production run at Kiev Plant 473. By January 1967, more than 250 of these high-wing transports had been produced. The U.S.S.R. is actively promoting export sale of the COKE in both Communist and non-Communist countries. Thus far, more than 50 have been exported.

The COOKPOT, the first Soviet turbofan transport, entered production at Kharkov Plant 135 in 1960, and probably was phased out in early 1966 after about 120 had been produced. Presumably the problems with this aircraft, excessive noise and vibration, have been solved in the follow-on turbofan, CRUSTY (Tu-134), which entered series production as COOKPOT was being phased out. Unlike its predecessor COOKPOT, which had the engines on the wings, CRUSTY has two rear-mounted engines and a "T"-type tail. The demand for this aircraft both for domestic use and for export is sufficient to support a long production run.

In 1964-65, two small aircraft powered by piston engines entered production. The An-2M, an agricultural version of Antonov's single-engine transport discussed above, has been in production at the Moscow plant, Dolgoprudnaya 464, since 1965. Antonov's CLOD (An-14) entered production at Arsenyev Plant 116 in late 1964. In order to supply a large domestic need and to provide for export, the U.S.S.R. probably will continue to produce both of these aircraft.

Two heavy transports now are in the early stages of series production. The long range CLASSIC (Il-62), powered by four rear-mounted turbofan jet engines and which resembles the U.K.'s VC-10, is the latest known design of the Ilyushin Design Bureau. After numerous delays, series production began at Kazan Plant 22 in early 1966. Six of these aircraft were believed to have been built by the end of the year and production will probably continue at a low but increasing rate.

The heavy transport COCK, now in series production at Tashkent Plant 84, is a long-range military transport, powered by four turboprop NK-12MV engines. It carries a maximum payload of 176,000 pounds for a range of 2,800 nautical miles, and a normal payload of 99,000 pounds for 5,100 nautical miles. By the end of 1966 some 4 to 6 COCKS had been built, including prototypes.

Several transports still are in some stage of development. The short-haul light jet, Yak-40 could be ready for series production in 1968. The new transport known as the Tu-154, a medium-range jet similar to the U.K.'s Trident (powered by three rear-mounted engines), has been widely publicized and might have entered prototype production in 1967. The Soviet supersonic transport (SST), Tu-144, is powered by four by-pass jet engines (Kuznetsov NK-144). Its speed is in the area of Mach 2.2-2.3, its range is 4,000 miles, and it carries 120 passengers. Even though the first flight may occur in 1968, the Tu-144 will not be operational before 1972.

d. HELICOPTERS — The production of helicopters makes up an important part of the Soviet aircraft industry. Some 7,000 helicopters have been built since World War II. In 1966, 235 helicopters were produced at three airframe plants: Kazan 387, Moscow

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23, and Rostov 168. (FIGURE 81 shows production of helicopters.) The HOUND (Mi-4), a piston-powered helicopter and three turboshaft helicopters—the HOOK (Mi-6), HIP (Mi-8), and HARKE (Mi-10)—are believed to be presently in series production. The HOUND is apparently being phased out in favor of the HIP. Prototypes of the HOODLUM (Ka-26), HARP (Ka-20), and HOPLIGHT (Mi-2), and the STOL convertiplane HOOP (Ka-22) have been built and other new designs are probably being developed. However, not all of these designs are likely to go into series production.

The HOOK is the world's largest helicopter and one that has no counterpart in the West. The HARKE is a flying crane version of the HOOK, combining a modified HOOK fuselage for carrying passengers and a long-legged quadricycle landing gear for straddling external loads. Since 1964, at least 40 HIPS, a turboshaft model capable of carrying 26 passengers, have been produced at Kazan Plant 387, and about 10 HARKES have been built at Rostov Plant 168. Even though the HOPLITE was first shown in October 1961 there is still no evidence that it is in series production, although Poland may be producing it under license from the U.S.S.R. Series production of the HOOP is not anticipated but HOODLUM was to enter series production in 1967. There is no evidence of series production of the HARP, but a follow-on model, the HORMONE, has been developed by designer Kamov.

e. MISCELLANEOUS AIRCRAFT — Other types of Soviet aircraft include flying boat patrol bombers, communications/utility aircraft, trainers, and reconnaissance aircraft. The U.S.S.R. has produced three seaplane patrol bombers designed by Beriyev: The MADGE (Be-6), the MALLOW (M-10), and the MAIL (Be-12)—all built at Taganrog Plant 86 in relatively small numbers. The MAIL appeared in 1961 but series production did not begin until about 1966.

The CREEK (Yak-12) is the only communications/utility type of aircraft produced, although the transports COLT and CLOD discussed above serve also in this capacity. An estimated 2,000 CREEKS were produced between 1954 and 1960.

Soviet production of trainer aircraft in recent years has been restricted to a fairly small number of the MAESTRO and MONGOL trainers. In earlier years after World War II as many as 3,000 trainers a year were produced, but since 1956 production has been below 1,000 a year (FIGURE 81). Production of the MAX (Yak-18), a primary trainer, has totaled about 8,000; the heavier and more powerful MOOSE (Yak-11), an intermediate trainer, has totaled some 4,000. The U.S.S.R. since 1963 has imported the MAYA (L-29), an intermediate jet trainer from Czechoslovakia. One Soviet trainer, MAGNUM (Yak-30) apparently has never entered series production; a test batch of 10 to 20 has been produced.

Soviet reconnaissance aircraft generally are adaptations of bombers such as the BEAGLE, BADGER, and BEAR, or fighters such as FISHBED. However, two aircraft, the MANGROVE and MANDRAKE, appear to have been designed primarily for aerial reconnaissance. An estimated 230 MANGROVE types (formerly FLASHLIGHT D) were built during 1958-63 at Saratov Plant 292. MANDRAKE, a twin-jet designed by Yakovlev, is believed to be used primarily as a high-flying target for fighter interceptor training. MANDRAKE was phased out at Ulan Ude Plant 99 by the end of 1965, with an estimated total output of about 80 aircraft.

f. AIRCRAFT ENGINES — The entire range of Soviet military and civil aircraft is powered by a fairly narrow range of engine types. In general the industry limits the number of engine designs produced and makes extensive use of off-the-shelf engines. New engines are designed and produced only when one of the existing engines (or some modification of it) cannot achieve the level of performance required. Aircraft engine plants, which have an estimated floorspace of 24 million square feet in all, are believed to be capable of supporting the airframe industry at peak capacity.

Turbojet engines, recently produced in series, are Type 31, which powers the FITTER, FISHPOT, and FIDDLER, and Type 37, various models of which are fitted to FISHBED, FIREBAR, and BREWER. No new engines of the turboprop type except the TVD-10F or the BE-30 are known to have been produced, although modifications of the AI-24 and NK-12 have been made. To power the COCK super cargo transport, the industry used the NK-12MV, a modified and improved version of the NK-12 and reportedly twice as powerful as the largest turboprop produced in the West.

The AI-20K (the basic version of the AI-20M) and the AI-24 (a scaled-down version of the AI-20) are being produced mainly as replacements. The newest engines of the turbofan design are the following: 1) The NK-8 designed by Kuznetsov, used in the CLASSIC, and scheduled also to power the forthcoming three-engine Tu-154; 2) the NK-144, also by Kuznetsov, being developed for the SST, Tu-144; and 3) the AI-25 designed by Ivchenko and being developed for the Yak-40. Titanium, a light metal with a high strength-weight ratio, will be used in all three turbofan models despite the difficulties the industry has experienced in using it.

Progress has been made in increasing the life of aircraft engines and in extending the time-before-overhaul (TBO). The lifespan and the TBO of the NK-8 is expected to be greater than that of previous Soviet engines, in part because of the use for the first time of air-cooled turbine blades. Also, considerable improvement has been made in the AI-20 series.

Soviet engineers have shown considerable ingenuity in designing the turboshaft engine for helicopters. The D25V helicopter engine (TV-25M) used in the very large helicopters, HOOK and HARKE, is the most recent model to enter production.

The industry is known to be working on three non-rotorcraft V/STOL propulsion systems. These are

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believed to be a lift/cruise engine, a direct lift engine, and a lift fan engine, but series production of these models is not likely to begin very soon.

4. Sources of supply

The Soviet aircraft industry is self-sufficient in materials and technical expertise. In past years, it has given major support to the development of aircraft industries in Poland and Czechoslovakia, and during the late 1950's established a virtually complete aircraft industry in Communist China.

Soviet airframe and aircraft engine plants are highly integrated, and until recently relied very little on subcontractors for parts and components. Because the complexity of aircraft construction has increased, the industry is turning more and more to subcontracting for many of its parts and components; however, Soviet plants subcontract to a far lesser extent than do plants in the West. Most of the airframe components are made in shops located at the primary plant, including castings, forgings, stampings, and machined parts, except for some of the large forgings which are made elsewhere. The making of ailerons, empennage assemblies, and especially landing gears, usually is subcontracted. Components such as instruments, electronic equipment, batteries, tires, and weapons systems are supplied to the Soviet airframe industry by specialized producers much the same as in the United States. Aircraft engine plants subcontract the production of generators, magnetos, pumps, carburetors and switches.

5. Research and development

Under the existing ministerial (MAP) structure, separate organizational units are responsible for research and development. Several research centers exist, each with specialized applied research functions. The most important of these centers is the Central Institute for Aerohydrodynamics (TsAGI), which is the backbone of the Soviet aviation industry in terms of supporting the ability of the industry to design and develop advanced aircraft. TsAGI provides basic aerodynamics design data and conducts model tests and static structural tests for the design bureaus. Other applied research organizations include the Central Institute for Aviation Engine Construction (TsIAM) which conducts applied research on propulsion, the All-Union Institute of Aviation Materials (VIAM), and the Scientific Research Institute of Aviation Technology and Organization of Production (NIAT). The several design bureaus, headed by such well-known designers as Tupolev, Mikoyan, Sukhoy, Ilyushin, Antonov, Tumansky, Solovyev, etc., are responsible for the development of airframes and propulsion systems. In a sense, their role is intermediate between research institutes on the one hand and series plants on the other. Another MAP organization is the Flight Test Institute (LII) at Moscow/Ramenskoye Airfield, which has the unique role of testing the aerodynamic systems development under MAP.

The outstanding feature of Soviet aircraft design philosophy is the practice of designing within the foreseeable state of the art. Designs are made to conform with proven manufacturing methods and equipment as much as possible and, once an aircraft has been put into series production, design changes are kept to a minimum. This does not mean that advancements in technology do not occur; rather, it signifies that small steps in technology are made as opposed to large advancements with each new systems design. When a new or advanced production technology is used by a chief designer in designing a new system, however, it then becomes a stipulated series production requirement. Another significant Soviet practice is to restrict the number of designs in production at a given time. Also, in the past the same basic design has been made to serve a variety of purposes, e.g., the civilian transport CAMEL and the BADGER bomber. Additionally, BADGER is being used simultaneously in three military roles; strategic, tactical, and naval.

E. Shipbuilding

1. General

a. BACKGROUND — The U.S.S.R. ranks today as one of the world's leading producers of naval ships. The Soviet shipbuilding industry completed more than 563,000 naval standard displacement tons of major combat ships during 1958-65. The following tabulation shows the number of tons completed per year:*

1958	30,200	1962	96,580
1959	43,555	1963	72,450
1960	68,635	1964	110,150
1961	65,000	1965	76,200

In the building of merchant ships, the U.S.S.R. is less impressive, ranking fifth in the world, but it is moving ahead rapidly. For its merchant fleet, which consists mainly of oceangoing tankers, dry cargo ships, river vessels, and fishing craft, the U.S.S.R. has been dependent on foreign shipbuilders for certain types of new vessels and for some repair services. Presently, however, the shipbuilding industry is being reshaped, with the goal of becoming less dependent on foreign shipbuilding for these services. Series production of a few standard types of merchant ships is continuing, and production of ship components is being coordinated more closely with the programs of the shipyards. The industry is too small to support the present rate of expansion of the merchant fleet, and complete independence in the field of shipbuilding and ship repair must be considered only as a long-term goal. Thus, the U.S.S.R. will continue to contract with other Com-

* Excludes minor combat ships such as subchasers, motor torpedo boats, guided missile patrol boats, mine warfare types, support ships, and other small craft.

Approved For Release 2008/09/08 : CIA-RDP08S01350R000100030002-2

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munist countries and with non-Communist countries for the building of ships.

b. EXPORTS — After World War II, the U.S.S.R. inaugurated a program of transferring naval vessels both to other Communist countries and to the less developed nations of North Africa, the Middle East, and Asia. In recent years the major non-Communist recipients of this naval aid program have been the U.A.R., Algeria, Syria, Indonesia, and India. Deliveries have included both major and minor combat surface ships and attack submarines. In 1966, a large number of surface-to-surface guided missile patrol boats such as the *Osa* and *Komar* classes were transferred to the U.A.R., Algeria, Yugoslavia, Cuba, and Syria. The U.S.S.R. supplies most of the naval ships of the eastern European Communist countries, except for mine warfare types and small patrol boats, which are built by Poland and East Germany.

Most of the commercial ships produced by Soviet shipyards are for the Soviet fleets, although a small number of tankers, hydrofoils, and fishing ships have been exported, both to other Communist countries and to the less developed non-Communist countries. In 1966, the U.S.S.R. signed agreements to export several tankers to Greece. Other orders include a 12,000-ton drydock to be delivered to Finland in 1968, several small fishing craft for Ghana, a tanker for North Vietnam, and a trawler for Indonesia. Recently the Satra Corporation of the United States placed an order with the U.S.S.R. for the delivery by the end of 1967 of two passenger-hydrofoil vessels of the seagoing *Kometa* type and 10 six-seater hydrofoil motor launches of the *Volga* type.

c. IMPORTS — Although the U.S.S.R. imports no major combat ships, it does, at the present time, import the *Polnocny* class of landing ship (LSM) and the *Zubov* class of hydrographic research ships (AGS) from Poland. In the early 1950's export restrictions by the West led the U.S.S.R. to begin producing certain ships, notably tankers, which it could no longer purchase. By the beginning of the 1960's, however, restrictions had been relaxed considerably. Consequently, of the approximately 1,200 merchant ships imported by the U.S.S.R. since World War II, nearly half have come from non-Communist countries. Denmark, Finland, France, Italy, Japan, and Sweden are among the largest such shipbuilders for the U.S.S.R. The Communist countries, on the other hand, between 1946 and 1966 delivered to the U.S.S.R. more than 560 cargo or passenger ships totaling 2,175,183 gross register tons (g.r.t.).* In addition, 51 tankers totaling 405,897 g.r.t. were delivered between 1946 and 1966. FIGURE 85 provides data on significant merchant ship completions by other Communist countries for the U.S.S.R.

* Gross register tons: The internal cubic capacity of the ship expressed in register tons—100 cubic feet to the ton.

2. Production and repair

a. MERCHANT SHIPS — The shipbuilding industry has operated primarily in support of naval requirements since the end of World War II. About 1950, however, Soviet planners saw the need for maintaining a much larger merchant fleet and undertook a program for acquiring ships. Oceangoing tankers, in particular, were in short supply. Because trade restrictions prevented purchases from the West, these ships had to be produced at Soviet shipyards. The lead ship of the *Kazbek* class of tankers was completed at the Nosenko yard at the Black Sea port of Nikolayev in 1951. In all, 70 ships of this type were built, and the building of other major oceangoing ships soon followed.

Between 1951 and 1967 the Soviet shipbuilding industry completed 1,309 vessels, totaling 3,852,752 g.r.t. (FIGURE 25). In 1966, two classes of tankers were still in serial production, one of which was the 32,840-g.r.t. *Sofiya* class (FIGURE 26). In addition, Soviet shipyards were constructing five types of dry cargo ships (the *Poltava* class cargo ship is shown in FIGURE 26), and were continuing building programs for refrigerator ships, factory trawlers, port icebreakers, and medium trawlers. With the addition of merchant ship production to the naval ship construction and conversion programs, Soviet shipyards are working near capacity. Still, the U.S.S.R. continues to place large orders for merchant ships abroad.

The shipbuilding industry has now developed its own techniques for the construction of large modern oceangoing ships. Several *Sofiya* class tankers have been constructed, and large orders for 11,000-12,000 g.r.t. cargo ships have been confirmed. With the exception of several tankers, hydrofoil passenger ships, and some fishing ships, nearly all Soviet production has been for domestic use. Even though the industry has been reorganized and series production of standard types of merchant ships is helping to reduce production problems and costs, the U.S.S.R. will continue to import merchant ships in quantity for many years. The high priority of the naval shipbuilding program and the inability of the industry to meet completely

FIGURE 25. SOVIET MERCHANT SHIP COMPLETIONS,* 1951–66

TYPE	TOTAL NUMBER COMPLETED	TOTAL GROSS TONS	TOTAL DEADWEIGHT TONS
Tanker	144	1,410,803	2,000,000
Cargo	258	1,119,609	1,389,200
Passenger	11	40,471	12,000
Fishing fleet ships	872	1,266,994	675,900
Special types	24	54,875	12,900
Total	1,309	3,892,752	4,090,000

* Excludes tugs, schooners, lighters, barges, passenger cutters, and other types for the maritime fleet.

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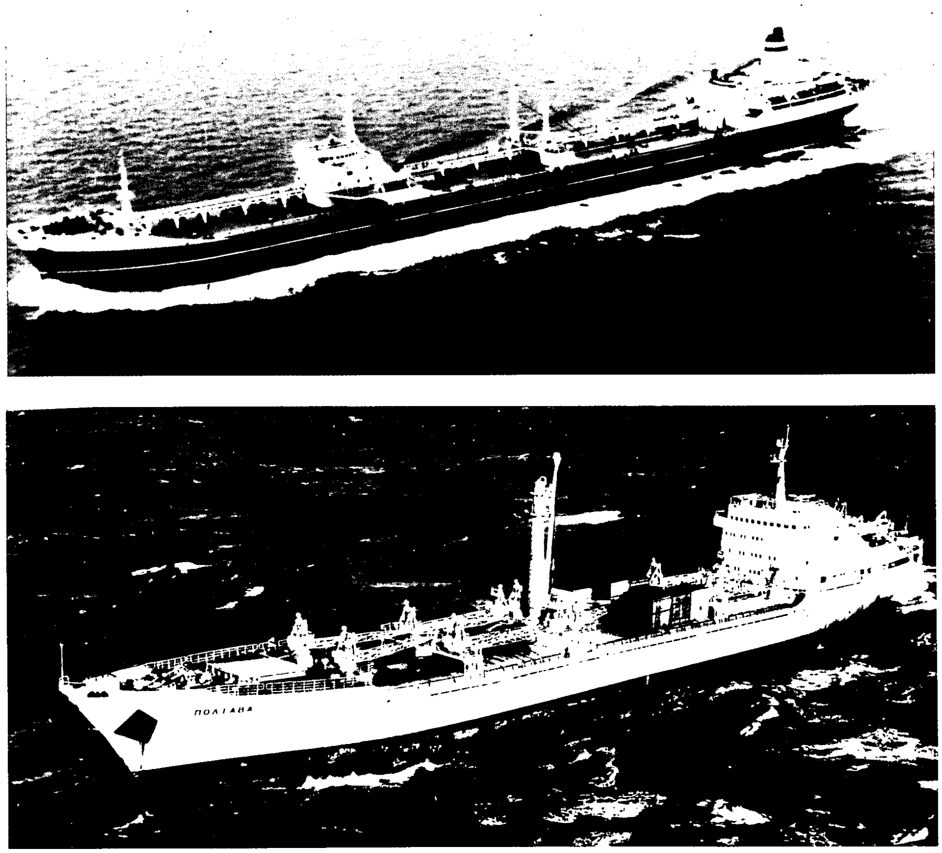

FIGURE 26. NEWER TYPES OF SOVIET MERCHANT SHIPS. (*top*) *Sofiya* class tanker. (*bottom*) *Poltava* class cargo ship.

the increased demand for merchant ships will necessitate continued reliance on imports.

b. NAVAL CONSTRUCTION — Immediately following World War II, the U.S.S.R. embarked on a program to reconstruct and improve war-damaged shipyards, to build new facilities, and to construct new naval ships. The program was unprecedented in size and effort for a nation not at war. This period can be divided into four somewhat overlapping stages: The first corresponding roughly to a decision to build naval ships and to rebuild shipyards, the second calling for preparation and execution of plans to replace wartime losses and to construct a force capable of defending the sea frontiers of the U.S.S.R., the third requiring the introduction of wholly modern units, and the fourth initiating qualitative refinement of the present fleet and development of new classes of ships and weapons.

The first stage, 1946-48, apparently followed a decision to give the navy a priority position in shipbuilding in the postwar period. While the yards were being rehabilitated and new facilities built, work was resumed on naval vessels begun before the war. Some units considered worth completing were finished and others—including some capital ships—were scrapped. Design and prototype development of new classes of naval ships, including W class submarines, *Chapayev* class light cruisers, *Skoryy* class destroyers, and *Kronshtadt* class large submarine chasers were begun in this stage. During this first stage, preparations already were underway to make the U.S.S.R. into an important naval power.

In the second stage, 1949-53, deliveries of the first wave of postwar-built warships were made. This stage included delivery of *Sverdlov* and *Chapayev* class cruisers, *Skoryy* class destroyers, and W and Z class submarines. Production also included *Kola* and *Riga* class escort ships, and P-4 and P-6 class motor torpedo boats. Designs and equipment of the principal surface vessels and W class submarines were not

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radically new; they were basically an improvement and enlargement of pre-World War II designs. Soviet planners apparently had ordered that a fleet of completely conventional vessels be made operational as quickly as possible, with equipment that could be acquired easily.

The third stage, 1953-58, was marked by the mass production of submarines and other naval ships at peak production rates. A number of major modifications to several classes of warships also were made, reflecting a desire to modify and improve combat capabilities of the navy. The W class submarine program was terminated during this period, and these units subsequently underwent four major alterations. Ballistic missile tubes were added to a few Z class submarines during 1955-58, the first Soviet units to be so equipped. The *Riga* class escort also was altered significantly, and its superstructure was virtually rebuilt. While later units of the *Riga* class were built in accordance with the newer design, an estimated 30 or more were altered. Other new construction begun in the third stage included Q class submarines, *Kotlin* class destroyers, and several other classes of smaller combatant ships, amphibious and landing craft, and auxiliary ships. The present, or fourth, stage began about 1959 and has been marked by a shift from the production of large numbers of a few types of conventional naval ships to the production of small numbers of a larger assortment of naval ships equipped with the most modern weapons systems. Included in this shift has been the introduction of nuclear-powered submarines and surface ships armed with missiles and propelled by gas turbines. Important submarine classes produced were the G class ballistic missile submarine; the N class nuclear-powered torpedo attack submarine; the H class ballistic missile, nuclear-powered submarine; and the E class cruise missile, nuclear-powered submarine; the J class cruise missile, diesel-powered submarine; and the F class torpedo attack, diesel-powered submarine. Important new surface ships are the *Krupnyy* class guided missile destroyers and the *Kynda, Kashin,* and *Kresta* classes of guided missile frigates. FIGURE 86 identifies principal naval ships built during 1959-67, and FIGURE 27 shows some of the newer types of Soviet naval vessels. During a 5-year construction period (1960-64), Soviet shipyards produced six missile-equipped destroyers and more than 100 submarines including nuclear-powered ballistic missile submarines, nuclear-powered guided missile submarines, nuclear-powered attack submarines, and diesel-powered guided missile and attack types. Also produced were over 600 minor surface combat ships such as submarine chasers, motor torpedo boats, guided missile patrol boats, and over 90 mine warfare types. This fourth phase also included a major overhaul and modernization program (including conversion of selected older ships and some of the newer classes), and construction of naval auxiliaries, particularly submarine support ships.

c. REPAIR ACTIVITIES — Almost all Soviet shipyards engage to some extent in the repairing of ships, several important yards being devoted exclusively to repair work. Repairs to ships of the merchant and naval fleets are customarily made at domestic shipyards, although some merchant ship repair work has been let to foreign shipyards. Although in recent years a large number of floating drydocks have been constructed to meet the increasing need for repair services, the 5-year plan for 1966-70 calls for additional increases to ship repair capacity. New ship repair complexes are being established at Il'ichevsk in the Black Sea region and at Slavyanka in the Far East. At the same time extensive work will be conducted to expand the capacities of the existing facilities at Odessa, Novorossiysk, Zhdanov, Archangel, Severodvinsk, Petrovka, and Kaliningrad.

3. Economic resources and requirements

a. COMPONENTS — Since about 1950 the Soviet economy has been able to meet nearly all of the requirements of the shipbuilding industry for raw materials and components. Supplies of diesel engines, boilers, turbines, and related gear are sufficient, and batteries, navigation and electrical apparatus, plumbing and galley equipment, and the like also are in adequate supply. Many of these components are manufactured at the shipyards or in plants located nearby. As other Communist countries have developed shipbuilding industries, they have increased their purchases of materials and components from the U.S.S.R. East Germany, for example, is dependent upon the U.S.S.R. for more than half of the steel used in hull construction.

Yards in the Baltic Sea and Black Sea areas and those in the Arctic regions are relatively well-supplied with components and materials because of the proximity of major industrial centers. Shipyards in the Pacific area and the remote Arctic ports, however, have frequent supply difficulties. The U.S.S.R. has tried to alleviate the supply problems of the Pacific area by increasing the output of ships parts in the Far East.

b. MANPOWER — The Soviet shipbuilding industry employs over 200,000 workers, or a little less than 1% of the total industrial labor force. A large portion of the shipbuilding industry's labor force consists of highly skilled workers, such as engineers, naval architects, designers, technicians, patternmakers, and machinists, who enjoy a somewhat higher wage than does the average industrial worker. The need for technical skills in shipbuilding is changing in response to changes in production techniques. Series production and greater use of prefabrication, for example, tend to reduce the number of highly trained shipbuilders needed. On the other hand, nuclear propulsion and modern strategic weapons systems with their complex electronics, require other types of specially trained shipbuilding technicians.

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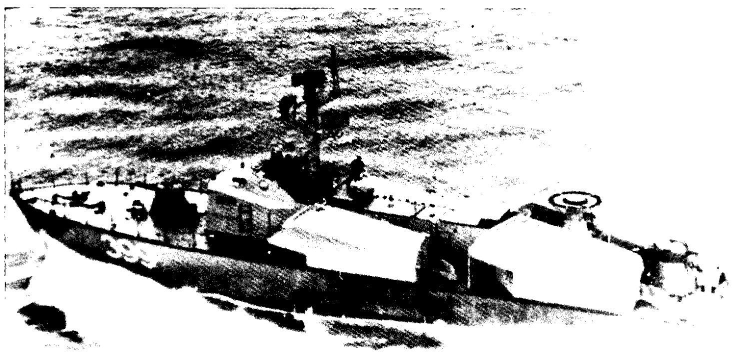

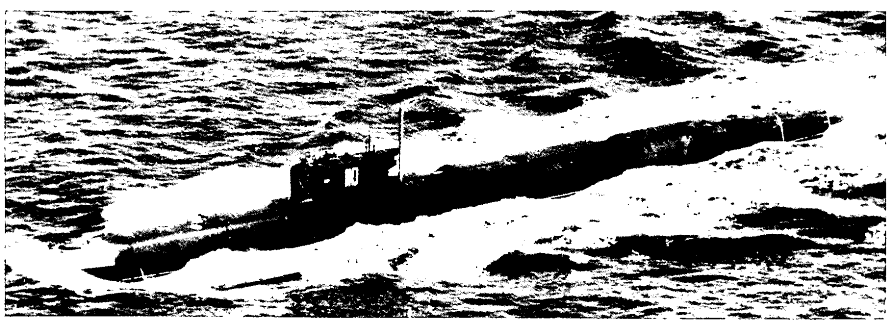

FIGURE 27. NEWER TYPES OF SOVIET NAVAL VESSELS. (*top*) *Osa* class large guided missile patrol boat. (*center*) Nuclear-powered guided missile submarine. (*bottom*) *Kresta* class guided missile frigate.

The Soviet training programs for shipbuilding are carried on at specialized institutes, and apprentice and on-the-job training programs are offered at almost every important shipyard in the U.S.S.R. The postgraduate divisions of some advanced shipbuilding schools conduct research programs. The principal institutions for training skilled labor and technical personnel for the shipbuilding industry are located at Gor'kiy, Leningrad, Nikolayev, and Odessa.

4. Shipyards

The location of the major Soviet shipyards has been dictated by the necessity of serving four widely separated maritime areas: The North, the Baltic, the Black Sea, and the Pacific. Increases in the minimum depth and improvements along the Volga-Baltic-White Sea Canal System has permitted the passage of certain types of combat ships between the White, Black, Caspian, and Baltic Seas. The Northern Sea Route is used increasingly to transfer newly built vessels from the Arctic and Baltic yards. to the Pacific area.

The principal shipbuilding centers of the U.S.S.R. are the Leningrad area on the Baltic Sea and the Kherson-Nikolayev area on the Black Sea (FIGURE 28). Other important yards are at Severodvinsk in

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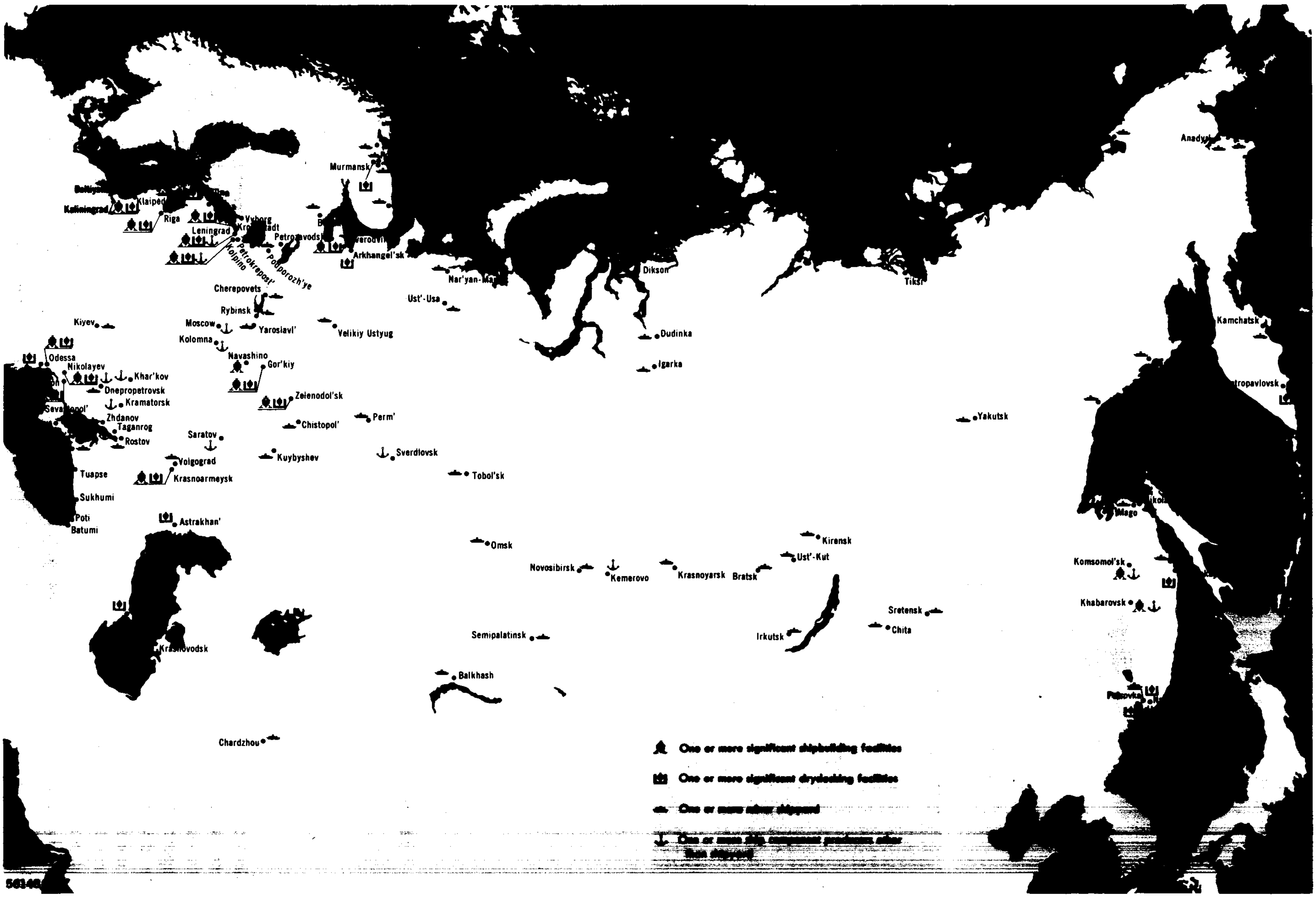

FIGURE 28. LOCATION OF SHIPBUILDING AND SHIP-REPAIRING INDUSTRY, U.S.S.R.

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the Arctic area, Gor'kiy in the interior, and at Komsomol'sk and Khabarovsk in the Far East. In addition to the principal Soviet shipbuilding facilities, there are numerous small inland shipyards and boatyards throughout the U.S.S.R., especially in the European half of the country around the central Volga region near Gor'kiy. Besides conducting repairs on local vessels, these inland yards construct some small naval craft, river passenger and cargo ships, barges, and other small craft. The growing importance attached to inland waterway transportation will in all probability result in an expansion of these inland shipbuilding and repair facilities. For example, the Yaroslavl Shipyard has been transformed from an insignificant boatyard to an important inland yard capable of building medium-sized freighters.

Most of the major yards in the U.S.S.R. use modern shipbuilding methods and are capable of serial production of naval and merchant ships of almost any type. Year-round production is made possible by using covered building docks and building ways at some of the major yards. One of the most important aspects of modern Soviet shipbuilding is the use of sectional assembly, in which individual sections as large as 200 tons can be lifted into position. Production methods in shipbuilding have been facilitated by the use of lightweight alloys, plastics, noncorrosive materials, and improved methods of welding.

5. Prospects for the industry

The Soviet shipbuilding industry will likely continue to strive for improvements in quality while maintaining a steady level of output. Production of nuclear attack and missile submarines probably will continue. The J class diesel-powered cruise missile submarine and F class diesel-powered attack submarine are in production, but these programs probably will be phased out before 1970. Other construction probably will consist of guided missile-equipped frigates, mine warfare types, the *Mirka* class PCE, *Komar* and *Osa* class PTG's, and *Shershen* class PTF. The expansion and modernization of naval shipbuilding and repair yards now under way will continue to have a high priority over the near future. The industry also will continue research and design efforts to develop new or improved types of submarines and surface ships.

Present plans to expand both the merchant fleet and the fishing fleet, and to carry on an oceanographic research program suggest that the Soviet leadership will strive to produce increasing numbers of nonnaval ships. Even though the industry has been reorganized and series production of standard types of merchant ships is facilitating growth, the higher priority given to naval shipbuilding will make necessary the continual import of merchant ships in quantity for many years.

F. Explosives (industrial and military)

1. Introduction

The U.S.S.R. possesses a large and well-developed complex for manufacturing explosives and propellants. The present level of output is sufficient for Soviet industrial and military requirements and for export.

During World War II, the U.S.S.R. achieved a high level of output of explosives, almost 900,000 tons a year. Requirements exceeded this amount, however, necessitating the annual import of about 220,000 tons, which came principally from the United States. Since that time, the capacity for explosives production has increased considerably; it is believed now to exceed 1.5 million tons annually. Output at this capacity would be sufficient to meet the requirements of a sustained major war.

A program of modernizing and relocating some of the facilities for the production of explosives has been under way since World War II. Explosives plants and associated chemical plants were highly vulnerable to military action in World War II because they were concentrated in the European U.S.S.R.; as a result, serious losses were incurred. The buildup of facilities in the Ural Mountains and in the eastern U.S.S.R. later in the war reduced this vulnerability. In the postwar era, the maintenance of these facilities coupled with the restoration of damaged plants, the building of new plants, and the transfer of factories from occupied countries provided a vastly larger and more dispersed industry for the production of explosives.

Peacetime production of explosives is planned according to the needs of the mining industry, the civilian construction industry, and the military. To meet these combined requirements, the U.S.S.R. in 1966 produced an estimated 581,200 tons of explosives. Detailed information on explosives production is shown in FIGURE 87.

Explosives production is a segment of the Soviet chemical industry. It is believed to be under the control of the All-Union Ministry of Chemical and Oil Engineering.

2. Constituent materials

The principal constituent materials utilized in Soviet production of explosives are ammonia, nitric acid, sulfuric acid, glycerin, toluene (toluol), benzene (benzol), and cotton linters (for cellulose and nitrocellulose). Estimated consumption of these materials in the production of explosives is given in FIGURE 88. Certain explosives manufactured from these materials may also be used as ingredients in other explosives; these include ammonium nitrate, dinitrobenzene, nitrocellulose, nitroglycerin, trinitroxylene, and some trinitrotoluene (TNT).

The Soviet chemical industry is able to supply constituent materials for explosives in quantities sufficient to meet the present requirements of industrial and

Approved For Release 2008/09/08 : CIA-RDP08S01350R000100030002-2

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military production. In fact, new plants built since World War II have increased capacity far above peacetime requirements. This extra capacity would be used in wartime conditions, when requirements for explosives would rise to several times the peacetime level. Under these conditions, toluene, and to a lesser extent, nitric acid, would have to be diverted from civilian users to fulfill military needs. Other materials would be available in quantities sufficient for both explosives and other needs.

The most serious limitation on the production of explosives during World War II was the inadequate supply of toluene. Substitutes for TNT, such as amatols and ammonals, were used, but because they are unstable, these materials are not used in peacetime. Although toluene is now produced in quantities in excess of current peacetime needs, this level of output might be insufficient in the event of war. Catalytic reforming of petroleum feed stocks, however, could provide the additional supplies needed.

Until recently, the capacity for production of nitric acid was inadequate to meet wartime requirements for both explosives and industrial and agricultural uses. Expansion of the facilities for production of nitric acid has improved this situation somewhat, but wartime needs would strain the available supply.

It is doubtful whether the U.S.S.R. places much reliance on the stockpiling of constituent materials, probably preferring to concentrate on expansion of productive capacity. Relatively small quantities of some strategic materials may be stockpiled, but there is no evidence of major efforts in this field. Moreover, while a few chemicals, such as toluene, are fairly easy to store (requiring only tankage of the type used for petroleum products), other important constituents of explosives, such as nitric acid, are difficult to store because they are corrosive and require specially lined containers.

3. Industrial explosives

Soviet industrial explosives can be divided into three major categories: Dynamites, ammonites, and bellites. Dynamites and ammonites together account for over 90% of total production (FIGURE 87). Of the estimated 185,000 tons of industrial explosives consumed in the U.S.S.R. in 1966, an estimated 120,000 tons were used in mining, and 65,000 tons were used by the construction industry and other consumers. An increase in the manufacture of industrial explosives will be required to meet planned increases for coal extraction. The capital construction program as planned also will increase requirements for industrial explosives.

In time of war, only a portion of the explosives normally consumed by industry could be diverted to military use. Requirements of the coal mining industry might actually increase under wartime conditions, because of the added demands of heavy industry for fuel.

4. Military explosives

Annual requirements for military explosives are determined by the output of ammunition. It is estimated that in 1966 about 339,000 tons of military explosives were used in Soviet ammunition production. The estimated consumption of military explosives by type in 1966 was included in FIGURE 87.

Before and during World War II, the U.S.S.R. made use of a variety of high explosive fillers such as TNT, amatol, ammonal, PETN, and picric acid. Technical assistance furnished by the United States and the United Kingdom during the war and by German scientists employed in the postwar Soviet explosives program helped create a productive capacity for newer explosives such as cyclonite (RDX).

Postwar production of high explosive fillers has been limited primarily to TNT, ammonium nitrate, and small quantities of RDX-base explosives. More sensitive explosives materials—such as picric acid, potassium chlorate, mercury fulminate, and lead azide—are used for initiator, primer, and booster compositions.

Soviet propellants are of the conventional smokeless type. Both single- and double-base propellants are made, but emphasis is on single-base types. Black powder, used extensively in World War II, is no longer used in significant quantities as a propellant.

It is believed that the U.S.S.R., like other major powers, does not store explosives in bulk form, preferring instead to store filled ammunition. Because TNT is one of the more stable explosives during storage, it probably forms a major part of the explosives used in ammunition to be stored.

5. Principal producers

Information on individual producers of explosives is given in FIGURE 89. Reliable information on individual plants is often fragmentary, and some of the information dates from World War II or the immediate postwar period. Some of the Soviet plants manufacturing explosives produce intermediates as well, but many are dependent on chemical and cellulose plants for such materials. Most of the plants are served by both road and rail facilities.

At the present time, the U.S.S.R. is believed to have several large explosives-producing plants comparable to those in the United States. Plant No. 673 at Kazan', for example, compares favorably in size with the U.S. Sunflower Ordnance Plant. Among the largest of such plants in the U.S.S.R. is Kirov Combine No. K98, located at Zakamsk in the Ural Region. There are several other large explosives producers, at widely dispersed locations; however, the explosives production industry continues to consist principally of small plants.

Approved For Release 2008/09/08 : CIA-RDP08S01350R000100030002-2

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G. Arms and ammunition

1. Introduction

The U.S.S.R. has a large munitions industry that is not only capable of satisfying current requirements for arms and ammunition, but has the reserve capacity to supply such items in quantities sufficient to meet expected wartime needs. It has attained world leadership in developing and producing new conventional weapons.

Plants of the munitions industry are widely dispersed throughout the U.S.S.R., although there are concentrations in the Moscow-Leningrad-Gor'kiy area and in the Urals. Since World War II, the U.S.S.R. has built no new weapons plants, but has reequipped and modernized many older ones, keeping in operation more than enough capacity to meet present requirements. In this way it has retained a production reserve capable of rapid mobilization. Soviet defense plants are required to produce a wide range of nonmilitary items.

Since World War II, an extensive program to develop missiles and nuclear weapons has been implemented. Since about 1960, this has been accomplished to some degree at the expense of conventional artillery. Nonetheless, reliance upon artillery has continued and a development program for artillery has led to the introduction since 1962 of new items of tube artillery, self-propelled multiple-rocket launchers, self-propelled one-round rocket launchers, and a quadruple-mount, self-propelled 23-mm antiaircraft gun. Modern individual and crew-served infantry weapons with increased firepower have also been developed and produced. Chief among these are three types of small arms, all firing the same ammunition, and a series of recoilless and antitank weapons.

During World War II, the U.S.S.R. relied almost entirely upon optical-mechanical fire-control equipment, even though domestic production of these items was inadequate both in quantity and quality. This deficiency has since been overcome. The U.S.S.R. is now satisfying its own needs for optical-mechanical fire-control instruments of good quality and for electronic fire-control equipment.

Since World War II, the effectiveness of domestic ammunition has been increased by greater care in manufacture and packaging and by the development of new ammunition for small arms and artillery. The U.S.S.R. is known to have produced at least one proximity fuze which was used with the 100-mm antiaircraft gun. After this weapon was replaced by surface-to-air missiles, production of the fuze continued for export to various countries and recently has been reintroduced in eastern Europe.

Land mine warfare is highly developed, and facilities for production of large numbers of high-grade mines are available. In this field as well as in the development of sea mines and torpedoes, the U.S.S.R. undoubtedly has benefited from the extensive expertise of German technicians transferred to the U.S.S.R. after World War II.

Postwar production of materiel has made possible a reequipment program which has considerably enhanced mobility and firepower of the army. It also has enabled the U.S.S.R. to equip armies of the eastern European Communist countries and to export substantial quantities of materiel to various non-Communist countries.

The degree to which new developments in military doctrine will affect the munitions industry is not clear. Current publications, statements of leading military figures, and observed trends within the army, indicate a continued need for improved infantry weapons, artillery (except for heavy artillery larger than 203-mm), mortars, radar, and ammunition of the type now in use. For the next few years, therefore, the activity and size of the munitions industry should approximate its present level.

Overall administration of the Soviet land armament industry is believed to be assigned to the Ministry of Defense, created in October 1965. However, all armaments plants produce both military and civilian goods and, therefore, other ministries may be involved in administration of the industry.

2. Production, supply, and use

The ability of the U.S.S.R. to produce great quantities of effective arms and ammunition was demonstrated in World War II. Under adverse wartime conditions, the output of weapons was increased by at least 500% over a substantial prewar level, even though many facilities were captured or damaged during the German invasion. After World War II, the munitions industry expanded the productive capacity by rebuilding and retooling plants which were destroyed or evacuated, by improving facilities relocated during the war, and by a general modernization of manufacturing methods.

Certain ground weapons—for example, antitank artillery—have been developed and replaced by rocketry, but a fairly wide range of conventional items is still being made (FIGURE 29). Even though production of particular types is being decreased, the overall production of ground weapons is not expected to decline. A number of new weapons have been placed in production, such as the PK general purpose machinegun, RPG-7 antitank weapon, ZU-23 dual antiaircraft cannon, the 40-round URAL-375 rocket launcher, the 16-round towed rocket launcher, the 122-mm howitzer D30, and the ZSU-23-4 self-propelled antiaircraft gun.

Soviet progress in production of electronic fire-control equipment has been notable. Although the equipment initially put into production was supplied by the United States and the United Kingdom during World War II, the fire control radar now being produced is of Soviet design. At least three antiaircraft gun-laying

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FIGURE 29. ESTIMATED PRODUCTION OF GROUND WEAPONS
(*Units*)

ITEMS	1964	1965	1966
Infantry Weapons:			
Machineguns			
7.62-mm company machinegun (RP-46)	3,000	0	0
7.62-mm Goryunov machinegun (M1943 & SGM)	6,000	5,000	2,000
7.62-mm light machinegun (RPK)	6,000	6,000	6,000
7.62-mm general-purpose machinegun (PK)	2,500	5,000	7,000
7.62-mm assault rifle (AKM)	230,000	230,000	230,000
Artillery:			
23-mm antiaircraft gun ZU-23 (Dual)	400	400	400
40-mm antitank grenade launcher (RPG-7)	6,700	6,700	6,700
Twin 57-mm self-propelled antiaircraft gun (ZSU-57-2)	50	0	0
Quad 23-mm self-propelled antiaircraft gun (ZSU-23-4)	0	30	75
122-mm howitzer (D30)	1,000	1,000	1,000
Field Rocket Launchers:			
115-mm rocket launcher (40 rd) URAL-375, M1964	50	75	75
140-mm rocket launcher (16 rd) towed (Airborne)	50	75	75
One-round rocket launcher on the modified non-amphibious PT 76 chassis	50	0	0
One-round rocket launcher on ZIL-135	0	15	30

radars, the SON-4 (WHIFF), SON-9 (FIRE CAN), and SON-30 (FIRE WHEEL) have been developed and produced. However, the decline in the deployment of conventional tube artillery has been accompanied by a decline in the production of fire-control radar. Four radars, namely: TRACKDISH, LONG TROUGH, PORK TROUGH, and SMALL YAWN, have been identified as being used in conjunction with field artillery. The FAN SONG surface-to-air missile control and guidance radar has been produced in quantities sufficient for wide deployment and for export.

The U.S.S.R. still makes considerable use of optical-mechanical fire-control devices upon which it depended almost exclusively during World War II. Little is known of the output of these devices but it is adequate for all current needs. The optical and precision-instrument plants were completely modernized following the war, and personnel were trained by the large numbers of German specialists forcibly transferred to the U.S.S.R. after the war. The release of the German technicians by 1952 indicated that the program was well advanced. For further information on production of optical equipment, see Subsection I, Other Military Equipment.

Ammunition produced in the U.S.S.R. during World War II was inferior in quality and effectiveness to that used in the United States, the United Kingdom, and Germany. Remedial effort resulted in the development and production of new kinds of small-arms ammunition and in improvement of artillery ammunition. General improvements in metallurgy have led to the manufacture of ammunition of greatly improved quality. Other advancements have been made in the production of fuzes, high-explosive fillers, and propellants.

Production of artillery and mortar ammunition in the U.S.S.R. is not an integrated process. Components are manufactured in separate plants and the final assembly of complete rounds takes place in military depots, where components are stored and then assembled as needed.

Ammunition production in the U.S.S.R. in 1966 is estimated as follows (in thousand of rounds):

Small-arms	303,942
Mortar	275
Rocket	312
Artillery	47,616
Recoilless	350

A wide variety of hand grenades has been produced since the war, but current output appears to be limited to one of each of the offensive, defensive, and antitank types, characterized by comparatively simple design and good quality. The U.S.S.R. has given considerable attention to development of land mines, current production of which is believed to include three types of antitank mines, three types of antipersonnel mines, and one dual-purpose mine. The production of hand grenades and mines in 1966 is estimated to have been 10 million and one million units, respectively.

Little information is available concerning new Soviet underwater ordnance, but the production of a high-quality magnetic induction mine has been confirmed. Since World War II, the U.S.S.R. has engaged in the development and production of mines, torpedoes, and depth charges.

3. Raw materials and manufacturing facilities

The U.S.S.R. is nearly self-sufficient in raw materials for conventional munitions production; however, the country apparently finds it economically desirable to import these materials from other Communist countries. For example, such strategic materials as tungsten and possibly molybdenum are still imported in quantity from Communist China.

Soviet munitions plants are adequately equipped. Substantial amounts of U.S. lend-lease and captured German special-purpose equipment were installed during the years immediately following World War II. Domestic production of modern machine tools and equipment for defense plants has been high.

Approved For Release 2008/09/08 : CIA-RDP08S01350R000100030002-2

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4. Principal producers

The principal producers of weapons and ammunition are located primarily in the European U.S.S.R. and the Urals, although there are a few plants in eastern and western Siberia. The major plants are listed in FIGURES 90 through 92. Most of them were in existence at the end of World War II, but many have been modernized since that time. Only a small fraction of the capacity of arms and ammunition plants is devoted to military production, various types of civilian products occupying the remainder of the capacity.

It is believed that at the present only three plants are manufacturing and/or assembling conventional artillery pieces, whereas six plants are engaged in the fabrication of small arms. Little is known about current production programs of armament plants, but apparently some artillery and small-arms plants have been or are being converted wholly or in part to the production of missiles and missile components.

Principal producers of antiaircraft fire-control radar are located in the Moscow area. A number of other plants produce radar (FIGURE 99), and many contribute some fire-control equipment.

The largest concentration of optical and precision instruments producers is in the Leningrad area (FIGURE 97). Other important producers are in the areas of Moscow and Novosibirsk.

H. Missiles and space equipment

1. Introduction

The foundation for the U.S.S.R.'s present missile production program is to a considerable degree the result of successful utilization of German techniques, materials, and design data—thus saving the Soviets several years in the development program. Such assistance was particularly valuable during 1946-48, when German missiles were reassembled in the U.S.S.R., and German technicians assisted in the establishment of production and test facilities. In order to secure as much technical information from the Germans as possible, the Soviets permitted them to work on advanced designs. After about 1949, Soviet policy restricted the assistance of the Germans to specific technical problems. This coincided with a buildup of a native Soviet development program. The Germans were no longer allowed access to Soviet production areas, eventually were disassociated from the missile program, and after a "cooling off" period, most of them were repatriated in 1952-53. The last ones returning to Germany in 1957-58.

During this developmental period the Soviets collected and exploited technical intelligence on the German missile program and directed the Germans to: 1) restore the missiles, missile research and test equipment, and associated ground support equipment which had been used in Germany; 2) improve the performance characteristics of the basic German V-2 missile (called A-4 by the Soviets); and 3) prepare for the Soviets various advance designs and concept which had never been translated into reality. This development work was centered at Moscow Missile and Space Development Center Kaliningrad 88, which became the principal missile airframe development center in the U.S.S.R.; Moscow Missile and Space Propulsion Development Center Khimki 456, which was the primary rocket engine development facility; Lavochkin's Special Design Bureau [*Lavochkina Opytnoye Konstruktorskoye Byuro* (*OKB*)] at Moscow Guided Missile Research and Development Plant, Khimki 301 (*Zavod 301*), where development work on aerodynamic missiles took place; and at the Ivankovskiy Guided Missile Plant (*Perviy Eksperimental'niy Zavod*) at Ivankovo, where air-to-surface missiles (ASM) were developed.

In the missile field, the U.S.S.R. has demonstrated the same development philosophy which has characterized its other programs—the use of proven designs, evolution-proven production techniques, off-the-shelf hardware where possible, and the application of one design in many roles. The original German V-2, modified by the Germans and Soviets, was the basis of the first two Soviet surface-to-surface missiles; the third and fourth were essentially improvements of the first two. The diameter of these missiles was 5.4 feet, the diameter of the V-2. In air-to-surface missiles, the first KENNEL (AS-1) model resembled a scaled-down version of the FAGOT (MiG-15) fighter airplane. Another, the KANGAROO (AS-3) probably used the wing of the FARMER (MiG-19) aircraft. Furthermore, the designs of the SALISH and SAMLET (SSC-2a and b) are themselves offshoots of the AS-1 design. The first Soviet ICBM used many components previously used in the earlier surface-to-surface missiles. Not until 1959, with the development of the SKEAN (SS-5), did the U.S.S.R. produce a missile which was almost entirely of Soviet design and domestically designed components.

As the top governing body of the U.S.S.R., the Politburo is responsible for reviewing and approving or disapproving the decision to design, develop, and produce a new weapon. The Council of Ministers, U.S.S.R., is in charge of overseeing the implementation of these decisions. As early as 1947 the Council of Ministers evidently created a strong group within its body to oversee and control the missile program. This authority is probably still functioning, and may be headed by Dmitriy Fedorovich Ustinov, whose background as a foremost leader in the Soviet defense setup combined with his current positions as a Secretary of the Central Committee of the CPSU and a candidate member of the Politburo of the Central Committee of the CPSU makes him a logical choice for this post.

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Functioning under this group within the Council of Ministers are the All-Union Ministries which are directly concerned with the administration of the missile program. The Ministry of Defense sets forth requirements (reviewed by the Politburo) and performs acceptance tests on new products. The Ministry of Defense Industry—MOP, headed by S. A. Zverev, has primary responsibility for the management of ballistic missile production. This Ministry was reconstituted in 1965 from the State Committee for Defense Technology, which was formerly MOP (1957), which in turn was composed of the Ministry of General Machine Building and the Ministry of Armaments (1955). Several known missile production facilities are subordinate to MOP. For example, in 1953, Moscow Missile and Space Propulsion Development Center Khimki 456 (MMSPDC) was transferred from the Ministry of Aviation Industry (MAP) to MOP. The MOP subordination of the leading missile engine facility in the U.S.S.R. is one of the best indications that missile production was directly controlled by this Ministry. MAP has responsibility for aerodynamic missile production. Other ministries which also participate in missile production to a lesser, but equally essential extent, are 1) the Ministry of Radio Industry, 2) the Ministry of Electronics Industry, 3) the Ministry of Shipbuilding Industry, and 4) the Ministry of Instrument Building, Automation Equipment, and Control Systems.

The State Planning Committee (*Gosplan*) directs the financial aspects of the missile program and the procurement of resources and material. At the factory level, it is probable that the critical nature of the missile industry exempts it, in most cases, from the usual controls. The requisition and distribution of supplies, then, is believed to be directed by MOP and MAP with *Gosplan*. Most significant, however, in the 1965 reorganization which reconstituted the Ministry of Defense Industry (MOP) was the reappearance of the Ministry of General Machine Building (MOM). While it is believed that MOP has responsibility for ballistic missiles, and that MAP exercises a similar role for aerodynamic vehicles, it has been thought that because of the rather rigid and delineated control exercised by these two ministries, there existed a higher authority with responsibility for the overall program as well as supervision of production of space hardware. These three programs have been expanding through the years, and the recent emphasis in the U.S.S.R. on management improvement could well signal that MOM has been recreated to exercise this function. It is also interesting to note in considering the role of MOM that the production facilities for weapons such as missiles and aircraft are referred to in the open press as machine building plants.

2. Missiles and engines developed and produced

The Soviets have produced a variety of surface-to-surface, surface-to-air, air-to-surface, and air-to-air missiles. FIGURE 93 gives the estimated production of these missiles.

a. SURFACE-TO-SURFACE BALLISTIC MISSILES (SS-1 – 12) — The Soviets have developed or produced 12 surface-to-surface ballistic missiles with ranges from 150 nautical miles to 6,500 nautical miles for the Strategic Rocket Forces (SRF). In general, the design has remained relatively simple and the development of the more advanced missiles has been based primarily on the earlier models, all with many similarities.

(1) *Short range missiles* — The first surface-to-surface ballistic missiles to be test-launched in the U.S.S.R. were reconditioned captured German V-2's, which were fired in 1947 to a range of approximately 150 nautical miles. The Soviets have worked with several nominal 150-nautical mile ballistic missiles of different designs. The original Soviet version of the German V-2, called the SCUNNER (SS-1), was the first to be produced, and probably provided some of the early operational capability. This missile was replaced by the SCUD A (SS-1b), a track-mounted missile of native Soviet design, originally using a lox-alcohol propellant, but now using storable propellants. A later improvement with storable propellants was the SCUD B (SS-1c). Series production of the SCUD A began at the Dnepropetrovsk Missile Production and Development Center. The SCUD B was also produced at Dnepropetrovsk, but later believed to have been transferred to the Zlatoust Armaments Plant 66, where it was still in production in 1966.

The first indication of native development of a 350-nautical mile missile, SIBLING (SS-2), was a project which apparently began in 1946 in Germany under the direction of a Soviet officer, then Colonel S. P. Korolev. German returnees indicated that this "Korolev" missile was essentially a lengthened V-2. In 1947, an increased thrust (40 ton) version of the V-2 power plant was observed in fabrication, and it is known that two sets of production equipment for the Korolev missile were assembled at the Kaliningrad 88 facility in Moscow in the fall of 1947. It is believed that this facility produced the SS-2 missiles that were tested at Kapustin Yar.

The SS-12, the newest Soviet missile in series production, is probably a single-stage ballistic missile, probably uses a storable liquid propellant, and has a range believed to be between 300 and 600 nautical miles. Testing of the vehicle began in 1964, and deployment is believed to be underway or imminent. Series production is believed to have begun in late 1965 at the Dnepropetrovsk facility; further, it is believed that the deployed missiles will replace the obsolescent SS-2 and SS-3's.

(2) *Medium range/intermediate range missiles* — The Soviets have developed and produced three missiles in this category: SHYSTER (SS-3), a 700-nautical mile missile; SANDAL (SS-4), a 1,100-nautical

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mile missile; and SKEAN (SS-5), a 2,000-nautical mile missile. Prototype production of the SHYSTER began in 1953 at Kaliningrad 88 (MMSDC), which at that time was the only missile production installation in the U.S.S.R. that had a vertical test facility of sufficient height to make an electronic checkout of a MRBM. Prototype production of the SHYSTER probably was continued at MMSDC until the mid-1950's, when a series production line was established at the Dnepropetrovsk center (DMDPC). The second missile in this category, the SANDAL, was first flight-tested in the summer of 1957. After the initial batch, there were no further tests until the spring of 1958—which suggests that the early missiles were hand-tooled, and that the interruption in the test program represented a shift in production facilities, also to DMDPC.

In June 1960, the first test-launching of the SKEAN occurred. Production of this system was undertaken at DMDPC.

(3) *Intercontinental range missiles* — The Soviets have developed and produced six ICBM's: The SS-6, SS-7, SS-8, SS-9, SS-10, and SS-11. The SS-6 served as both an ICBM and a booster for most of the space vehicles. It is still the principal space booster, and the operational models were retrofitted for space use. Limited production of the SS-6 is still going on for use as a space booster.

In early 1961 the test program of a new ICBM designated SADDLER (SS-7) was inaugurated. Telemetry intercepts have revealed many similarities in the instrumentation of SADDLER and SKEAN, which, along with other information, suggests that the same design team and criteria employed for SKEAN were most probably involved in the development of SADDLER. Series production and subsequent variations of the system took place at Dnepropetrovsk.

Testing of the third ICBM vehicle, SASIN (SS-8), began in the spring of 1961.

The SS-9 is a third generation, two-stage, tandem ICBM. It is the largest known Soviet operational missile, with an overall length of 105 feet and capable of ranges exceeding 7,000 nautical miles. The system was estimated to be designed at Dnepropetrovsk, where the initial batch of R&D missiles was also produced. Series production is believed to have started in mid-1965 at Dnepropetrovsk, with deployment at dispersed hard sites.

The SS-10 has never been put into series production, and the program has been discontinued. The exact role of SS-10, which underwent a limited testing program in 1964, has not been determined. This vehicle has been assessed to be a two-stage tandem missile with a separating reentry vehicle. It is estimated that the Soviets used the booster as a test vehicle for either a third generation ICBM, a test bed for subsystems, or possibly an interim step to a new space booster. All production, which never exceeded R&D quantities, was believed to have taken place at Moscow/Kaliningrad 88.

The SS-11, the newest operational storable liquid ICBM, is a relatively small two-stage vehicle with a 75-foot length. Series production probably began in late 1965. The missile is now being deployed at dispersed single silo hard sites.

b. NAVAL MISSILES — The Soviet Navy began a developmental program for missiles in the mid-1950's. The earliest developments covered both ballistic and aerodynamic systems. These missiles were evolved from the aerodynamic V-1 or were adaptations of ballistic systems designed for the ground forces. In addition, the surface-to-air missiles (SAM's) of the PVO (air defense forces) have also been adapted to naval use. To date, the Soviet Navy has deployed three cruise and three* ballistic surface-to-surface missiles and one—possibly two—SAM's.

(1) *SS-N-1* — The first missile to be operational was the SS-N-1, a short-range, turbojet powered, RATO-boosted, aerodynamic missile with a range of about 100 nautical miles.** It is carried by two classes of destroyers (*Kildin* and *Krupnyy*), and was believed to be operational about 1958. While the system is still operational, production is believed to have been phased out in 1964 after more than 500 missiles were produced. Being an aerodynamic vehicle, it probably was produced at a Ministry of Aviation Industry plant, although the specific installation has not been identified.

(2) STYX (*SS-N-2*) — The next missile to become operational was the STYX. This is a short-range (12 to 30 nautical mile), aerodynamic missile. It has a RATO booster and liquid-rocket sustainer engine. The missile is fired from the *Komar* and *Osa* classes of patrol boats, with two missiles carried on the former and four on the latter. This system became operational about 1959.

Production of the STYX, believed to be centered at one plant, Arsenyev Aircraft Plant 116 (*Zavod 116*), is one of the most active programs of the Soviet missile effort. Series production probably got underway in 1958-59; cumulative estimated production through 1966 amounts to some 2,000-2,500 missiles. This seemingly large total production rate is required to meet the needs of the Soviet Navy, with between 150 to 200 patrol boats equipped with the STYX, plus the fairly sizable numbers of the *Komar* and *Osa* craft transferred to eastern European Communist country navies as well as such other countries as Cuba, Indonesia, and the U.A.R.

* The first of the naval ballistic missiles, a version of the 150-nm.-range SCUD, probably was retired in about 1960-61; hence, it will not be discussed further.

** It is believed that the designed maximum range of the SS-N-1 is 150 km. (81 nm.). Few firings have exceeded 45 nm., and probably none have gone to 150 nm.

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(3) *SS-N-3 and variants* — The most recent of the surface-to-surface cruise missiles introduced into the Soviet Navy is also probably one of the most versatile—the SS-N-3. This missile is a RATO-boosted, turbojet-propelled weapon with a range of up to 450 nautical miles, and is believed to have become operational in 1961. The missile is launched from three classes of submarines—the conventional-powered W and J, and the nuclear-powered E. The W class is a conversion carrying from one to four missiles. The J class is a new class of submarine, carrying four missiles. The E class has two variations—the E-I carrying six missiles and E-II carrying eight missiles. In addition to these submarines there are the *Kynda* class and *Kresta* class guided missile cruisers (DLGM). The *Kynda* carries two quadruple launchers of SS-N-3's. In addition, it is equipped with one SA-N-1 (SAM) battery. The *Kresta* carries two twin SSM launchers (probably for SS-N-3, and two SA-N-1 launchers). Aside from its naval use, the SS-N-3 has also been identified as the SHADDOCK (SSC-1), used by ground forces coastal defense units.

The SS-N-3 was probably designed by Vladimir Nikolayevich Chelomey, possibly a first assistant to S. A. Lavochkin, who headed the aerodynamic cruise missile development until his death in 1960. Chelomey succeeded Lavochkin as Chief Designer; his design bureau is located in the Reutovo suburb of Moscow, probably at Plant 67 (*Zavod 67*). Initial production of the missile took place at Plant 67, but series production is believed to have been undertaken at three other plants. Total production of the SS-N-3/SS-C-1 is estimated to be about 2,000 missiles.

(4) *SS-N-4* — There are two ballistic missiles now operational in the Soviet Navy. One of these, the SS-N-4 was operational in late 1960. It is carried in tubes on three classes of submarines: the Z-V carried two and the G carries three. Both of these are conventionally powered. The H-I class, a nuclear-powered submarine, carries three SS-N-4; however, this class is being converted to the H-II in order to carry the longer-range SS-N-5. The SS-N-4 is a storable, liquid-propellant missile with a maximum range of 350 nautical miles. Production of the SS-N-4 is estimated to have taken place at Leningrad Arms and Tank Plant Bolshevik 232 (*Leningrad-Voenniy Zavod imeni Bol'shevika 232*). Total production is estimated at about 500 missiles, with production now phased out.

(5) *SS-N-5* — The most recently developed naval missile is the SS-N-5, primarily intended for the H-II class of nuclear-powered submarines. It is a storable, liquid-propellant system, with a range of about 650 nautical miles. Each submarine is equipped with three missiles. The IOC (initial operational capability) for the missile system was 1963. Although the location of production is unknown, it might be a follow-on missile to the SS-N-4, and as such, produced at Plant 232. Production so far has been quite limited, with less than 200 produced.

(6) SARK (*SS-NX-1*) and SERB (*SS-NX-2*) — Two other possible naval missiles are of interest. In November 1962, the SARK was paraded in Moscow. The size of the missile precluded its being placed in any known naval missile tube. The vehicle has since become regarded as a dummy or early prototype. In November 1964 the SERB was displayed; its sizing was such that it was estimated to be a model of a second generation missile. It has not yet been firmly established whether this is the SS-N-5, which would make the SERB a liquid missile, or whether it is a new missile and probably a solid propellant. Nothing is known of production sites and quantities for either of these missiles.

(7) *SA-N-1* — The Soviet Navy has one active adaptation and possibly a second of the SAM's. The *Kynda* class DLGM is equipped with one battery of SA-N-1's, which appears to be a version of the GOA (SA-3). In addition to the *Kynda* class, there is the *Kashin* class DLG (frigate), which has two dual SA-N-1 launchers. The GUIDELINE (SA-2) has a naval version called SA-N-2, seen on the cruiser Derzhinskiy.

(8) *New class vessels* — A new class of frigates called *Kresta* is now under construction. Its missile armament is not yet determined, but it has been suggested that it could be equipped with both the SA-N-1 and a surface-to-surface cruise missile, probably the SS-N-3. There have also been reports of a new missile submarine class under construction; this would probably be equipped with a new missile system.

c. SURFACE-TO-SURFACE AERODYNAMIC MISSILES — Soviet cruise missiles allocated to the military forces are somewhat unique in that they serve a dual purpose. The apparent same missile system, or one very closely related to the family, is used in the ground forces and naval forces/air forces. There are two basic systems deployed: The SSC-1, a 150- to 300-nautical mile-range system, and the SSC-2 (a and b), a 35- to 150-nautical mile-range system.

(1) SHADDOCK (*SSC-1*) — The SSC-1 was first seen in the Moscow Parade of November 1961, when it was given the NATO codename SHADDOCK. Studies of the system led to belief that the SSC-1, which achieved IOC in 1964, was a direct outgrowth of the Soviet developments of the SS-N-3, a naval cruise missile. A second role has been attributed to the SSC-1; namely, with the coastal defense forces as separate from the ground forces equipment seen in the Moscow parades. The coastal defense version of SSC-1 may also be slightly modified. For production information see the SS-N-3 write-up.

(2) SAMLET (*SSC-2b*) — The Soviet SAMLET—formerly designated as the SSCD-1 KENNEL S, a subsonic, surface-to-surface cruise missile—was first visually observed in a Cuban military parade on 2 January

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1963. This missile, of Soviet origin, is a modified version of the KENNEL (AS-1), and is deployed as a coastal defense system. The SAMLET differs from the ASM KENNEL in that there are modifications of the vertical tail design and the guidance antenna.

The German scientists deported to the U.S.S.R. after World War II reported Soviet activity in developing a coastal defense system. A launching of such a missile was reported to have taken place as early as 1953. There is some deployment of SAMLET in the coastal defense of the U.S.S.R. In addition, the Soviets have provided the system to Cuba, Communist China, North Korea, Bulgaria, East Germany, and Poland.

(3) SALISH (*SSC-2a*) — Another version of the KENNEL air-to-surface missile was seen in the Cuban parade in January 1965. This is the SALISH, which differs from the KENNEL and the SAMLET in that it has a larger antenna system on the vertical stabilizer. The SALISH antenna has a different configuration than SAMLET, while the missile has a longer, more pointed nose.

The existence of SALISH has been traced back to 1961. Shipping crates now identified as KENNEL-type appeared on flat cars along with other army vehicles. Information is very limited on the deployment of the system; however, the SALISH is known to be in Cuba and East Germany, as well as the U.S.S.R.

The production site for the SSC-2a and b has not been identified, but has been estimated that in addition to the KENNEL (AS-1), the Ivankovskiy Guided Missile Plant also produced these surface-to-surface variants.

d. ANTITANK GUIDED MISSILES (ATGM) — The U.S.S.R. has produced three antitank guided missile systems (ATGM's) which have been deployed. They are the SNAPPER (AT-1), SWATTER (AT-2), and the SAGGER (AT-3). All three systems are two-stage, solid propellant missiles, with a shaped charge high explosive warhead, though there are some variations among them.

(1) SNAPPER — The SNAPPER was first seen in the May Day 1962 Moscow Parade; it is still believed to be deployed, although considered obsolete. In addition, it has been sold to the eastern European Communist countries, and to the U.A.R., Iraq, Afghanistan, Cuba, and Indonesia. This wire-guided, manually operated system has an effective range of from 600 to 2,000 meters. It has been mounted on two vehicles—a modified BRDM, a lightly armored, highly mobile, wheeled combat vehicle with three missiles; and the UAZ-69, an unarmored, light, wheeled vehicle mounting three missiles. It is estimated to have been operational in 1960. Series production would have begun about 1958 or 1959, although R&D and prototype production would have begun several years sooner. The missile weighs about 53 pounds, is 45.3 inches long, and 5.35 inches in diameter.

(2) SWATTER — The SWATTER first appeared in the 7 November 1962 Moscow Parade. It was probably operational in 1961 and has been gradually replacing the SNAPPER. It is mounted on the standard BRDM, which mounts four missiles. The guidance appears to be by manual command through a radio frequency link; it is overall more effective than SNAPPER, with its increased maximum range (up to 2,500 meters), velocity, lethality, and azimuth coverage. The missile weighs 42 pounds, and is 49 inches long and 5.2 inches in diameter.

(3) SAGGER — The SAGGER, publicly displayed in the May 1965 Moscow Parade, has been sighted deployed in East Germany. SAGGER appears to be a supplement to SWATTER, to increase Soviet ATGM firepower and to improve coverage at minimum distances. Its effective range is from 200 to 2,500 meters. Six missiles are mounted on the BRDM, manually controlled through a wire link. SAGGER was estimated to be operational at the time it was first paraded in 1965. It is a little over 31 inches long and has a diameter of 4.5 inches and weighs 24 pounds.

About the time that SNAPPER was first seen, 1962 or thereabouts, its production is estimated to have begun phase-out. The SWATTER is currently in series production. SAGGER production is estimated to have begun in 1964 but has not yet reached its peak.

As yet, no production facilities for ATGM's have been identified. Suspect plants would be those producing general armaments, electronics, and/or solid propellants. Of these three types of facilities, the most likely to be engaged in production of ATGM's—based on the experience of the French, Germans, and Swiss—would be a general armaments or aerospace-type facility. It is estimated that the solid propellant motors in all three ATGM systems, based on previous knowledge of Soviet development of similar small missiles—AAM's, would be a double-base extruded propellant. A prime suspect area for an integrated ATGM production site is Gor'kiy, where are located the Gor'kiy Motor Vehicle Plant/Molotov, which is thought to produce the BRDM; Gor'kiy Arms Plant *Novoye Sormovo* 92 (*Zavod 92*); Gor'kiy Communications Equipment Plant Lenin 197-Frunze 326, which is part of the radio-electronics industry; and the Gor'kiy Fuse Plant 956 (*Zavod 956*). In addition, there is a firing range (polygon) near Gor'kiy which has been identified with ATGM's for the Chief Rocket and Artillery Directorate (*Glavnoye Raket'noyei Artilleriyskoye Upravaleniye - GRAU*). Another possible producer of ATGM's is the Kovrov Machine Tool and Arms Plant Kirkish 2.

e. AIR-TO-SURFACE MISSILES (ASM's) — The Soviets displayed an arsenal of four air-to-surface missiles for the first time during military and naval parades in July 1961. These were designated as the KENNEL (AS-1), KIPPER (AS-2), KANGAROO (AS-3), and

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KITCHEN (AS-4). New ASM's and/or variants of the existing missiles may be under development. Little information is available on ASM production, hence, the estimates given below are only approximate.

(1) KENNEL — The KENNEL, with an IOC date of 1956, is a subsonic air-to-surface missile with a range of 55 nautical miles, and was first displayed during the Leningrad Navy Day Parade in July 1961. Soviet Naval Air Force BADGERS (Tu-16) were observed each carrying 2 KENNELS under their wings. The missile is similar in appearance to the MiG-15 fighter, and is believed to be a product of the Mikoyan-Gurevich Design Bureau.

The guidance system of the KENNEL was developed by German scientists at the Moscow Guided Missile Research Center KB-1 (*Konstruktovskoye Byuro* 1). Production of the airframe and final assembly of the AS-1 took place at the Ivankovskiy Guided Missile Plant. German technicians working at this facility reported that in 1953, Soviet workers were engaged in assembly of missiles designated "KS." Evidence that the AS-1 is referred to as the "KS" was obtained from Indonesian reports referring to the Tu-16 "KS" missiles. The Soviets gave the BADGER/KENNEL weapon system to the Indonesians, and it was displayed by them in October 1962. The U.A.R. was also given the KENNEL by the U.S.S.R.; it was shown by them in July 1966.

Although the Germans reported "KS" missile production in 1953, it is believed that full series production of the KENNEL did not occur until 1955. An improved variant of the AS-1 may have been developed in the early 1960's to replace the KENNEL missiles assigned to the Naval Air forces, and possibly for use by Long-Range Aviation as well. Total production of the AS-1 and the possible follow-on is estimated to be 800 to 1,000.

(2) KIPPER — The KIPPER was observed at the Tushino Air Show in July 1961, partially retracted into the lower portion of the fuselage of the BADGER. This aerodynamic missile with a range of 100 nautical miles is believed to have reached operational status in late 1960. Analysis of this missile shows that it is an original airframe design and does not equate to any known Soviet aircraft. The KIPPER probably was developed by the Mikoyan-Gurevich design team. The production facility for the KIPPER may be Tbilisi Airframe Plant 31 (*Zavod 31*); Ufa Plant 26 (*Zavod 26*) is believed to be producing the RD-9b as the propulsion unit for the KIPPER. A production run of 600-800 missiles has been estimated for this air-to-surface missile.

(3) KANGAROO — The KANGAROO was also seen for the first time at the Tushino Air Show, retracted into the fuselage of a BEAR (Tu-95). This aerodynamic missile, which became operational in late 1960, has a range of 350 nautical miles and probably uses some components of the FARMER (MiG-19). Its propulsion system is believed to be the Type 31 engine, which was in production at Moscow Aircraft Engine Plant 45 (*Zavod 45*). Evidence is lacking on the production facility for the KANGAROO, but Tbilisi Plant 31 is viewed as the probable producer. It is estimated that approximately 300 AS-3 missiles have been produced.

(4) KITCHEN — Although the fourth air-to-surface missile, the KITCHEN, was first seen by Tushino Air Show observers in 1961, it still had not reached operational status as of mid-1967. The KITCHEN was observed carried semisubmerged in the fuselage of the BLINDER B aircraft; it has been assessed to be a liquid rocket-propelled boost-glide vehicle, with a maximum range of 280 miles. No evidence is available concerning the design authority or a production site for this missile, nor have production estimates been developed.

(5) *Recent developments* — A fifth air-to-surface missile is viewed as a possibility. The sighting of an aerodynamic object carried under the left wing of a BADGER occurred in July 1966. Unfortunately, the sighting did not provide enough detail concerning the propulsion or guidance system to determine if the vehicle was actually an ASM, a decoy or target drone, etc. In the event that this vehicle is an air-to-surface missile, it is speculated that it may be a follow-on missile for the obsolescent KENNEL.

f. AIR DEFENSE MISSILES — The U.S.S.R. has, since the early days of its missile program, shown a deep concern for developing, producing, and deploying air defense missiles. The GUIDELINE is the most widely deployed air defense missile system in the world, indicating a long production run at a fairly high rate. Since the GUIDELINE appeared, the Soviets have publicly displayed newer, larger air defense missiles, demonstrating firstly a continuing interest in SAM's, and secondly, a determined effort to develop a defense against missiles as well as aircraft.

(1) GUILD (*SA-1*) — The development of the first Soviet surface-to-air missile, GUILD, began in 1947 under the direction of General S. A. Lavochkin at his special design bureau in Khimki. The system was designated V-301, and the defense concept from which its characteristics were generated was the desire for protection of large cities—especially Moscow—from massive bomber attacks. The design and development effort was based on German technology which the Soviets had acquired after World War II. Although the Germans had had several SAM's in the developmental stage at the conclusion of the war, the Soviets centered their efforts on the WASSERFALL and SCHMETTERLING vehicles. While experimental work was taking place on the airframe, research was undertaken on the development of a propulsion system at Moscow Missile and Space Development Center Kaliningrad 88 and at Moscow Missile and Space

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Propulsion Development Center Khimki 456. As they had done for the airframe, the Soviets capitalized on German achievements in propulsion. The V-301 used the engine from the German Wasserfall, but the Soviets adapted it to burn kerosene as a fuel and red fuming nitric acid (also known as RFNA or AZOT) for the oxidizer.

The B-200 guidance system intended for use with the V-301 materialized in about 1949. It was developed at Moscow Guided Missile Research Center KB-1 (also known as *Leningradskoye Shosse Institut—LSI*). Several teams of the top German scientists in the U.S.S.R. were brought to the institute to assist in the perfection of the guidance and control system which would be incorporated into the V-301 missile system. Problems with the guidance system were overcome by 1951, and initial R&D production of the V-301 began. The flight test program at the Kapustin Yar Missile Test Range began in July 1951 and continued for approximately one year, during which time about 100 vehicles were tested.

Series production of the V-301 may have begun in 1952 at Moscow Guided Missile Plant Tushino 82 (*Zavod 82*), with some production also taking place at Moscow Guided Missile Research and Development Plant Khimki 301. Information suggests other plants were probably associated with component development and production of the V-301.

Initial deployment of the V-301 system occurred at the end of 1954; it has been estimated that the V-301 Moscow defense system became operational by the end of 1955. A total of some 18,000 missiles were produced before production was phased out, probably in 1958.

(2) *32-B surface-to-air missile* — The Germans in 1951 began work at Moscow Guided Missile Research Center KB-1 on a guidance system for a new missile called 32-B. Work on the design of the airframe was probably conducted at Moscow Guided Missile Research and Development Plant Khimki 301. It has been estimated that the flight test program for the 32-B began as early as 1952. Although this missile probably never reached series production, its value lay in the fact that it contributed greatly to the successful development of the V-750, Guideline.

(3) Guideline (*SA-2*) — Information on the development of the Guideline is rather sparse: some of the facilities for the development of the Guild and 32-B SAM's may also have contributed to the Guideline program. A new contributor to this SAM program might have been Scientific Research Institute 24 and Dyat'lov's Institute, which conducted R&D work on the German Rheintochter, an unguided solid-fueled SAM. It is possible that the Guideline booster might have been tested at NII 24's Sofrino Engine Test Facility, northeast of Moscow. Preliminary R&D studies on the Guideline probably began as early as 1951. Flight tests occurred during 1954-57, with series production beginning in late 1957 or early 1958. The facilities which may have participated in the production program include Moscow Guided Missile Plant Tushino 82, Saratov Airframe Plant 292, and the Dolgoprudnaya Airframe Plant 464 (*Zavod 464*).

The Guideline was first displayed on 7 November 1957; deployment began late in 1958. Since then, the system has been extensively deployed not only throughout the U.S.S.R. and in eastern Europe and Asia, but also in Cuba, the U.A.R., India, Afghanistan, and Indonesia. There are four versions of the Guideline missile, each succeeding model having improved capabilities. These have been in production from about 1957 to date (mid-1967). The first two versions are used with an S-Band radar, Fan Song A or B, which was produced from about 1957 to 1960. The last two variations are used with a C-Band radar, Fan Song C or E, which was produced from about 1960 to 1966. The S-Band models (missiles and radars) have been phased out and replaced by the C-Band models in the U.S.S.R., although the S-Band models are in use elsewhere.

(4) *GOA* (*SA-3*) — The GOA was designed to fill the low-level intercept gap in the Soviet air defense. Development work probably began about 1957, with the flight test program possibly beginning late in 1959 or early 1960. What is believed to be a GOA test area in the final stages of construction was seen at Kapustin Yar late in 1959. Series production of the GOA probably began by 1960; the weapon was displayed publicly in November 1964. Although there is no information on development and production facilities, it seems reasonable to assume that the facilities active in the Guild and Guideline programs continued in the same role for the GOA. Production figures for GOA (Figure 93) includes the SA-N-1 naval missile, which is a GOA.

(5) Griffon — A fourth in the family of surface-to-air missiles was displayed in November 1963. The role of this weapon, designated Griffon, has not been determined; however, its physical characteristics imply it could serve in an antiaircraft or anti-cruise missile role, or even with limited capability in an antiballistic missile role. The Griffon obviously drew heavily from the design of the Guideline; it might be assumed, since there is no evidence to the contrary, that the same research and development facilities were associated with both weapons. The Griffon was to be deployed at elaborate air defense missile sites in the Leningrad area. Since 1963, these sites have been modified and the Griffon missile has probably been abandoned in favor of a new long-range SAM system. Although no production facility has been positively identified with the Griffon, NII Leningrad probably was directly involved in the design of the casing for the solid motor booster.

(6) Tallinn *System* — This new long-range SAM system has been under development since about

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1964. Extensive deployment is expected to continue through about 1970. Series production of the TALLINN missile probably began in 1965, with some units of the system estimated to have become operational in 1967.

(7) GALOSH (*ABM-X-2*) — Little is known about the GALOSH system except for some deductions obtained from parade photography. This missile in a canister—which was first seen in November 1964—has been associated with deployment of an ABM system around Moscow. Production was estimated to have begun in 1966, although the facilities are unknown. If the four GALOSH engines are used by GRIFFON, then an association may exist relating NII 13 in Leningrad to at least the development phase of both of these systems. GALOSH is believed capable of exo-atmospheric intercept. A Soviet newsreel has shown GALOSH being fired, but nothing related to a test program is known.

(8) GANEF (*SA-4*) — The GANEF is a tactical SAM used in conjunction with ground forces operations at the Soviet front. The missile is characterized by four solid boosters and a ramjet sustainer. Maximum intercept altitude is estimated to be about 70,000 feet. It has an estimated effective range of 25 to 30 nautical miles.

g. AIR-TO-AIR MISSILES — Soviet fighter aircraft were observed carrying five different types of air-to-air missiles at the Tushino Air Show in July 1961. These missiles have been nicknamed ALKALI, ATOLL, ANAB, AWL, and ASH.

(1) ALKALI — Soviet activity in developing air-to-air missiles as armament for advanced aircraft dates back to the early 1950's. At that time, German scientists and technicians assigned to the Moscow Guided Missile Research Center KB-1 reported that the Soviets were working on a radar beam-rider air-to-air missile designated ShM—a weapon later identified as ALKALI. The Germans were required to assist in some design components of the various elements of the receiver, accelerometer stabilizing and control units, gyros, pneumatic servovalves, torque motors, and coupling rods. By the end of 1953, the Germans were informed that successful flight tests had been achieved; it is believed that the missile became operational in 1957. The Germans were unable to identify any Soviet designer associated with the ALKALI, nor could they pinpoint any production facilities for this missile.

(2) ATOLL — The ATOLL is an infrared homing missile almost identical in shape to the U.S. infrared SIDEWINDER. It became operational in 1959. While it is believed that the Soviets had access to U.S. plans of the SIDEWINDER 1 or 1A, or an actually spent missile, any information gained from these would seem to have proven beneficial to revised or later models, e.g., ATOLL A, etc. When the Soviets seized most of the German infrared personnel and facilities after World War II, they thereby acquired infrared homing systems suitable for air-to-air missiles. In 1958, the Soviets announced the development of an infrared homing missile. Recent information indicates that ATOLL production takes place at Bryansk Ammunition and Agricultural Machinery Plant Seltso 121. The design team of this missile is unknown. It is known that infrared work was conducted in several plants in Moscow, Leningrad, and Kiev.

(3) ANAB, AWL, *and* ASH — Early development of the ANAB, a semiactive radar homing missile, was noted by the Germans in the Moscow Guided Missile Research Center KB-1. Further intelligence on this or the ANAB A (an infrared homing missile), the long-range air-to-air missiles the AWL (a probable semi-active radar homing missile), and the ASH, a semi-active radar homing missile, is not available.

h. SPACE BOOSTER AND VEHICLE PRODUCTION — Over the nine year period since the launching of SPUTNIK I, a simply instrumented aluminum sphere, the Soviets have attempted more than 230 launchings, ranging from small astrogeophysical and interplanetary probes up to large multimanned space vehicles. To date more than 14 different types of space vehicles of varying weight, size, configuration, and complexity have been produced and expended. This includes LUNA moon probes—several of which circled and photographed the moon's surface, and two of which soft-landed on the moon; the sophisticated MOLNIYA communications satellites, which can transmit color television signals; the VOSKHOD multimanned space capsules; and the various interplanetary probes to Mars and Venus. Space vehicles of lesser consequence include the ZOND interplanetary probes, the two POLYOT maneuverable satellites, and the ELEKTRON radiation-measuring satellites. More than 80 of these vehicles, including 11 VOSTOK's, two VOSKHOD's, and almost 70 COSMOS military-reconnaissance satellites, have been identified as heavy-weight vehicles—ranging from 10,000 pounds to over 14,000 pounds. In mid-July 1965, the Soviets successfully launched PROTON I, a new space vehicle weighing about 27,000 pounds and employing a new and more powerful space booster. In addition to the more than 230 space vehicles launched, an additional 90 to 100 were probably expended in static ground tests, wind tunnel tests, launch failures, etc. Production of these space vehicles is being carried out in Moscow.

3. Principal production and test facilities

a. MOSCOW MISSILE AND SPACE DEVELOPMENT CENTER KALININGRAD 88 (MMSDC) — MMSDC [*Moskva/Podlipki Nauchno-Issledovateliskiy Institut* (*NII*) *i Zavod 88*] is the principal Soviet research and development center for ballistic missiles, space boosters, and space capsules. (Identifying details on production facilities are set forth in FIGURE 94. Locations of missile airframe and rocket engine plants are plotted

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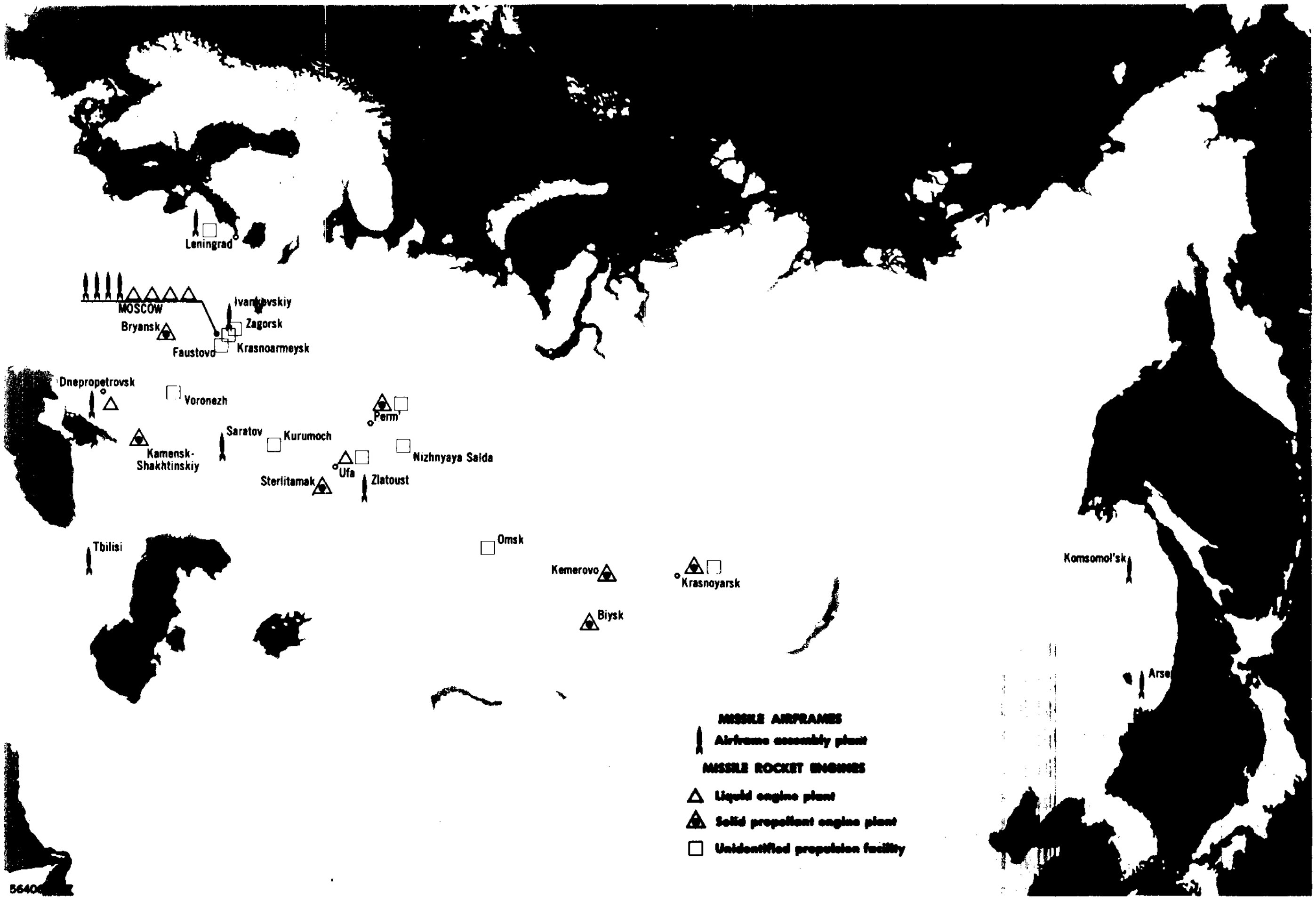

FIGURE 30. LOCATION OF MISSILE AIRFRAME AND ROCKET ENGINE PLANTS, U.S.S.R.

on FIGURE 30.) Established in 1945-46, MMSDC became the headquarters for the late General S. P. Korolev. The importance of the center is implied in the choice of its title: The Central Design Bureau for Space and Intercontinental Rockets (TsKBKMR). As a general rule, ballistic missiles are produced here during the R&D phase of production. If large quantities are planned, the missile is eventually "farmed out" to a second, or series-production plant. Should the missile not go into large scale deployment (as was the case with the SS-6), or the total requirement be small (as in the case of the SASIN (SS-8)), the limited production required would then take place at MMSDC.

MMSDC comprises three separate and distinct facilities. Research, design, and development of ballistic missiles and space vehicles for the various Soviet programs are accomplished at TsKBKMR. Numerous "design teams" are physically located here, and from this installation exercise control over the various branches located at production facilities, such as Dnepropetrovsk Missile Development and Production Center. The second area, identified as Plant 88, is concerned with the production of prototype missiles and space boosters. This is probably where assembled, and where the series production of the SS-6 and SS-8 took place—and probably continues to take place for the SS-6. The third area is occupied by Scientific Research Institute 88, which has been linked with the scientific research on space vehicles, ballistic missiles, propellant and associated instrumentation, materials, and technology. This organization supplements the work of the Central Design Bureau group and implements the programs when they get to the R&D hardware stage.

The basic facility contained approximately 1,300,000 square feet of floorspace at the end of World War II. In the mid-1950's, the former Central Artillery Design Bureau was incorporated into MMSDC, adding 560,000 square feet of floorspace. Since then, MMSDC has undergone considerable expansion concomitant with its expanding responsibilities. Most of the 1.2 million square feet of floorspace added in 1955-59 was for new assembly/fabrication and engineering buildings. Early in 1960, MMSDC's new products, the SKEAN, SADDLER, SASIN, VOSTOK capsules, space probes, and the COSMOS series came to fruition and were tested or orbited. The additional production and assembly buildings thus were required as MMSDC expanded its role in research and development programs and entered into new

space v[illegible] ble floorspace at

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MMSDC in mid 1967 was estimated as approximately 3,300,000 square feet.

b. DNEPROPETROVSK MISSILE DEVELOPMENT AND PRODUCTION CENTER (DMDPC) — Construction of this facility began in 1945, with the announced purpose of providing a new plant for truck production. It was then known as the Dnepropetrovsk Motor Vehicle Plant (DAZ); production was limited, and beginning in 1950, there were indications that a major change in activity was contemplated. Evidence in late 1951 or early 1952 indicated a transfer of the former activities of DAZ (or discontinuance), a change in the name and subordination of the plant, and conversion at least in part to military production.

The most significant link of DAZ (now referred to as DMDPC) with the Soviet guided missile program has been its known relationship with Moscow Missile and Space Propulsion Development Center Khimki 456. In 1950-51, about 500 workers from DMDPC reportedly arrived at Plant 456 for training in processes associated with production of rocket engines. After 1951, engineers, specialists, and technicians from Plant 456 frequently visited DMDPC. Evidence indicates that Plant 456 also sent to an unidentified plant in Dnepropetrovsk, "Article 7," one of a series of developmental rocket engines. DMDPC reportedly produced its first missile, a modified V-2, in 1952 and reportedly began engine testing in the same year. Engine production is believed to be continuing. Civilian production also is still carried on here—Bel'arus tractors and Dnepr' refrigerators being the most prominent products.

Series production of missiles probably began at DMDPC in 1956, with the SCUD A, followed by SCUD B. Later in the year, series production of the SHYSTER began, and in late 1957 production of the SANDAL probably got underway. From a production standpoint, it was a relatively simple task for DMDPC to initiate production of the SANDAL since it was basically an elongated SHYSTER. In 1961, DMDPC initiated production of the SKEAN, and in 1962 began to make the SADDLER. Series production of both the SS-9 and SS-11 is believed to have started at DMDPC in late 1965. The SS-12 was possibly in series production in late 1966 or early 1967. DMDPC is now regarded as the main surface-to-surface ballistic missile series-production center in the U.S.S.R., and may well serve as a systems-manager for various systems. Currently making the SS-9, SS-12, and possibly the SS-11, it is thought to be a series producer of rocket engines also acting as a "lead plant" to farm out production to other plants.

c. MOSCOW MISSILE AND SPACE PROPULSION DEVELOPMENT CENTER KHIMKI 456 — MMSPDC [*Zavod i Opytnoye Konstruktorskoye Byuro (OKB) 456*] — This is considered to be the major Soviet facility for liquid rocket engine design and development. Before World War II, it was associated with aircraft production, however, during the war the equipment and labor force were moved to Tashkent. Plant 456 had been rebuilt and rehabilitated by the time the German missile specialists and their equipment arrived from the Soviet Zone of Germany in 1946. By 1953, the subordination of MMSPDC was transferred from Ministry of Aviation Industry (MAP) to the Ministry of Defense Industry (MOP). MMSPDC covers about 200 acres of land, and has a floorspace of about 1.4 million square feet, of which 1.3 million square feet are in one building. The facility features at least three liquid rocket test stands with a possible fourth stand. Its major concern has been the development of large, progressively higher-thrust engines. This facility has also produced templates and tooling for the main series producer of each engine and provided guidance in the initial production stages as seen at Dnepropetrovsk in the early 1950's.

Recent developments at MMSPDC have illustrated the center's continuing work in more advanced engines, particularly those that will eventually be utilized in advanced space work. This is seen in the expansion of the Flight Experimental Testing facility (*LOI*). Ground observations of a new 325-foot tower lead to the assessment of its function as conducting toxic fumes to greater heights for dispersion into the atmosphere. The requirement for such a tower implies work on toxic propellants, such as fluorine containing oxidizers, or work with beryllium fuels. The chief engineer-designer reportedly proposed in 1958 a colloidal solution of beryllium in fuel as a propellant. This appears to confirm work with beryllium reduction. Research with such propellants creates toxicity problems which are partially remedied by such dispersion methods; if such toxic fumes were dispersed in their original state, the level of the toxicity transmitted to the atmosphere would possibly prove dangerous to residents of surrounding areas. The new construction in the LOI area indicates that MMSPDC is now set up to support the space program through research and development of upper stage engines using exotic propellants. This contrasts to its earlier role as a central design bureau for all engines utilized in ballistic missiles, as well as space boosters and upper stages. The increasing number of solid motor ballistic missile systems and the decreasing number of new liquid engine ballistic systems gives additional emphasis to Khimki's new role with space/upper atmospheric vehicles.

d. MOSCOW GUIDED MISSILE PLANT 67 — Guided Missile Plant 67, with an estimated floorspace total of 1.5 million square feet, is believed located in the Reutovo area of Moscow. Several direct observations in 1964 and 1966 have not revealed information concerning the plant's product; however, an analysis of the physical characteristics of the equip-

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ment observed revealed probable involvement in aerodynamic cruise vehicle production. This information, coupled with the knowledge that the design bureau of V. N. Chelomey of the Soviet cruise missile program is located in the Reutovo area, leads to the belief that Plant 67 is working in conjunction with or for the Soviet cruise missile program. This may be the facility where the SS-N-3/SHADDOCK was designed and initially produced before serial production was farmed out to several subsidiary plants.

e. IVANKOVSKIY GUIDED MISSILE PLANT — This installation is located along the Volzhskoe Reservoir on the southwest outskirts of Podberez'ye, a suburb of Ivankovskiy, and has an estimated floorspace of 1,000,000 square feet. The plant was constructed in 1937, with U.S. aid, for production of seaplanes and was dismantled and evacuated in 1941 with the approach of the German armies. After the war, the plant was reequipped with machinery seized from former German aircraft companies and was used as an aircraft experimental plant. Between 1946 and 1953, German engineers and technicians assigned to the Ivankovskiy plant reported that they assisted the Soviets in the design and construction of the V-1 type weapon, rocket-powered aerodynamic test vehicles, rocket-powered research aircraft, and a bomber. German sources also reported that in 1953 the Soviets were producing subassemblies of missiles designated "KS," the Soviet designation for the KENNEL air-to-surface missile. The plant is also the suspect producer of the SALISH and SAMLET cruise missiles because of their derivation from the KENNEL.

The current function of the plant is unknown. It is estimated that production of the KENNEL may have ceased in 1960 and the SALISH and SAMLET in 1962-63. (Production of an improved version of the KENNEL could be continuing, although there is no evidence of this.) However, based on the assumption that this plant was the pilot for development and production of the first air-to-surface missile, it is believed that it may be a design authority for other air-to-surface and possible cruise missiles.

f. KURUMOCH ROCKET ENGINE TEST FACILITY — The Kurumoch facility was in the construction stage when observed in late 1959. It is contained in a 2 x 5 nautical mile rectangle and is connected by both rail and road to the Kuybyshev industrial and transportation net. One of the more outstanding aspects of the area is the exceptionally large number of buried or semiburied tanks. In the facility there is a possible cold flow structure; a test support building which could be used for the processing of the various pieces of equipment to be used in the tests; a possible laboratory building; and an assembly and checkout type building. About 600 feet from the assembly-type building, there is a large test stand, which it is estimated, has a thrust capacity of from one million pounds to an upper-thrust limit on the order of four million pounds.

It is questionable if Kurumoch would remain a single test stand facility. Continued expansion and modification of facilities has been noted at other liquid propellant test facilities, and if Kurumoch follows this pattern, it appears likely that a certain amount of expansion would occur here too. It is possible that Kurumoch may now have multiple stands and/or smaller stands for component testing.

g. ZAGORSK (KRASNOZAVODSK) MISSILE EXPERIMENTAL/TEST FACILITY — Various reports indicate that the Zagorsk facility was at least in the planning stages as early as 1947. Later sources reported the construction of a rocket-related facility north of Zagorsk in 1956. The facility appears to have served as a field station of Moscow/Kaliningrad 88 for the testing of rocket engines and final assembly of surface-to-air and ballistic missiles of all sizes, including ICBM's. It may also have a capability for modification and/or final assembly work in support of missile testing. Moscow personnel from Khimki 456 and Kaliningrad 88 were observed visiting Zagorsk during 1956.

During the winter of 1946-47, a German engineer attached to Kaliningrad 88 was taken to an area north of Zagorsk to determine the suitability of this region for a test facility and to prepare construction drawings for combustion chamber, turbopump, and complete rocket engine testing facilities. Eleven test stands with varying thrust capacities up to and including 100 tons were to be provided. It was further reported that in 1947, a German engineer at Kaliningrad 88 was asked to design a rocket engine test stand with a safety factor of four, capable of rocket engine thrusts to 250 tons. This subsequently designed facility was to be located in the Zagorsk area also. Confirmation of any actual construction of the Zagorsk facility was not obtained from the Germans.

Information obtained from another source indicated that construction of the facility occurred in the area north of Zagorsk, near Krasnozavodsk, during 1956, and the probable completion by the fall of the same year. This source indicated a larger facility than Khimki 456, but one consisting of fewer buildings than those comprising Kaliningrad 88. Although the facility was by no means finished in July 1956, undoubtedly some sort of development activity was underway. Information of July 1956 reported at least three test stands in the area, and there appears to be a working relationship between Khimki 456 and Zagorsk.

Progress has been made in Soviet missiles and space boosters which, in the case of space boosters, includes an increase in physical size and total thrust. It is probable that the Zagorsk facility has also experienced an increase in size. Since MMSDC is historically the principal research and development center having

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responsibility for all space boosters and payloads, it seems likely that it worked on the new 2-4 million pound thrust, two-stage PROTON booster. Because Zagorsk is historically connected with both Moscow/Kaliningrad 88 and Khimki 456, it is likely that the PROTON booster was tested at Zagorsk, necessitating a certain amount of expansion of facilities, probably reflected in new or modified test facilities, handling facilities, and assembly and checkout facilities.

4. Missile propulsion

a. LIQUID ROCKET ENGINES — Despite some substantive endeavor towards the development of a rocket engine prior to World War I notable advancements in the 1930's with the development and construction of small liquid propellant rocket engines, significant achievements were not made until the end of World War II, when the U.S.S.R. imported German machinery and technical know-how in this field. The German experience, which was exploited to the fullest, provided the Soviets with the base from which they evolved their high-thrust liquid rocket engines. As Soviet conservative technological methods stress reliability and performance over radical design, their basic rocket engine design has not varied greatly over the past 20 years. Rocket engine production plants are described in FIGURE 95.

Initially, much effort appeared to be directed toward modification of the power plant incorporated into the German V-2 missile. Strengthening the chamber head, plus increasing the chamber pressure, resulted in the Soviet-designated A4/35, which had a thrust of 77,000 pounds—about 21,000 pounds more than the V-2 engine. Plans were also made for a further upgraded version to 92,000 pounds thrust. While work was being done on modifying the V-2 engine, German and Soviet technicians were also working on the German WASSERFALL engine. This engine, designed for use in a German anticraft weapon, had been selected, with modifications, for use in the Soviet GUILD surface-to-air missile. Many of the technological strides in 1946-52 were made by the Germans; the Soviet research, however, contributed such facets as sophisticated brazing techniques for the chamber wall of the A-10 engine, which was composed of steel inner and outer skins, with a middle layer of corrugated copper serving to form the coolant channels. In the early 1950's, work began on clustering engines. It is estimated that two additional years are required for clustering a basic engine to meet system requirements whereas it takes about four years to develop a basic rocket engine to the point of system testing.

Liquid rocket engine research, development, and production centered on the Moscow Missile and Space Propulsion Development Center Khimki 456. V. P. Glushko, probably the foremost Soviet designer in this field, led the R&D effort at Khimki, and it was to this facility that the foremost German scientists and scientific equipment were taken after the war. Initial Soviet production of the standard German engine began here in 1947. There are two facilities other than MMSPDC that are known to have engaged in liquid rocket engine production: Moscow/Kaliningrad 88 and Dnepropetrovsk Missile Development and Production Center. In addition, static test facilities for liquid rocket engines exist at Zagorsk, Ufa, Krasnoyarsk, Omsk, Perm, Nizhnaya Salda, Voronezh, and Kurumoch.

b. SOLID PROPELLANTS — The first Soviet interest in solid propellants, for reasons other than gun applications, came in the 1930's when the Soviets developed a propellant for use in their KATYUSHA artillery barrage rocket. Early Soviet solid propellant rockets, FROG 1 (Free Rocket Over Ground) and FROG 2, as well as the booster of the GUIDELINE, are still using their basic type of propellant, with only slight variations.

Up to 1958 the Soviets chose to expend their efforts on developing and refining the liquid propellant engines that the Germans had developed in the 1940's. Today, all known operational Soviet strategic missiles still use liquid propellants. The Soviets, it seems, were satisfied to apply solid propellant technology to only small, short-range, artillery or tactical-type weapons possibly because their chemical industrial base was not capable or versatile enough to include a composite propellant production program; however, a growth in the U.S.S.R. solid propellant industry has been apparent. There was a threefold increase between 1955 and 1963, but the application to missiles was minimal. It was estimated in 1967, however, that the existing solid propellant production facilities can support a sizable deployment program for all known systems, with a remainder available for such other military systems as artillery rockets, RATO (rocket assisted takeoff) rockets for aircraft, mortar launchers, conventional ammunition, flares, sounding rockets, rescue signals, torpedoes, aircraft engine starters, and fireworks. Thus the Soviets are believed to be capable of producing considerably more solid propellants with current facilities as new missile systems are developed. Facilities for large grained solid motor production are believed to exist at Biysk, Kamensk-Shakhtinskiy, Kemerovo, Krasnoyarsk, Perm, and Sterlitamak (FIGURE 95).

In 1963, only a few of the Soviet missile systems in series production utilized solid motors. These included the FROG-7, GUIDELINE and GOA, but together these required less than 1% of assessed Soviet capacity. Several new missiles utilizing either solid propellants completely or a solid booster were displayed in various parades beginning in 1964. These included GRIFFON, GANEF, GALOSH, and possibly SERB. In May 1965, the Soviets unveiled two more solid propellant missiles: an MR IRBM, the SCAMP (SS-X-1), and an

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ICBM, the SAVAGE (SS-X-3). In November 1965, another ICBM, the SCROOGE (SS-X-2), was shown. While it has not been determined whether any of these missiles is in series production now, it would seem that the Soviets have made great strides even if these new systems are only prototypes.

In developing their solid propellant missiles for strategic range, the Soviets appear to have had difficulty in finding the right formulation for casting large-grain diameters. This problem has apparently been solved because there is now flight testing of what is believed to be a solid propellant test vehicle to MRBM ranges, and a solid propellant ICBM has recently been tested to ranges in excess of 4,500 nautical miles.

5. Import and export of missiles and components

The U.S.S.R. does not import any missile system, although the Soviets may have imported some electronic and/or guidance components from several eastern European Communist countries. Exports to Warsaw Pact countries, Yugoslavia, Cuba, and Far Eastern Communist areas, as well as to non-Communist countries, are taking place, however, on a relatively large scale.

Missile exports to the eastern European Communist countries and East Germany and Cuba have included primarily GUIDELINE surface-to-air missiles, antitank missiles, SNAPPER, possibly SWATTER, and probably SAGGER, and the aerodynamic coastal defense and surface-to-surface tactical missiles SAMLET and SALISH respectively. The Warsaw Pact countries have received the SCUD SRBM. Soviet assistance to Communist China probably involved assisting in the establishment of the Shuang-Cheng-Tzu Missile Test Range, guidance in establishing several missile R&D facilities and assembly plants, and the supplying of a limited number of surface-to-surface missiles, including an MRBM, an SRBM, surface-to-air missiles (GUIDELINE), and cruise missiles (SAMLET). North Korea and North Vietnam both have GUIDELINE, ATOLL air-to-air, and SAMLET coastal defense missiles. Principal recipients of exports to the non-Communist bloc area have been the U.A.R., Indonesia, and India. The prime exports have been the air-to-air ATOLL, air-to-surface KENNEL, surface-to-surface naval missiles STYX, and SNAPPER antitank guided missiles. FIGURE 96 provides a breakdown of countries receiving Soviet missile aid and the types of material shipped.

6. Sources of supply

The production of guided missiles and space systems in the U.S.S.R. is a vast task, yet there is no evidence of any shortages of the necessary items that go into the production stream. It is assumed that all or nearly all supply is accomplished within the U.S.S.R. itself. While some of the eastern European countries (e.g., East Germany, Czechoslovakia, and Hungary) have capabilities for supply of certain components in quantity, there is little evidence of such support today. Nevertheless, for convenience the Soviets may obtain some components from these countries. The immensity of the supply task for the missile industry is such that it spreads across the entire spectrum of Soviet industrial effort.

Supply, as used in this discussion, means the delivery of basic items to the final manufacturer or producer. Such intrinsic components as rocket engines, nuclear warheads, and fuels, whether liquid or solid, are not included. But the furnishing of electronics, computers, special metals or alloys, tracking devices, and ground support equipment (AGE – aerospace ground environment equipment) are accepted as part of the basic provisioning of the Soviet missile program and must be provided in large quantity and variety by facilities of many industries.

The major industries include the electronics, optical, machinery, and chemical equipment plants which supply various components of the missile; metallurgical plants which provide the metal for the missile airframe and other components; and the trailer, tractor, and railroad equipment plants which make the ground support equipment.

I. Other military equipment

1. Chemical, biological, and radiological (CBR) warfare materiel and countermateriel

a. STRATEGIC SUPPLY POSITION FOR FINISHED PRODUCTS

(1) *General* — The U.S.S.R. places a high priority on preparations for offensive chemical warfare (CW) and for defense against CBR warfare. It produces large quantities of CW agents and defensive equipment. No Soviet facilities have been identified that now mass-produce BW agents; however, the U.S.S.R. is well versed in BW production techniques and could easily produce large quantities of BW agents and munitions. Radiological warfare (RW) weapons are not produced because the U.S.S.R. considers them ineffective weapons. An increasing potential for BW/CW agent production may be expected from the industrial and scientific programs presently under way.

(2) *Production* — Production of CW materiel by the U.S.S.R. is estimated to be at least 15,000 tons, and possibly as high as 30,000 tons a year. Production includes nerve agents, mustard, a mustard-lewisite mixture, hydrogen cyanide, and phosgene. In addition, mustard, hydrogen cyanide, and phosgene production could be diverted from industry to the military. The Soviets developed agents similar to tabun in 1943-44, but the acquisition of German nerve-gas production processes and equipment after World War II and the availability of skilled German scientific and technical personnel greatly assisted the U.S.S.R. in producing nerve gas in the early postwar period. Such production could have begun by 1947.

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Published reports indicate that a compound similar to the V-type nerve agents—noted for their high percutaneous toxicity—was first synthesized in the U.S.S.R. in 1948. It is estimated that V-agents could have been developed as early as 1953 and that production of these compounds could have been initiated by 1956. Nerve agents produced are soman, sarin, and an unidentified agent, VR55.

Current production also is believed to include an adequate quality of CW-agent disseminators, such as aerial spray tanks, bombs, shells, rockets, and, possibly guided missiles. Portable flamethrowers as well as fixed, cart-mounted, and tank-mounted units are produced.

The current level and disposition of CW-agent stockpiles are not positively known. Current estimates indicate that the U.S.S.R. has at least 200,000 tons of CW agents, and perhaps considerably more. It is assumed that about 30,000 tons of this supply would be kept in filled munitions and 170,000 tons in bulk. About one-half of the stockpile is believed to consist of nerve agents.

Present industrial pharmaceutical and biological plants and the pilot plant facilities of Soviet research institutes can be utilized for BW agent production. However, there is no indication of large-scale production. The Soviets have gained experience which can be used for BW agent production through their extensive production of live dry vaccines and the use of the deep-culture production process. Through the use of modern propagation techniques, the Soviet Union can produce large volumes of concentrated pathogens suitable for use in a BW offensive. The U.S.S.R. has imported two Heden continuous culture fermentors from Sweden. These fermentors can produce large quantities of microorganisms in short periods of time.

In addition, the U.S.S.R. has designed and produced its own fermentor. The apparatus has been used for several years for the deep cultivation of microorganisms under sterile conditions and on a "semifactory" scale. Candidate BW agents, including brucella, tularemia, and anthrax have been successfully cultivated under these conditions.

The U.S.S.R. has also developed a method for the submerged cultivation of pathogenic plant fungi and has demonstrated its capability to produce the causative agents of rice blast and white blast of corn. The capability can be expanded to other plant diseases.

Experiments with viral continuous tissue culture and the "biphasic" culture techniques have been conducted. These techniques could be utilized for the large-scale production of BW agents. In addition, the U.S.S.R. has made significant progress in preservation for storage of microorganisms in the dry state, and manifold and chamber-type vacuum-freeze dryers for laboratory and commercial production have been built. Vacuum-freeze drying directly assists dry vaccine production and would also be valuable to the U.S.S.R. in producing and storing BW agents for extended periods. The technical resources and equipment available in industries which have facilities for fermentation could also support production of various BW agents.

The U.S.S.R. has a high capacity for the production of defensive materiel. Annual production of military protective masks ranges between 0.8 million and 1.5 million units. These masks are a modernized version of the World War II *Shlem*-1, capable of providing protection against CBR agents. For civilian defense purposes, the GP-4U gas mask is available. Protective clothing—both permeable and impermeable—is mass-produced, as are vaccines and antibiotics. The U.S.S.R. also manufactures CBR detection and decontaminating equipment.

Antibiotics and vaccines now stockpiled in the U.S.S.R. can be used in the BW defense program.

b. Raw materials — The chemical industry of the U.S.S.R. is capable of supplying sufficient raw materials to satisfy peacetime requirements for CW agent production. The increase in the production of chlorine since World War II has been impressive, and is believed adequate to meet military and most industrial demands. Production of fluorine, sulfur, phosphorus, and other potential CW agent chemicals is also adequate. The U.S.S.R. also has adequate supplies of the raw materials required to produce BW defense-related vaccines, antibiotics, and pharmaceuticals in addition to materials needed to produce protective masks and clothing. The raw materials utilized in the production of vaccines and antibiotics can also be used for BW agent production.

c. Imports and exports — The U.S.S.R. has supplied CW defensive and offensive materiel such as flamethrowers to several Communist and non-Communist countries. Toxic CW agents may have been furnished to Communist China, and possibly the U.A.R. and North Korea. The U.S.S.R probably does not import CW materiel. In the field of BW, the Soviets have supplied the eastern European Communist countries with defensive materiel, but also has imported various items in this category from both Communist and non-Communist countries.

d. Plants — About 30 plants reportedly were associated with CW production during World War II; however, not more than one-third of these are estimated to have produced CW toxic agents. With the emergence of the nerve gases in the postwar period, it is assumed that only a small number of the World War II producers continue to produce WWII-type CW agents.

Two facilities believed to be producing nerve agents are Chemical Plant No. 91, Beketovka (near Volgograd), and a large new plant located at the Central Chemical Proving Ground, Shikhany. Chemical Plant No. 91 is one of the largest producers of

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chemicals in the U.S.S.R.; it initiated nerve agent production with captured German equipment. The Shikhany plant may produce the new nerve agent, VR55. Two other plants, important because of their production of organo-phosphorus compounds and WWII production of CW agents are Chemical Plant *imeni* Kalinin, Dzerzhinsk (near Gor'kiy), and Chemical Plant 755 at Shchelkovo. Other potential producers are Chemical Plant No. 102, Chapayevsk, and Chemical Plant 673, Kazan.

It is not known whether the U.S.S.R. has a specialized facility for large-scale production of BW agents. Production of BW agents in quantity would be possible in many of the laboratories and research institute of microbiology and epidemiology as well as in the vaccine- and serum-producing facilities which are widely dispersed throughout the country.

Major installations which could assist in BW agent research and production include: 1) The N. F. Gamaleya Institute of Epidemiology and Microbiology; 2) the All-Union Institute of Experimental Veterinary Medicine (VIEV); 3) the State Scientific Control Institute of Veterinary Preparations (GNKI); 4) Mechnikov Scientific Research Institute of Vaccines and Serums, and 5) the Leningrad Scientific Research Institute of Vaccines and Serums. The installations are in or near Moscow, except as noted elsewhere.

2. Military engineering equipment (bridging and stream-crossing, camouflage, infrared, and topographic)

a. General — The U.S.S.R. is one of the largest producers of military engineering equipment in the world. It produces sufficient bridging and stream-crossing equipment to satisfy its own military requirements, and to export some equipment to both Communist and non-Communist countries. A wide range of camouflage, infrared, and topographic equipment is produced, and some is exported. For all four classes of equipment, the U.S.S.R. produces nearly all of the necessary raw materials and components. Efforts are being directed toward complete independence from non-Communist sources.

b. Strategic supply position of finished products

(1) *Bridging and stream-crossing equipment* — Quantitative appraisal of Soviet production of military river-crossing equipment is not possible because of the paucity of information; however, it is obvious from the quantities of this materiel held by Soviet troops and from reported exports to the eastern European Communist countries that the U.S.S.R. produces sufficient amounts to meet military requirements. More than 40 plants and shipyards (centered around Leningrad, Moscow, and Odessa) reportedly have fabricated river-crossing equipment. While many of these are now engaged in nonmilitary production, they are capable of changing to military production at any time.

Items produced include light and heavy ponton bridges; pneumatic, wooden, and metal assault boats; fixed and vehicular-launched bridges. A family of amphibious vehicles with carrying capacities ranging from one ton to possibly 15 tons are available for use by the engineer troops in support of shore-to-shore and over-the-beach operations. Power utility boats, fixed and floating bridges, assault boats, and propulsion units have been acquired by the U.S.S.R. from Czechoslovakia, East Germany, Hungary, and Rumania. Czechoslovakia reportedly supplies ponton bridges to the U.S.S.R., and East Germany has supplied the Group of Soviet Forces Germany (GSFG) with pontons, assault and power utility boats, and some truck-mounted bridges.

Soviet-manufactured equipment is in use throughout eastern Europe Communist countries; however, since production of the more important items, such as ponton bridges, conforms to standard designs throughout the Warsaw Pact nations, the presence of specific items in these countries is not indicative of the types or quantities of equipment being supplied by the U.S.S.R.

(2) *Camouflage equipment* — Little information is available about the quantities of camouflage equipment manufactured or the factories engaged in this work. Production of this equipment poses little, if any, difficulty. The availability of necessary raw materials, the development of synthetics, and the existence of numerous textile plants make the country potentially capable not only of supplying the military with all types of camouflage items, but of providing for exports as well. Soviet-produced ungarnished nets and individual camouflage items are known to be used by various Soviet bloc armies.

(3) *Infrared equipment* — During the 1950's, the expansion of the precision optics and electronics industries enabled the U.S.S.R. to provide its armed forces with many types of infrared equipment. Increased production in later years is reflected in the wide deployment of infrared devices for ground, shipborne, airborne and missile applications. Factory data are lacking on volume of output, but the current use pattern of infrared devices tends to indicate that production capacity is adequate to meet military and space requirements. Production includes metascopes; night-driving devices (both vehicular-mounted and head-mounted binocular types); sights for snipers' rifles, machineguns, and tanks; alarm and intruder devices; infrared guidance systems for missiles; fire-control apparatus for sea, ground and air; communication devices such as infrared-beam voice or signal equipment; infrared reflectors; air and sea approach devices; and thermal direction finders. Figure 97 describes some of the major producers of military infrared devices. Plant No. 393, at Krasnogorsk, probably is the most important producer in the U.S.S.R. There have been reports of infrared

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viewing devices mounted on Soviet-made armored vehicles held by the East German Ground Forces; however, the equipment may originate in either the U.S.S.R. or East Germany. The U.S.S.R. is self-sufficient in practically all raw materials for the production of infrared components and assemblies.

(4) *Topographic equipment* — The rapid development of the Soviet topographic industry after World War II can be attributed to the acquisition of German experts and the transfer to the U.S.S.R. of portions of the *Carl Zeiss* and *Askania* plants from East Germany. Types of surveying and related instruments exhibited in Moscow in late 1965 indicate that up-to-date precision optical, electrical, and electronic components are used in the design and manufacture of complex topographic equipment. Production includes a wide variety of surveying, photogrammetric, and reproduction devices including optical, photo- and cinetheodolites, automatic alidades, levels, compasses, stereoscopes, stereographs, stereoprojectors, electrooptical and photographic rangefinders, and automatic aerial cameras equipped with electrical controls and ultrawide-angle lenses. Production figures for these items are not available, but the output is more than sufficient to meet domestic needs. FIGURE 97 lists seven of the known producers of topographic equipment.

Imports of topographic equipment have dwindled since 1958. Procurement from leading countries of the non-Communist world in 1966 was limited to complex devices. Four electronic ordinate plotters were purchased from Switzerland, and a Soviet offer was made—subject to U.S. export license—to purchase a U.S.-made power scanning stereoviewer.

3. Instruments, gages, and servomotors of special military interest

Little is known about the production of gages, instruments and servomotors for military use, but the many plants producing precision instrument and electrical equipment are capable of satisfying most of the Soviet military requirements. The large Soviet production capabilities in the field of precision instruments and the evident complexity of Soviet weapons tend to support this conclusion.

Manufacture of precision instruments has been expanding since the end of World War II—especially since the beginning of the 7-year plan. In 1966 the instrument manufacturing plants subordinate to the Ministry of Instrument Making, Automation Equipment, and Control Systems were slated to produce 4,500 types of instruments, mechanisms, and machines, including 500 new types of devices. Production is to increase at an average annual rate of 13.5% during 1966-70.

Several Soviet plants are capable of manufacturing servogenerators and servomotors for missiles, aircraft, tanks, and artillery pieces. The production of servomotors probably is carried out in electric motor plants. The use of servomechanisms on conventional armaments has been limited although the progressive complexity of Soviet weapons may require more extensive use of such devices in the future. Major producers of instruments, gages, and servomechanisms of military interest are listed in FIGURE 98.

Dependence upon imports has greatly decreased in recent years, but efforts to procure Western types of measuring and control instruments have continued. In 1965, such efforts included an unsuccessful inquiry relating to U.S.-made 60-cycle servomotor generators suitable for use in precision industrial or military control systems.

4. Quartermaster supplies

The U.S.S.R. has sufficient industrial and technical capability to satisfy the peacetime and wartime requirements of the armed forces for quartermaster equipment and supplies. Although the U.S.S.R. imports some important raw materials, such as hides, wool, nonferrous metals, and dyestuffs, these imports are not essential to the manufacture of most quartermaster items. The chemical industry has provided new types of materials and has increased the production of plastics, artificial fibers, synthetic rubber and leather, and other materials suitable for making military textiles, protective clothing, parachutes, and other quartermaster goods.

Items which have both military and civilian use (e.g., petroleum product containers, tents, and kitchen equipment) are commonly produced to uniform specifications acceptable to the military. This system simplifies manufacturing operations and keeps the producing industries in a state of preparedness for mobilization. New types of POL-handling devices, such as portable containers made of flexible rubber and lightweight rubberized pipelines, have been produced. Uniforms of high quality are manufactured in clothing factories wholly or partly engaged in military production. Manufacture of these and other quartermaster items poses few problems for the U.S.S.R. Nevertheless, significant quantities of uniforms and certain other quartermaster supplies and equipment are manufactured to Soviet specifications in East Germany and Czechoslovakia, both for the Soviet forces in East Germany, and for export to the U.S.S.R.

During World War II, the Moscow and Leningrad areas were the most important producing centers of quartermaster materiel. Although these areas continue to be important, there has been some dispersion of production to Kaunas, Kiev, Lvov, Minsk, Gor'kiy, Sverdlovsk, and other towns. There is little information to identify specific Soviet producers of quartermaster supplies and equipment. However, Kanat Mill, Leningrad, has been identified as a producer of heavy nylon rope, suitable for parachute cords; Verteno Mills, also in Leningrad, as a manu-

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facturer of synthetic and wool textiles for uniforms; and Clothing Factory No. 16 as partly engaged in the manufacture of military uniforms.

5. Optical and photographic equipment of military value

a. General — The capability of the U.S.S.R. to produce precision optical and photographic equipment is adequate to satisfy most military and civil requirements, including those of the space program. The assortment of products includes a variety of items for various consumers. Equipment produced for military use and space programs includes telescopes, field glasses, periscopes, rangefinders, bombsights, gunsights, and optical sights for mortars and tanks. Photographic equipment consists of satellite cameras, special types such as superwide-angle cameras, aerial reconnaissance and fire registering cameras, and high-speed stereophotographic and photogrammetric devices. Other products manufactured by the industry are microscopes, film and photographic papers, exposure meters, enlargers, projectors, microfilm equipment, and a broad assortment of amateur and professional cameras.

The U.S.S.R. has imported military optical and photographic equipment from East Germany, Czechoslovakia, and Hungary in the past. East Germany continues to be an important supplier. Some complex devices have been imported from non-Communist countries, mainly West Germany, Austria, and Japan. Soviet-made military optical instruments have been exported to other Communist areas and to less developed countries outside the bloc.

Most precision optical and photographic equipment produced for military use is of good quality. Items in limited production, such as complex cameras used for tracking rockets and missiles, are generally of much higher quality than equipment designed for series production.

b. Production and supply — Production data for military items of optical and photographic equipment are not available. The production of all types of cameras reached 1.8 million units in 1960—about five times the output in 1951, but it decreased to less than 1.2 million units in 1964 and 1.1 million in 1965. About 50 plants have been identified as producers of precision optical and photographic equipment. About 12 plants, employing an estimated 60,000 persons, are wholly or partly engaged in producing military end-items. In addition, small quantities of specialized equipment for military use are produced by research institutes.

Most of the optical precision equipment plants are located west of the Ural Mountains. Many were evacuated eastward during World War II, but have been reestablished in their former locations, leaving some machinery and personnel at the wartime sites to continue functioning as new plants. The plants that were rebuilt following World War II were supplied with key technical personnel, machinery, and equipment from former German factories, and provided an impetus to postwar growth. For example, more than 90% of the *Zeiss* optical equipment plant at Jena was dismantled and sent to factories in Krasnogorsk, Kiev, and Leningrad. These and other plants producing precision optical and photographic equipment for the armed forces are included in Figure 97.

The establishment of several optical glass factories, including one in Leningrad, and a similar plant in Krasnogorsk, has made the U.S.S.R. independent of East Germany for raw optical glass. Moreover, an improved Soviet-made plastic, reportedly free from shrinkage defects, is in use for the manufacture of high-precision lenses and prisms. Domestic suppliers probably account for most of the other raw materials used in the production of precision optical and photographic equipment.

Imports or procurement from foreign sources in support of the military and space effort include large telescopes from East Germany and satellite-tracking cameras from West Germany. Conventional sighting, aiming, and fire-control devices have been exported to the other Communist countries and to less developed countries such as Cuba, India, Indonesia, and Tanzania.

6. Medical supplies and equipment

The U.S.S.R. is believed to be self-sufficient in the production of most of the drugs, plasma, serums, medical equipment, and instruments required by its armed forces. The quality of production is variable but sufficient quantities are produced to satisfy requirements despite rejects. No military medical supplies are known to be imported. The accumulation of military reserves of medical items has a higher priority than does provision for the current requirements of the armed forces or of the civilian population. Drugs, disinfectants, vaccines, serums, blood substitutes, dressings, medical and dental instruments, and hospital and laboratory equipment (particularly portable items) are known to be stockpiled for military use. Special care is taken to prevent deterioration of such stockpiles; items which have become obsolete are replaced.

As far as is known, the Ministry of Defense, U.S.S.R., does not have under its jurisdiction any factories which produce medical materiel. However, special employees of the Ministry supervise the manufacture of medical goods scheduled for use by the armed forces to safeguard quality and insure adherence to specifications. In addition, key military medical personnel supervise research and development, planning of production, and procurement of medical materiel for the armed forces. Representatives of the Quartermaster Corps probably exercise similar control over such items as tents, litters, hospital bedding, garments

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for patients and hospital personnel, and bags used in disinfecting clothing.

J. Electronic equipment

1. General

Since the mid-1950's the Soviet electronics* industry, which was relatively unimportant before World War II, has ranked second only to that of the United States. Most of the Soviet production of electronic equipment, ranging from basic components to complex equipment and electronic systems, is for military use. In recent years, primary emphasis has been on increasing the production of relatively new types of electronic devices for missile and space applications while keeping annual production of conventional military equipment at a fairly stable level. Replacement spare parts required for deployed materiel probably account for about one-half of the annual output of conventional military electronic products in terms of value. Output of electronic equipment is believed to be adequate for current military needs, and given sufficient priority, also could satisfy most of the nonmilitary requirements. In addition to meeting heavy commitments to the military and space programs in recent years, the industry has produced large numbers of household radio and television receivers, and large quantities of equipment needed for the modernization and expansion of civil telecommunications and broadcasting systems.

Foreign trade in electronic products is not significant in relation to the total value of domestic production. The U.S.S.R. is a net importer of electronic equipment from eastern Europe. Recently, the U.S.S.R. has turned to Japan and western Europe for production machinery, computers, and computer peripheral equipment, and for other specialized electronic equipment in short supply domestically. Only small quantities of electronic equipment are exported, primarily to other Communist countries and to the less developed countries. The U.S.S.R. does not produce nonmilitary electronic goods in sufficient quality or quantity to compete effectively in world markets with the industrially advanced countries of the non-Communist world.

The higher level of production of nonmilitary electronic equipment in recent years was achieved, in part, through improved standardization, greater mechanization of the industry, and the introduction of some automation in principal factories. Other factors contributing to output gains were expanded labor force and increased production capacity through the expansion of existing electronics plants. Except for new manufacturing facilities for electronic computers and semiconductor components, relatively few new plants were built during 1959-65 for the production of nonmilitary electronic equipment.

It is estimated that the production of electronic equipment in the U.S.S.R. increased in value terms from about 2 billion rubles in 1958 to about 7 billion rubles in 1965. Of total production in 1965, military and space electronic equipment accounted for an estimated 5 billion rubles. Conventional types of military products represented only a relatively small share of military-space output, probably amounting to about 1.5 billion rubles. The output of ground-based equipment is estimated at about 1.2 billion rubles, of which about 80% represents noncommunication devices (mainly radar). Communication devices, including tactical radio equipment, account for the remaining 20%.

Soviet output of electronic equipment production has increased rapidly over the past decade. Soviet output has grown from less than one-fourth of that of the U.S. in 1955 to about 60% of the U.S. level in 1965. Production of military electronics has grown even more rapidly relative to the United States, having reached an estimated 90% of the U.S. level in 1965. The following tabulation compares tentative estimates of the 1965 production of electronic equipment in the U.S.S.R. and the United States (in billions of U.S. dollars):

	U.S.S.R.	United States	U.S.S.R as percent of United States
Nonmilitary	2.7	8.5	32
Military	7.8	8.8	89
Total	10.5	17.3	61

a. Production — The electronics industry of the U.S.S.R. consists of a few hundred plants wholly or partly engaged in the production of electronic items. Since 1965, administrative authority has been assigned to newly organized industrial ministries. The Ministry of the Radio Industry is responsible for the production of end-equipment and the assembly of electronic systems, but development and production of components is under the authority of the Ministry of the Electronics Industry. Limited responsibilities relating to the production of military electronics or electronics for other important production programs continue to be exercised by the Ministries of Defense Industry, Shipbuilding Industry, and Aviation Industry. The Ministry of Instrument Making, Automation Equipment, and Control Systems is in charge of the production of electronic instruments and process control computers, and the long-established Ministry of Communications has retained some control over the production of telephone, telegraph, and related wire equipment.

Based on fragmentary information the labor force employed in the electronics industry is estimated to

* Electronic equipment includes all types of equipment which utilize electric or electronic, acoustic, or visual means for the transmission and reception of signals, signs, and images of any kind. The electronic equipment manufacturing industry includes all industrial facilities that produce wire, radio, electronic, and other signal equipment and components, used for the transmission of aural, visual, and control signals.

Approved For Release 2008/09/08 : CIA-RDP08S01350R000100030002-2

Approved For Release 2008/09/08 : CIA-RDP08S01350R000100030002-2

have increased from about 800,000 workers in 1958 to more than one million in 1965. In recent years, a more effective utilization of manpower has resulted from installation of improved production equipment in conjunction with greater standardization of production methods and electronic products. Nonetheless, average output per man-hour in the electronics industry of the U.S.S.R. still lags behind that of the United States. The distribution of the labor force in the Soviet electronics industry is not known. The largest share of the labor force is required for the production of military-space equipment and systems. Skilled labor appears to be in short supply. There are indications that the industry is hampered by a shortage of engineering personnel skilled in techniques of manufacturing high-quality semiconductor devices and microminiature circuits and of assembling complex types of equipment, such as electronic computers.

Production technology has been improved through greater use of domestic and foreign plant equipment. Greater amounts of capital, including an estimated 40 million during 1963-65, have been allocated for imports of technically advanced production equipment and entire plants from non-Communist countries, including Japan, France, Italy, and the United States. Recent purchases from foreign sources include equipment for producing silicon transistors from Japan, a cathode-ray tube factory from Hungary for delivery in 1967, and machinery for the production of color television picture tubes and a television receiver factory from France for delivery in 1968.

Progress in manufacturing microminiaturized components is evident in the recent appearance of film-type electronic circuits, including hybrid thin-film units in consumer equipment. Despite improvements in quantity and quality of production, some perennial deficiencies exist in the manufacture of consumer items and civil telecommunications equipment. For example, better production techniques have reduced, but not eliminated, operational deficiencies in certain makes of television receivers. Furthermore, volume of production remains inadequate for planned installations of high-capacity telephone multiplexing and microwave radio-relay equipment.

The principal raw materials required by the industry are available domestically. Except for copper and aluminum, the quantities of raw materials needed by the electronics industry account for only a small share of domestic production. Facilities for processing and purifying materials are adequate to supply most of the essential requirements for electronic materials such as synthetic quartz, germanium, silicon, ductile tungsten and molybdenum, and ceramic compounds.

Plants of the electronics equipment industry are dispersed widely throughout the U.S.S.R. The heaviest concentrations are in the Leningrad and Moscow areas, although a number of other cities—mainly in the western part of the country—have become important centers of production. A number of plants, such as those in Novosibirsk, Tashkent, and Ufa were started during World War II with machinery evacuated from western U.S.S.R. During the Seven Year Plan about 20 computer equipment factories were constructed in industrialized areas of Armenia, Belorussia, and Lithuania, including three final assembly plants in Yerevan, Minsk, and Vilnius. FIGURE 99 gives location, name, and descriptive data of the major plants of the industry.

b. PRODUCTS AND PRINCIPAL PRODUCERS

(1) *Radio and television equipment and related components* — Consumer items such as radio broadcast and television receivers constitute the largest share of output, by value, of this category, accounting for more than one billion rubles in 1965. Despite prolonged effort toward uniformity of consumer items, less than 50% of 1965 production consisted of standardized television and radio broadcast receivers. About 40 different types of radio receivers and more than 30 models of television receivers are in production. Output of transistorized television and radio broadcast receivers has greatly increased in recent years, and microminiaturized household radio broadcast receivers have been produced. Film-type assemblies include relatively small quantities of a radio broadcast receiver named "Mikro." It is equipped with hybrid circuits utilizing thin-film passive components, which combine a high degree of compactness and reliability. Military radiocommunication sets have been equipped with transistors for several years, but serial assembly of tactical ground radio equipment of reduced size and weight still is limited to a few models.

Increased production of radio relay equipment, including fixed and mobile sets, has not been adequate to provide the large quantities required for civilian and military communication systems. The U.S.S.R. produces relay equipment ranging from low to high capacities and imports radio relay sets from Hungary and Czechoslovakia. Annual production of mobile military radio relay sets of the R-400 series suitable for military use is estimated at about 700 sets equipped with capacities of 2, 6, or 12 telephone channels. Production of civilian radio relay sets with capacity up to 120* channels is estimated at less than 100 sets per year, and equipment providing 600* two-way channels per radio frequency trunk at about 400 sets per year. Modernized 600-channel* sets are produced either experimentally or in limited quantities, and a new type of radio relay equipment designed to provide substantially higher capacity is scheduled for series assembly in 1968. To meet requirements for transmission over long distances, the U.S.S.R. has started the manufacture of tropospheric scatter radio relay apparatus with a capacity of about 60-telephone channels. Tropospheric scatter equipment has an ef-

* Utilization of design capacity of these systems depends on the application of multichannel carrier multiplexing equipment.

Approved For Release 2008/09/08 : CIA-RDP08S01350R000100030002-2

Approved For Release 2008/09/08 : CIA-RDP08S01350R000100030002-2

fective range of 200-400 km. between stations against 25-50 km. for line-of-sight microwave radio relay apparatus. More than 50 plants are known to be wholly or partly engaged in manufacturing radio and television items for use in broadcasting and communication networks.

Production of electron tubes, semiconductor devices, and microminiature circuits to a large extent has been based on designs and industrial techniques used in leading countries of the non-Communist world. Special-purpose tubes, including various Soviet-designed types, are produced in substantial quantities. Major types include magnetrons, carcinotrons, traveling-wave tubes, transmit-receive switching tubes, black-and-white wide-angle television picture tubes, and cathode-ray storage tubes. Miniature and subminiature tubes are manufactured in quantity. Transistors and diodes have been mass-produced for several years, but the yield of usable devices is thought to be very low. Output of special-purpose transistors appears to be below current needs, and these are available mainly for high-priority devices. Other basic circuit components, such as capacitors and resistors, are in mass production, and miniaturized versions are serially manufactured. Microminiature circuits, including hybrid integrated circuits, have been manufactured on a small scale for consumer equipment.

Five plants account for a major portion of output of tubes. They are located in Leningrad, Moscow, Fryazino, Novosibirsk, and Saratov. Semiconductor devices are made in diverse facilities including three of the tube plants; in passive component plants in Moscow, Tallin, and Yerevan; in special sections of electronic equipment plants, and in plastics factories.

Production of radio broadcast and television receivers, electron tubes, and semiconductor devices since 1958 and production plans for 1967 and 1970 are as follows (in thousands of units):

Year	Radio (broadcast) receivers	Television receivers	Electron* tubes	Semi-conductor devices
1958	3,902	979	110,000	60,000
1959	4,035	1,277	119,000	87,000
1960	4,165	1,726	125,000	125,000
1961	4,228	1,949	147,000	210,000
1962	4,251	2,168	160,000	320,000
1963	4,796	2,473	170,000	420,000
1964	4,766	2,927	180,000	500,000
1965	5,159	3,655	190,000	700,000
1966	5,800	4,400	n a	n a
1967**	6,200	4,900	n a	n a
1970**	7,500-8,000	7,500-7,700	n a	n a

* Includes television picture tubes, transmitting, and special-purpose tubes.

** Planned.

(2) *Wire and cable equipment* — Wire and cable equipment produced in the U.S.S.R. includes dial telephone exchanges, manual telephone switchboards, subscriber sets, multichannel carrier equipment, and telegraph instruments including teletype switching equipment, teleprinters and facsimile devices. Plants producing wire equipment, components, and accessory items constitute only a small segment of the telecommunication equipment industry.

Increases in the production of wire apparatus have not kept pace with growing requirements of civilian long-distance communication networks; also, production of equipment for local automatic telephone lines has been insufficient. Major difficulties are evident in the manufacture of multichannel carrier terminal equipment. Units providing up to 60-channel capacity have been produced for several years. However, Soviet factories have failed to produce the quantities needed for the modernization and expansion of the public networks. Multiples of 60-channel units reportedly have been grouped in combinations up to 300 channels as part of a 1920-channel system. The U.S.S.R. imports some 60-channel equipment from East Germany and is attempting to procure higher capacity equipment from non-Communist countries.

Production of military wire equipment is believed to be adequate to meet the relatively small needs for this type of materiel. Most military devices still are manufactured in somewhat bulky, though serviceable versions of the early postwar period. Military needs for greater mobility have been met in part through increased production of vehicular installations of manual switchboards, automatic exchanges, multichannel carrier devices and teleprinters. About 20 plants are known to be engaged wholly or partly in the production of telephone and telegraph equipment and components, but two factories—the VEF Electrical Equipment Plant in Riga and the Red Dawn (*Krasnaya Zarya*) Plant in Leningrad—account for a large share of the total. Eight factories manufacture most of the wire conductors and cable, including multiconductor and coaxial types. Two plants—the Moscow Electric Cable Plant No. 330 in Moscow and the Northern Cable Plant *Sevkabel* in Leningrad—produce about one-half of the total.

(3) *Other electronic equipment* — Value of civilian and military production of this branch of the industry in 1965 is estimated at more than 5 billion rubles. Of this amount, industrial electronic devices* account for about 0.5 billion rubles; conventional types of military equipment for ground, shipborne and airborne use, an estimated 1.4 billions; and new types of electronic items for use in the military and space programs account for the remainder.

Information is lacking on the production of new electronic devices for systems not yet fully identified. A large portion of the Soviet electronics industry is

* Radiocommunication, broadcasting, public address, and television equipment produced for industrial use are not included in this estimate.

Secret

Approved For Release 2008/09/08 : CIA-RDP08S01350R000100030002-2

Approved For Release 2008/09/08 : CIA-RDP08S01350R000100030002-2

oriented toward manufacturing long-range radars and other electronic equipment for ballistic missiles, antimissile missiles, communication satellites as well as space tracking, data transmission, processing, and related systems. Related production activities are reflected in the deployment of Hen house missile/satellite tracking, Dog house target acquisition, and other electronic installations.

In the conventional military sector, radars—mainly ground equipment—have accounted for more than one-half the annual production of electronic equipment in recent years. The radars being produced are search, early warning, height finding, surveillance, acquisition, ground control intercept, identification of friend or foe, and bombing-navigational types. New conventional ground radars have been produced in recent years, as indicated by the deployment of Sheet bend, Back net, and Squat eye for surveillance; Side net and Thin skin for improved height finding; and Bread bin, a trailer-mounted meteorological unit. Other product categories of conventional electronic equipment are countermeasure devices for ground, shipborne, and airborne use, navigational aids similar to Loran and Shoran, radio altimeters, fixed and mobile direction finders, and sonar.

Electronic products for industrial use include traffic surveillance devices, testing and measuring apparatus, medical and other scientific equipment, checking and regulating devices, and electronic computers.

Electronic devices and components in this category are produced in more than fifty multiproduct plants, and in specialized radar and computer factories. The principal producing plants for radar and special electronic equipment are located in the areas of Gor'kiy, Kuntsevo, Leningrad, Moscow, and Novosibirsk. Shipborne radar, including anticollision equipment, is manufactured in Minsk and Rostov.

2. Foreign trade

Foreign trade in electronic equipment and components tripled in value during the Seven Year Plan; however, in 1965, imports and exports combined amounted to only about 2% of the electronic equipment produced. Imports of military equipment are not significant. From other Communist countries the U.S.S.R. imports mainly components, telephone and telegraph equipment, high-capacity microwave radio-relay systems, and special types of equipment. Soviet exports are mainly end-items. Technologically superior components and equipment are imported from the Industrial West, in relatively small quantities and various items including military radars are exported to some of the developing countries of Africa, Asia, and the Middle East.

During 1959-65, Soviet imports of equipment and components from other Communist countries included the following: Automatic telephone exchanges and multichannel radio relay equipment from Hungary, 60-channel telephone carrier equipment and high-capacity telephone cable from East Germany, and telephone subscriber sets, TV broadcast transmitters, low-capacity multiplexing equipment, and radio receiver tubes from Czechoslovakia. Imports and recent purchases from countries outside the bloc consisted of automatic telephone switching equipment from Italy; high-capacity coaxial cable from Finland; direction finders, marine radar for long-range navigation, and facsimile equipment from Japan; color television tubes for a current pilot project to be shipped from France; computers for industrial use from the United Kingdom; and civil aviation equipment for ground and airborne use to be shipped from the United States.

Exports of electronic equipment for use in networks linking the U.S.S.R. with countries of eastern Europe include transmission equipment for radio relay systems and repeaters for a coaxial telephone and television transmission system to Czechoslovakia, Rumania, Poland, and Bulgaria. Exports to other Communist countries are identification friend/foe (IFF) equipment sent to Yugoslavia, and diverse telecommunication items, including vehicular radiocommunication equipment and mobile ground radars for antiaircraft and missile air defense installations, to North Vietnam.

Civil telecommunication and other electronic equipment exported by the U.S.S.R. to less developed countries (non-Communist) includes wire and radiocommunication equipment, radio broadcast receivers and transmitters, carrier telephone apparatus, and teleprinters. Military signal equipment including mobile ground radars has been exported to Afghanistan, Algeria, Cambodia, Cuba, U.A.R., Guinea, India, Indonesia, Iraq, Somali, and Syria.

K. Chemicals and allied products

1. Introduction

a. Importance — The Soviet chemical industry is second only to that of the United States, but its output in 1965 was only about one-fourth to one-third as large. The Soviet lag, both quantitative and qualitative, is most pronounced in sectors producing the more modern chemical products such as plastics and manmade fibers. Production of major chemical products in the U.S.S.R. and the United States in 1965 are compared in the following tabulation (thousand tons):

	U.S.S.R.	United States	U.S.S.R. as percent of United States
Caustic soda (100%)	1,199	6,099	*20*
Manmade fibers	407	1,497	*27*
Fertilizers*	7,389	11,675	*63*
Plastics	802	5,216	*15*
Sulfuric acid (100%)	8,518	22,500	38
Synthetic rubber	565	1,840	*31*

* Expressed as 100% nutrient. The figure for the United States applies to the year starting 1 July 1965.

Approved For Release 2008/09/08 : CIA-RDP08S01350R000100030002-2

Approved For Release 2008/09/08 : CIA-RDP08S01350R000100030002-2

Within the Soviet bloc, the U.S.S.R. is the leading producer of most all types of chemicals; in 1965 it accounted for more than one-half of the total output of caustic soda, about two-thirds of the sulfuric acid, and more than three-fourths of the synthetic rubber.

The U.S.S.R. produces thousands of different types of chemicals. Many are used extensively in machine building, metallurgy, petroleum refining, agriculture, and the manufacture of consumer goods; others are used for military purposes such as explosives, rocket propellants, chemical warfare agents, parts for aircraft, missiles and radar installations, and as materials for the atomic energy program. More than one-half of the Soviet production of chemicals goes to heavy industry and transport, whereas nearly 40% of the chemicals produced are consumed as intermediates in the manufacture of other chemicals.

In value of output, the Soviet chemical industry increased rapidly during 1959-65. Output in 1965, estimated at 13 billion rubles, was nearly 2½ times the 1958 level. The share of the chemical industry in the total industrial output of the U.S.S.R. rose from about 4.2% to 5.6% during this period. The industry is relatively capital-intensive, the value of fixed capital per worker being higher than that of most other industries. The chemical industry's share of industrial fixed productive capital was 8.3% in 1966. Investment in the chemical industry by 1965 had risen to 1.9 billion rubles, or about 11% of total investment in industry, compared with less than 5% in 1958. Employment in the chemical industry was estimated at 1.2 million workers in 1965, and the industry used about one-tenth of the total industrial consumption of electricity and heat.

b. Development — Even though the average annual rate of growth of the chemical industry during 1959-65 was 50% above that of all industry, output of chemicals in 1965 was short of the original goal by about 20%, in spite of the large capital investment made during the period. Because of difficulties encountered during the Seven Year Plan period, the unsatisfactory development of modern chemical processes and equipment, failure to meet construction schedules, and lags in assimilating new technology, many new or expanded facilities failed to reach scheduled capacity. The industry is attempting also to convert its raw material base from coal and agricultural products to oil and natural gas, but has failed to meet the schedule set for the change. Thus a number of synthetic materials derived from oil and natural gas, such as certain types of rubber and plastics, have not been produced as scheduled. Output of plastics in 1965 was less than one-half, and manmade fibers only three-fifths, of the original targets. Production of major chemicals in selected years for the 1958-66 period are given in Figure 31.

Under the new Five Year Plan (1966-70), chemical output is scheduled to double, implying a rate of growth substantially higher than the increase of 50% planned for industry as a whole. Planned investment of an estimated 14 billion rubles is almost double that in 1961-65. As in the preceding plan, major emphasis rests on expanding output of agricultural chemicals and synthetic materials and enlarging the petrochemical base. To facilitate the achievement of the goals, technical data and equipment are being purchased from industrialized Western countries and from certain of the eastern European Communist countries. Even though the 1966 plan for production of chemicals (an increase of 12%) was slightly overfulfilled, growth problems persisted. Commissioning of new installations continued to lag, and many plants operated below planned capacity. Even so, the Soviet chemical industry, having rich reserves of petroleum, natural gas, coal, salt, phosphates, and other minerals, has a strong potential for rapid growth in the immediate future.

c. Location — The R.S.F.S.R. produces about three-fourths of the total chemical output of the U.S.S.R., and in 1965 accounted for 53% of Soviet production of fertilizer, 83% of the tires, and 77%

Figure 31. PRODUCTION OF MAJOR CHEMICALS AND ALLIED PRODUCTS
(Thousand metric tons, except where otherwise noted)

	1958	1960	1963	1965	1966
Ammonia*	1,100	1,440	2,460	3,465	....
Caustic soda (92%)	709	765	1,049	1,303	1,393
Chlorine*	442	496	627	833	905
Ethyl alcohol**	164	171	197	236	*na*
Fertilizers***	12,419	13,867	19,935	31,253	35,800
Manmade fibers	166	211	308	407	458
Nitric acid (100%)	1,920	2,190	3,856	5,500	*na*
Plastics	237	312	567	802	971
Soda ash (95%)	1,692	1,887	2,545	2,871	2,963
Sulfuric acid (100%)	4,803	5,398	6,885	8,518	9,366
Synthetic rubber*	293	326	457	565	....

* Estimated.

** In millions of decaliters (one decaliter=2.642 gals.).

*** Major fertilizers in terms of the following nutrients: 20.5% N; 41.6% K_2O; 18.7% P_2O_5.

Approved For Release 2008/09/08 : CIA-RDP08S01350R000100030002-2

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FIGURE 32. MAJOR SOVIET CHEMICAL PLANTS

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of the manmade fibers. Plants within a radius of 500 km. of Moscow probably account for almost one-half of the total chemical output of the U.S.S.R. The share of chemicals produced in the oil- and gas-bearing regions of the U.S.S.R. rose during 1959-65, as large petrochemical complexes were built in the Caucasus, in the Volga area, in Bashkir, and at Omsk. Growth was also rapid in the Urals and in western Siberia. The Ukraine also is important for chemical production. The location of selected chemical plants in the U.S.S.R. is shown in FIGURE 32.

d. FOREIGN TRADE — Soviet data on foreign trade in chemicals, rubber, and allied products in selected years for 1958 to 1965 are shown in FIGURE 100. Trade in chemicals, rubber, and allied products by value represented 6% of total Soviet foreign trade in 1965. Imports of these products exceeded exports by 175 million foreign exchange rubles in 1958, but by 1965, this import deficit has risen to a total of 336.2 million foreign exchange rubles or about double, reflecting in part the failure of domestic production to keep pace with requirements for chemicals.

The U.S.S.R. imports rubber, artificial fibers, lacquers, photographic films, pharmaceuticals, and raw materials for the production of synthetic fibers and plastics. Its most important chemical exports are fertilizers and associated raw materials, coke chemicals, synthetic rubber, and rubber products.

2. Industrial chemicals

a. SULFURIC ACID — Sulfuric acid, a basic product of the Soviet chemical industry, is used in large amounts in the production of fertilizers, chemicals, petroleum products, iron, steel, nonferrous metals, rayon and cellulose film, paints and pigments, explosives, and other industrial products. Production of sulfuric acid rose 77% during 1959-65, to a level of slightly over 8.5 million tons. Nevertheless, output in 1965 was 2.5 million tons below the original plan goal, mainly because of delays encountered in building new facilities and bringing them to full capacity. The shortage of sulfuric acid had repercussions on the Soviet fertilizer industry, idling production capacities for superphosphate. (Production of sulfuric acid in 1958-66 is included in FIGURE 31.) Output of sulfuric acid is scheduled to rise to 15.6 million tons by 1970, an increase of 83% during the 5-year plan period. Increases in scale are planned for plants specializing in the production of sulfuric acid, and more sulfuric acid is to be produced by branches of industry other than the chemical branch.

Sulfuric acid is produced at more than 75 plants in the U.S.S.R. The principal producers are located in the R.S.F.S.R. and the Ukrainian SSR, which account for about one-half and one-fifth, respectively, of total output. Major producing plants are listed in FIGURE 101. The contact process, which provides greater flexibility in output of various grades of acid than the competing tower process, provided two-thirds of the sulfuric acid obtained in the U.S.S.R in 1965, as compared to only 52% in 1959. The achievement still fell far short of the share originally envisioned for the contact process (78% of a far larger output of sulfuric acid).

Pyrites, the commonest of the sulfide minerals, have been the predominant raw material used in the production of sulfuric acid, but planners are attempting to use instead greater amounts of sulfur and waste gases from nonferrous metallurgical plants and oil refineries. The share of pyrites in the total output of sulfuric acid fell from 71% in 1958 to 45% in 1965, and would have fallen even lower had not substantial delays been encountered in building and operating new units at metallurgical and petrochemical facilities. FIGURE 33 illustrates the changing structure of the raw materials base for sulfuric acid.

An estimated 40% to 45% of the sulfuric acid produced in 1965 was used in the production of fertilizers. Soviet consumption of sulfuric acid by major branches of industry in 1963 is shown in the following tabulation (in percent):

Chemicals		50
Of which: Mineral fertilizer	37	
Artificial fibers and other	13	
Ferrous metallurgy		15
Nonferrous metallurgy		7
Oil		10
Paper		2
Machine building and food		6
Other		10
Total		100

b. SYNTHETIC AMMONIA — Synthetic ammonia, the most important basic nitrogen compound, is consumed in large amounts in the production of fertilizers, nitric acid and other chemicals, industrial and military explosives, missile propellants, and other products. It is also widely used in industrial processes such as refrigeration, petroleum refining, water purification, and extraction of metals.

Output of synthetic ammonia in 1965, estimated at about 3.5 million tons, was more than triple that of 1958. Costs of production were reduced 21% during this period, largely as a result of the growing use of natural gas as a raw material (FIGURE 34) and of an increase in the size and productivity of the producing plants. Still, lags that occurred in the introduction of new processes prevented even further reductions in production costs. Furthermore, natural

FIGURE 33. RAW MATERIALS STRUCTURE OF SULFURIC ACID PRODUCTION
(Percent)

	1958	1960	1965 PLAN	1965 ACTUAL	1970 PLAN
Pyrites	72	58	40	46	42
Sulfur	13	23	21	28	20
Waste gases (SO_2)	13	16	28	20	28
Hydrogen sulfide	2	3	11	6	10

Approved For Release 2008/09/08 : CIA-RDP08S01350R000100030002-2

Approved For Release 2008/09/08 : CIA-RDP08S01350R000100030002-2

FIGURE 34. RAW MATERIALS FOR THE PRODUCTION OF AMMONIA
(Percent of total ammonia production)

	1958	1960	1962	1963 PLAN	1965
Solid fuels (coal)	42	33	24	19	15
Coke gas	35	33	25	20	18
Natural gas	1	16	39	51	60
Other	22	18	12	10	7

gas—even though used more extensively—still accounted for only about 60% of the ammonia produced in 1965, whereas in the United States, over 80% of the ammonia is produced from natural gas.

In the 1966-70 plan, the production of ammonia is to increase by 120% to support the rapid growth planned for nitrogen fertilizers. The trend toward the increased use of petrochemical materials and the construction of installations with larger unit capacities will continue. Improvements in process technology are to include the use of higher pressures in gas reforming and improved catalysts and compressors.

More than 85% of the synthetic ammonia produced in the U.S.S.R. is consumed in the manufacture of nitrogen fertilizers, although a portion of the ammonium nitrate reported as fertilizer may go into explosives or propellants. Synthetic ammonia is produced chiefly at large complexes that also produce nitric acid and nitrogen fertilizer. Major plants producing these chemicals are listed in FIGURE 102.

c. NITRIC ACID — Nitric acid is essential for the production of high explosives and ordnance propellants, and can be employed as an oxidizer in guided missile propellants. Its primary use, however, is as a raw material for the manufacture of nitrogen fertilizer, and in 1965 the production of fertilizer consumed an estimated 70% of the nitric acid produced in the U.S.S.R. The remainder was used to produce explosives and propellants, synthetic dyes, photographic supplies, pharmaceuticals, and other high-value chemicals. In 1963 the U.S.S.R. reported the development of a process to make ultrapure nitric acid, used in the manufacture of chemical reagents and the production of semiconductors and other items of the radio-electronics industry.

Production of nitric acid in 1965 is estimated at 5.5 million tons, an increase of 186% over the estimated output in 1958 (FIGURE 31). Plans for its production in 1966-70 have not been announced, but the increase in output of nitric acid is likely to be substantial in view of the anticipated growth in output of nitrogen fertilizer. Major producers of nitric acid are listed in FIGURE 102.

d. BENZOL, TOLUOL, AND PHENOL — Benzol, toluol, and phenol are widely used in the manufacture of plastics, synthetic rubber, high-octane gasoline, dyes, pesticides, explosives, solvents, and pharmaceuticals—products that are essential to a modern industrialized economy. The estimated production of these products has been as follows, in thousand tons:

	BENZOL	TOLUOL	PHENOL
1958	401	121	62
1960	490	131	77
1963	583	146	109
1965	673	157	137

Between 1959 and 1965 the estimated production of benzol increased 68%, phenol 122%, and toluol 30%. The major producing regions for these products are the Ukraine, R.S.F.S.R., and western Siberia.

The production of benzol fell far short of the increase of 150% planned for the period 1959-65; lags were particularly evident in the commissioning of new materials. Although it had been planned to produce about 40% of the benzol by means of petrochemical processes in 1965, about 90% of the output in 1964 was still obtained as a byproduct in the manufacture of high-temperature coke. Only a few facilities producing benzol from petrochemicals were commissioned during 1959-66; these included facilities at the Ufa Synthetic Alcohol Plant, and the Perm and Angarsk oil refineries. The industry is still emphasizing production of petrochemical benzol, and 55% of the total output in 1970 is to be of this type. Production of benzol is also to be expanded at a coke chemical plant in Avdeyevka, and at metallurgical plants in Magnitogorsk and Novolipetsk. In addition, the quality of benzol produced from coke is to be upgraded to make it more satisfactory for use in organic synthesis.

The chemical industry, by far the largest consumer of benzol, was scheduled to account for 87% of total consumption in 1965, as compared with 48% in 1959. Most of the benzol used by the chemical industry is processed into intermediate products such as phenol, ethyl benzene, nitrobenzene and caprolactam, which are further processed into synthetic rubber, plastics, synthetic fibers, dyestuffs, pharmaceuticals, and other products. The U.S.S.R. also exports substantial quantities of benzol—as much as 17% of the estimated output in 1965.

The estimated production in 1965 of 137,000 tons of phenol was at least 100,000 tons below the original Seven Year Plan goal. The lag resulted primarily from delays in commissioning new petrochemical facilities. During 1959-65, capacity for production of phenol was expanded at a chemical plant in Groznyy and at several coke-chemical plants, and new installations were commissioned at petrochemical plants in Kazan, Novokuybyshevsk, and Ufa. Most of the phenol is obtained synthetically from benzol and other chemicals, the remainder being recovered as a byproduct in the manufacture of coke.

The chemical industry, the major consumer of phenol, uses large quantities for the production of plastics and fibers. The demand for phenol is scheduled to more than double by 1970, and major

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additions to capacity will come primarily from new or expanded petrochemical plants. Major end-uses for phenol in 1964, and those planned in 1970, are shown in the following tabulation (in percent):

	1964	1970
Phenol-formaldehyde resins	*40*	*47*
Caprolactam	*16*	*12*
Plasticizers, pesticides, dyestuffs, etc.	*12*	*17*
Petroleum refining industry	*14*	*10*
Other requirements	*18*	*14*

Toluol is used as a solvent for paints, varnishes and lacquers, as an additive for aviation gasoline, and as an intermediate in the manufacture of explosives, various chemical products, and pharmaceuticals. The supply of toluol—an estimated 157,000 tons in 1965—exceeded the demand, and 56,000 tons (about 36% of total output) were exported. Most of the toluol produced in the U.S.S.R. in 1965 was obtained as a byproduct in the manufacture of high temperature coke, but by 1970 more than 55% of the toluol is to be produced by the petrochemical industry.

e. Ethyl alcohol — Ethyl alcohol is used extensively in the U.S.S.R. as an industrial raw material. It is estimated that about half of the synthetic rubber produced in 1965 was obtained from ethyl alcohol. It is also used in the manufacture of plastics, paints and varnishes, drugs, perfumes and beverages. Military applications of ethyl alcohol include the production of explosives and smokeless powder propellants. By 1970, the relative importance of ethyl alcohol in the Soviet rubber industry will fall as the supply of more economical petrochemical raw materials increases. The demand for alcohol in the production of plastics, lacquers, dyes, drugs, and man-made fibers will continue to rise.

Ethyl alcohol is produced in the U.S.S.R. by the fermentation of edible agricultural products such as grain and potatoes, by synthesis from petrochemical feedstocks, and by processing of wood. Production in 1965 of 236 million decaliters (Figure 31) represented an increase of 44% over that in 1958, as compared with a planned increase of 24%. Even though the share of nonfood alcohol (synthetic and wood) increased from 29% of total output in 1958 to an estimated 46% in 1965 (Figure 35), the production of synthetic ethyl alcohol increased more

Figure 35. PRODUCTION OF ETHYL ALCOHOL, BY SOURCE
(*Million decaliters*)

	1958	1965
Total	163	236
Food	116	*127
Nonfood	48	*109
Synthetic	26	*79
Hydrolytic and sulfite	21	*30

* Estimated.

slowly than had been planned. Most of the plants producing synthetic alcohol operated below their projected capacities for the first 6 years of the 7-year plan because of the inadequate supply and poor quality of the available petrochemical raw material. Major plants that produce synthetic ethyl alcohol are located at Novokuybyshevsk, Ufa, Guryev, Orsk, Saratov, and Sumgait.

Because of the declining importance of ethyl alcohol in organic synthesis, output during 1966-70 is planned to increase by only 18-20%. Of the total, that produced from edible products is scheduled to increase by 6-8%, and that from inedible products by 25-27%. The industrial use of ethyl alcohol derived from edible products is to be discontinued. Reportedly, only nonfood alcohol was used in the rubber industry by the end of 1965, but the claim appears to have been premature.

f. Chlor-alkali products — The major alkali products—soda ash and caustic soda—are widely used in the production of soap, paper products, and chemicals. In addition, soda ash has important use in the manufacture of aluminum and glass, and caustic soda is used in the manufacture of rayon and in petroleum refining. In recent years, almost 40% of the soda ash has gone to the chemical industry and about one-third to the glass industry. The chemical industry has also been the largest consumer of caustic soda, accounting for about one-half the total output. Chlorine, usually produced in conjunction with caustic soda, is used in the sterilization of water and sewage and in bleaching operations. It is also used in the production of various chemicals, including synthetic rubber, gasoline additives, plastics, pesticides, and chemical warfare agents.

Soviet production of soda ash rose 71% during 1959-65, to a level of 2.9 million tons. Even though growth was substantial, output fell short of the planned goal because of delays in introducing new capacity, and the U.S.S.R. continued to be a net importer of soda ash. The 1965 imports amounted to 268,000 tons, exceeding exports by 180,000 tons. Major suppliers of soda ash in that year included Belgium, Poland, and Communist China. Production of soda ash is scheduled to increase 50% in 1966-70. Equipment with larger unit capacities is to be used to permit economies of scale. Further economies are being sought by increasing the production of soda ash at aluminum plants, utilizing nepheline ore, which can serve as a raw material for both soda ash and aluminum. Increased mechanization of soda ash plants is also planned, particularly in packaging and loading operations. Mechanization, automation and other improvements reportedly will permit an increase of 40% in labor productivity at soda plants in the period 1966-70.

Production of caustic soda in the U.S.S.R. increased 84% during 1959-65, to a level of 1.3 million tons

Approved For Release 2008/09/08 : CIA-RDP08S01350R000100030002-2

Approved For Release 2008/09/08 : CIA-RDP08S01350R000100030002-2

(92% basis). Delays in the introduction of new facilities caused shortages, necessitating large imports. In 1965, imports accounted for 14% of the caustic soda consumed by Soviet industry. Plans for production of caustic soda through 1970 have not yet been revealed, but recent trends suggest that the scheduled rate of increase exceeds that of soda ash. Facilities at Sumgait, Yerevan, and Kemerovo are to be expanded, and new installations are planned at Pervomayskiy, Nakhichivanskaya Oblast, and Tadzhik S.S.R.

Production of chlorine in 1965 reached an estimated 833,000 tons, an increase of 88% over the estimated output in 1958. Numerous problems delayed expansion, however, and caused output to fall far short of the 7-year plan goal, which called for an increase of 160%. Moreover, technical and other difficulties apparently caused a sharp rise in unit investment costs for chlorine plants. Some of the equipment—for example, electrolyzers—was poor and affected the quality of the chlorine produced in at least one Soviet chlorine plant.

Although the 1970 goal for production of chlorine is not available, considerable growth evidently is planned. Capacities at Yerevan, Sterlitamak, and Kemerovo are to be expanded, and new plants will be built at Pavlodar, Pervomayskiy, and Yavan.

Although a small amount of chlorine is produced by chemical reaction, the major part is manufactured by the electrolysis of brine, utilizing either the diaphragm or mercury process. The use of the mercury process probably is expanding more rapidly than the diaphragm technique.

The large plants producing soda ash, caustic soda, and chlorine are listed in FIGURE 103, and FIGURE 31 shows the output of these products for selected years.

3. Fertilizers and pesticides

a. MINERAL FERTILIZERS

(1) *Introduction* — Although the U.S.S.R. is the world's second largest producer of fertilizer and output has expanded rapidly in recent years, the quantity of fertilizer produced still fails to satisfy the requirements of domestic agriculture. Moreover, by Western standards the quality of Soviet fertilizer is low and the assortment is narrow. Concentrated superphospate and complex fertilizers that are produced in large quantities in the United States are produced on a relatively small scale in the U.S.S.R. The nutrient content of Soviet fertilizers is considerably lower than that produced in the Industrial West. Many Soviet fertilizer plants are poorly located with regard to both raw materials and markets; as a result, shipping costs are relatively high and there are substantial losses in transit. Poor packaging and a shortage of storage facilities may cause waste of an estimated 15-20% of all Soviet fertilizers. In spite of domestic shortages, the U.S.S.R. exports substantial quantities of fertilizers, chiefly potassium salts. Apatite, a raw material for phosphorous fertilizers, is also sold abroad in large quantities.

The 5-year plan for 1966-70 for fertilizer calls for continued rapid growth of output, improvement of quality and lowering of production costs. During this period, output is scheduled approximately to double, reaching a level of 63 million to 65 million tons in 1970. The quality and usefulness of the fertilizer is to be raised by increasing the relative share of granulated, concentrated, and complex types. Economies of scale are planned through the construction of large new facilities and the expansion of many existing ones. To accomplish these goals, as much as one-fifth of all investment in chemicals in 1966-70 will be allocated to the fertilizer industry. The large investment planned for this industry demonstrates the importance attached by the regime to increased agricultural production. Expansion of fertilizer capacity is also of military significance, inasmuch as certain fertilizers and associated raw materials can be diverted to the manufacture of explosives and missile propellants.

(2) *Production* — Production of mineral fertilizer in the U.S.S.R. increased about 150% during 1959-65, to a level of 31.3 million tons, equivalent to a nutrient content of 7.4 million tons. In 1966, the first year of the new plan, production increased 14%, to 35.8 million tons (FIGURE 31). Soviet output of fertilizers in 1965 was about 4 million tons below the original goal of the 7-year plan, and neither the scheduled assortment nor quality was attained. Defective equipment, shortages of raw materials, and difficulties experienced with the development and assimilation of new technology were major factors in the failure to meet goals.

Soviet production of fertilizer by class in selected years 1958-65 is shown in FIGURE 36. Of the major classes—nitgrogen, potassium and phosphorus—the nitrogen group has grown most rapidly in recent years, accounting in 1965 for about 37% by nutrient value of all Soviet fertilizer. The principal nitrogen fertilizers produced are ammonium nitrate urea, aqueous ammonia, and ammonium sulfate. Ammonium nitrate accounted for an estimated 55% of all nitrogen fertilizers in 1965, compared to 74% in 1958, its relative share falling because of the rapid growth of urea and aqueous ammonia. Of the phosphorus fertilizers (excluding phosphorite meal), simple superphosphate accounted for over 80%, and complex and concentrated types for only 11% of the total in 1965. Major sources of phosphorus raw materials are found on the Kola Peninsula and the Karatau in Kazakhstan. The principal potassium fertilizers produced in the U.S.S.R. are potassium chloride and mixed potassium salts, major raw materials being

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Approved For Release 2008/09/08 : CIA-RDP08S01350R000100030002-2

FIGURE 36. PRODUCTION OF MINERAL FERTILIZERS*
(*Thousands of tons*)

YEAR	NITROGEN		POTASSIUM		PHOSPHORUS		PHOSPHORITE MEAL	
	Standard (20.5%N)	Nutrient (100%)	Standard (41.6% K_2O)	Nutrient (100% K_2O)	Standard (18.7% P_2O_5)	Nutrient (100% P_2O_5)	Standard (19% P_2O_5)	Nutrient (100% P_2O_5)
1958....	4,124	845	2,413	1,004	4,651	870	1,228	233
1960....	4,892	1,003	2,606	1,084	4,878	912	1,473	280
1963....	8,575	1,758	3,365	1,400	5,860	1,096	1,997	379
1965....	13,217	2,712	5,691	2,368	8,550	1,599	3,690	701

* In addition, total production includes a small amount of boron fertilizers.

obtained in the northern Urals, Belorussia, and the western Ukraine.

The number of mineral fertilizer producers increased from 63 in 1958 to approximately 100 in 1965. Large new facilities were erected in the Central Plains industrial region, the Ukraine, Middle Asia, the Caucasus Mountains region, Bashkir, and Siberia. Major plants commissioned in 1959-66 included nitrogen installations at Shchekino, Tol'yatti, Salavat, Navio, and Nevinnomyssk; phosphorus fertilizer facilities at Chardzhou, Sumgait, and Tol'yatti; and two potassium combines at Soligorsk (Belorussia). Selected fertilizer plants are listed in FIGURE 104.

(3) *Supply* — The quantities of fertilizer allocated to Soviet agriculture in selected years 1958-66 are shown in the following tabulation (in thousands of tons of nutrient):

1958	2,459
1960	2,624
1963	3,594
1965	6,303
1966	*est* 7,200

The effective consumption of fertilizers, however, was considerably less than the amounts allocated because of losses during distribution and because of poor methods of application. Even if consumption were equivalent to allocation, the U.S.S.R., with a sown acreage over 70% greater than that of the United States would have used less than one-third as much fertilizer per acre as the United States in 1965. By 1970, allocations of fertilizer to Soviet agriculture are scheduled approximately to double. The bulk of the fertilizer allocated to agriculture has traditionally gone to industrial crops such as cotton, flax, hemp, and sugar beets, but in recent years the percentage used for grain has been rising. Grain is scheduled to receive almost one-half of all fertilizer allocation to Soviet agriculture in 1970.

b. PESTICIDES

(1) *Introduction* — The use of insecticides, herbicides, defoliants, seed-treating agents, and other pesticides is an important means of increasing the production and labor productivity of agriculture in the U.S.S.R., where as much as 20% of the potential harvest is lost to insects, weeds, and diseases. The facilities for production of certain types of pesticides are also of military interest inasmuch as they can be converted to the manufacture of chemical warfare agents.

(2) *Production and supply* — During the 7-year plan, the production of pesticides more than quadrupled, rising to a level of over 103,000 tons of active ingredient in 1965 (equivalent to 198,000 tons of Soviet "standard" pesticides. The assortment increased from about six basic types to some 50 types during this period. Production of herbicides increased eighteenfold, and growth in organophosphorus products, fungicides, and defoliants also was very rapid. Output data for pesticides by major class are set forth in FIGURE 37. Although the acreage treated with pesticides more than tripled during the 10-year period 1956-65, output of chemical preparations remains far short of requirements, and quality and assortment are still unsatisfactory. In 1965, less than one-third of the demand for herbicides was met.

Although preliminary plans for production of pesticides in 1966-70 have been contradictory, they suggest that scheduled output in 1970 is to be between 250,000 tons and 350,000 tons (expressed as active ingredient). Thus the plan represents a sharp reduction from the 450,000 tons planned for 1970 under the Khrushchev program announced in 1963. A number of new plants are to be built, including large installations at Pavlodar, Mozyr, Tol'yatti, Volgograd, and Chimkent. Pesticides presently are

FIGURE 37. PRODUCTION OF PESTICIDES, FOR SELECTED YEARS
(*Tons of active ingredient*)

TYPE	1958	1960	1963	1965
Organo-chlorine........	16,666	19,974	27,090	43,450
Organo-phosphorus.....	123	689	3,851	6,216
Seed-treating agents....	940	1,590	3,362	4,526
Herbicides............	1,425	2,812	13,103	25,183
Fungicides*...........	......	......	6	4,199
Defoliants............	1,567	2,165	5,620	9,189
Other................	2,449	5,058	7,410	10,441
Total..............	23,170	32,288	60,442	103,204

* Some of the data on fungicides may be included in the category "Seed-treating Agents."

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produced at about 30 plants, important producers being located at Shchelkovo, Ufa, Beketovka, and Dzerzhinsk.

Because of domestic shortages, Soviet imports of pesticides have grown rapidly in recent years, their value increasing from 6 million rubles in 1960 to 39 million rubles in 1965.

4. Rubber

a. General — The U.S.S.R., second largest consumer of rubber in the world, also ranks second in the production of synthetic rubber. However, output of synthetic rubber in 1965 was only about one-third as large as U.S. output. During 1959-65, some success was achieved in modernizing the Soviet rubber industry, but standards of efficiency and quality remained generally below those attained in the Industrial West.

Confronted by increasing demands for rubber and handicapped by a synthetic rubber industry that failed to keep pace with these demands, the U.S.S.R. has been obliged to import sizable quantities of natural rubber. Soviet imports of natural rubber, only 35,000 tons in 1955, averaged 273,000 tons annually in 1959-65.

The current 5-year plan (1966-70), calls for further modernization and expansion of the rubber industry, with production of synthetic rubber scheduled to increase by 120%. Particularly large increases are planned in production of two relatively new types of rubber, polyisoprene and polybutadiene, which may be used in some applications where natural rubber formerly was preferred. The industry will use more extensively the synthetic raw materials derived from oil and gas and reduce the share of raw materials obtained from agricultural products.

b. Production and consumption

(1) *Production* — Production of synthetic rubber was originally scheduled to increase 170% during 1959-65. Costs per unit of output were to be lowered by shifting the raw material base of the industry from coal and agricultural products to petroleum and natural gas and by adopting a new process for the production of butadiene that would eliminate the use of ethyl alcohol as an intermediate. Development of the necessary technology proved both slower and more expensive than anticipated, however, and actual production increased by only about 90%. Thus output in 1965—estimated at 565,000 tons—was little more than 70% of that initially planned. The biggest shortfall was in production of the stereoregular rubbers—polyisoprene and polybutadiene. Production data for synthetic rubber are included in Figure 31.

Although construction of new capacity during 1959-65 was delayed by shortages of equipment and frequent revisions of processes, six new plants were commissioned. All, however, have experienced problems in reaching designed capacity or planned levels of costs. Shortages of petrochemical raw materials have hampered operation of the new plants, and difficulties in development of a new process for butadiene have resulted in continued production of substantial quantities of rubber by the obsolete process utilizing ethyl alcohol. In addition, technical problems were encountered at new polyisoprene plants at Tol'yatti and Volzhskiy, a polybutadiene plant at Yefremov, and a butyl rubber plant at Sumgait. Soviet rubber plants are identified in Figure 105.

Despite the shortcomings noted, considerable progress has been made in the development of synthetic rubber. Styrene-butadiene rubber, a type commonly mass-produced in the West, has become the principal general-purpose rubber in the U.S.S.R., replacing in part the inferior sodium-butadiene rubber that accounted for at least half of all Soviet synthetic rubber in 1959. Improved types of chloroprene and vinyl pyridine rubber were developed and produced, and the quality of butadiene-styrene rubber upgraded somewhat by oil-extension and the use of better emulsifiers. Despite the shortfall in production of polyisoprene through 1965, the existing capacities reportedly are large and may still yield substantial quantities of rubber.

(2) *Consumption* — The supply of natural and synthetic rubber available for consumption and reserves in the U.S.S.R. rose from an estimated 500,000 tons in 1958 to 800,000-900,000 tons in 1965. Even though the end-use pattern is not known in detail, as much as 65% of the total supply of natural and synthetic rubber probably goes to the production of tires. The plan for the consumption of synthetic rubber in 1965 was as follows:

Consumer or end-use	Percent of synthetic rubber consumed
Tire industry	*50*
Rubber and asbestos technical goods	*27*
Artificial leather and film materials	*9*
Cable industry	*5*
Paints and varnishes	*3*
Building materials and construction industry	*1*
Paper industry	*2*
Other	*3*
Total	*100*

5. Plastics

a. Introduction — Although the U.S.S.R. ranks second in the world in total chemical output, it is only sixth in the production of plastics. Soviet production of plastics was less than one-sixth that of the United States in 1965, and Soviet manufacturing techniques for plastics were generally inferior to those of the United States and western Europe. Thermosetting plastics (products such as phenolics which cannot be reshaped after heating) made up about two-thirds of Soviet production in 1965. However,

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the more modern thermoplastics, such as polyethylene and polypropylene, which are shaped while hot are presently receiving particular attention. The ability of thermoplastics to resist corrosion and extremes of temperature, their excellent electrical properties, and relatively low cost make many of these newer plastics useful substitutes for metals, leather, wood, asbestos, and other traditional materials.

An ambitious program for expansion of the Soviet plastics industry is scheduled for the 1966-70 period. Production in 1970 is planned to reach 2.1 million to 2.3 million tons, an increase of about 170%. Among the more rapidly growing plastics, production of polyolefins (polyethylene, polypropylene) is to increase by more than four times and polystyrene by three times. Petroleum and natural gas are to contribute three-fourths of the raw material for plastics, as compared with about one-tenth in 1958. To expedite development of the Soviet plastics industry, a large number of plants and associated technical data are to be purchased from the West. Contracts already signed provide for the delivery of several polyethylene plants with annual capacities totaling 192,000 tons and two polyvinyl chloride plants with a combined capacity of 120,000 tons. These plants alone could account for one-fifth or more of the increase in output of Soviet plastics planned for 1970.

b. Production — Production of plastics in the U.S.S.R. for selected years during 1958-66 is included in Figure 31. Production increased to 971,000 tons* by 1966, still far short of the original 1965 target of 1.8 million tons. Errors in planning and design delayed construction of new plants, and plants in operation often were slowed down by shortage of raw materials and problems of quality control. A list of major Soviet plastics plants is provided in Figure 106.

Estimated production of principal types of plastics in the U.S.S.R. in 1958 and 1965 was as follows (in tons):

Type	1958	1965	Number of times increase
Urea resins	30,000	210,000	7
Polyethylene	660	53,700	81
Polyvinyl chloride	18,000	113,000	6
Polystyrene and its copolymers	6,000	31,200	5
Ion exchange resins	n a	n a	7
Epoxy resins	n a	n a	13

The share of thermoplastics, such as polyethylene, polyvinyl chloride, and polystyrene, in the total output of plastics increased 50%, but still accounted for only about 30% of the total in 1965. Production of promising engineering plastics such as polycarbonates and polyformaldehyde still was on an experimental or small-scale basis in 1965. Some progress was made in 1959-65 in increasing the production of fluoroplastics, which have good electrical properties and high resistance to corrosive chemicals, but output was still insufficient to meet requirements. Because of inadequate domestic production, the U.S.S.R. has imported substantial quantities of plastics and associated raw materials. In 1965, net imports of these products by value amounted to about $43 million.

* Excludes production of bitumen and asphaltic types.

The quality of many Soviet plastics, including both the older types such as phenolics, and newer ones such as polyethylene, failed to improve materially in recent years, and in some cases even worsened. The shortcomings in quality have been chiefly due to inferior raw materials, lack of skilled workmen, deficiencies in plant design, and the obsolete nature of many existing specifications.

c. Consumption — The machine building industry consumed 40% of the output of the Soviet plastics industry in 1965. Nevertheless, polymers and synthetic resins account for only 1.5% of the materials used in machine building. The defense industry probably has been a large consumer of plastics, but almost no information is available on which to base an estimate of its requirements or consumption. In 1965, approximately 35% of all plastics material reportedly was processed into finished articles, including parts for machines; about 27% was used for synthetic fibers, paints and lacquers; 20% went to the cable industry; the remainder was used in the form of glues, binders, sealants and other products in various branches of the economy.

6. Manmade fibers*

a. Introduction — Manmade fibers accounted for about 14% of the total output of textile fibers in the U.S.S.R. in 1965; in the United States the share was 38%. Moreover, Soviet output of manmade fiber was only 27% as large as U.S. output in 1965, in spite of rapid growth in recent years. The lag is most pronounced in synthetic fibers, where Soviet output in 1965 was only one-tenth of that of U.S. output. Soviet output of rayon is less than half the U.S. level.

About two-thirds of the manmade fibers produced in the U.S.S.R. are used in the production of consumer items. The remainder presumably is used in producers goods and defense, including such articles as insulators, belts, filters, netting, cord, parachutes, and protective clothing. Because Soviet demand for manmade fiber and yarn far exceeds the domestic supply, the country has been a fairly large importer of these products. In 1965, imports of manmade fibers and yarn were valued at almost 40 million rubles.

* Manmade fibers include cellulosic fibers such as viscose and acetate rayon and synthetic fibers such as orlon and dacron.

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b. PRODUCTION

(1) *Volume* — At least 13 new plants for the production of manmade fibers were commissioned during 1959-65. By 1966, the level of production had reached 458,000 tons, almost triple the level in 1958 (FIGURE 31). Even so, 1965 production was approximately 40% below the level anticipated in the original 7-year plan. The shortfall in synthetic fibers was particularly severe in 1965, when output (77,500 tons) amounted to only about one-half of the original plan. By 1970, planned production of manmade fibers is to be 780,000 to 830,000 tons, or about double the 1965 level. Ten large plants for the production of manmade fibers are to be commissioned during this period. These include a dacron plant and an acrylonitrile plant purchased from the West, each having a productive capacity of 50,000 tons per year.

(2) *Mix* — Changes in the assortment of Soviet manmade fibers during the 7-year plan were as follows (in percent of total output):

TYPE OF FIBER	1958	1965
Viscose and cuprammonium	*90.8*	*76.7*
Acetate	*1.5*	*4.3*
Synthetic	*7.7*	*19.0*
Total	*100.0*	*100.0*

Viscose, the major cellulosic fiber, accounted for about three-fourths of Soviet manmade fibers in 1965, but its share in total output is to decline substantially in 1970. On the other hand, the share of synthetic fibers (which are to triple in output) is to rise from 19% to 33% by 1970. In 1966, Soviet production of synthetic fibers included chiefly nylon 6 (Kapron), polyester fibers similar to dacron (Lavsan), and polyacrylonitrile fiber (Nitron). Nylon 66 (Anid), polyvinyl chloride, polypropylene and polyvinyl alcohol fibers were produced on a small or experimental scale. Substantial increases in production of polyester, polyacrylonitrile and nylon fibers are planned by 1970, and additional capacity also is to be built for polyvinyl alcohol and polypropylene fibers. Within the cellulosic sector, production of acetate (including triacetate) fibers is to be considerably expanded. About one-half of the present production of manmade fibers is in the form of staple fiber and one-half is in the form of continuous filament, but the emphasis in 1966-70 will be on continuous filament.

(3) *Problems* — The main problems facing the Soviet manmade fiber industry continue to be construction delays, poor-quality raw materials, low productivity of labor, and a shortage of spare parts—particularly parts for imported machinery and equipment. The low quality of Soviet raw materials for manufacturing fibers, particularly cellulose and caprolactam, and the poor properties of many Soviet textile dyes have evoked numerous complaints. The U.S.S.R. possesses the technology and plant capacity to support a substantial level of rayon production, although much of the equipment is inefficient. Production of the more sophisticated synthetic fibers has presented greater difficulties. Substantial purchases of equipment and processes from the West have made possible improvements in the assortment and quality of fibers produced. However, the industry has not been very successful in its research and development of fibers. During 1961-65, the U.S.S.R. reportedly failed to develop and introduce on a commercial scale a single new process for the production of manmade fibers.

(4) *Organization and location* — Manmade fibers are produced primarily by the chemical industry, although some are also at plants in light industry. The R.S.F.S.R. accounts for about four-fifths of total production of manmade fibers and the Ukraine about one-tenth. The most important manmade fiber plants commissioned during 1959-65 included those for the production of viscose fibers at Barnaul, Ryazan, Balakovo, and Cherkassy; nylon 6 at Chernigov, Daugavpils, Engels, and Rustavi; dacron at Kursk, and orlon at Saratov. A further listing of major producers is given in FIGURE 107.

L. Processed food products

1. Introduction

The moderate rate at which the food processing industry is growing has been disappointing to Soviet consumers, who in the late 1950's had been promised rapid advances. During the period 1959-65, when the gross value of output of all industry increased by 84%, that of the food processing industry increased by only 63%. The share of the food processing industry in the gross value of output of all industry remained at about 10% in 1958 and 1965.

The Soviet food processing industry is labor-intensive. In 1965, it employed about 2.5 million persons and ranked third among Soviet industries in number of workers. Increases in labor productivity are achieved relatively slowly. During 1959-65, labor productivity in the food processing industry increased 38%, compared with 42% for industry as a whole.

The food processing industry includes meat and dairy processing, milling and baking, canning, sugar refining, etc. FIGURE 38 lists the major branches of the food industry and their percentage shares of the industry's total production, production capital, and production workers.

In contrast to the organization of Soviet heavy industry, which tends to be concentrated in large plants, much of the processing of food in the U.S.S.R. is carried out by a multitude of small localized enterprises, which in 1965 numbered about 193,000. The processing of perishable foods is carried on in the agricultural areas of the European U.S.S.R. Flour milling is concentrated in the Ukraine and in the

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FIGURE 38. RELATIVE SHARES OF THE MAJOR BRANCHES OF THE FOOD INDUSTRY, 1964
(*Percent*)

BRANCH	GROSS PRODUCTION	VALUE OF PRODUCTIVE CAPITAL	NUMBER OF PRODUCTION WORKERS
Meat	14.5	9.8	11.9
Dairy products	12.1	10.3	11.1
Fish	9.1	24.9	11.8
Sugar	4.6	13.0	7.1
Flour milling	7.4	6.2	5.2
Baking	14.4	8.4	21.0
Canning	3.8	5.3	7.9
Confection	6.6	2.3	5.8
Vegetable oil	9.1	0.6	3.0
Wine	6.4	5.6	3.4
Alcohol	1.7	2.1	1.9
Liquor	1.9	1.1	1.6
Beer	1.1	2.5	2.3
Tea	1.5	0.5	0.4
Tobacco	1.1	0.9	1.3
Other	4.7	6.5	4.3
Total	100.0	100.0	100.0

central industrial region around Moscow. The baking industry is located according to the distribution of the population.

In terms of quality, variety, and packaging, the food processing industry of the U.S.S.R. lags far behind that of the United States. Industrially processed meat, canned goods, and beer are of particularly low quality. Industrially processed milk, butter, vegetable oil, and margarine are still retailed to a great extent in bulk form in the U.S.S.R. Foods that are prepackaged, precooked, and/or frozen constitute a very small share of total output. Processing facilities for most agricultural products are insufficient, and storage, transport, and refrigeration facilities are far from adequate.

2. Production

a. GENERAL — During 1959-65, the gross output of the food processing industry increased at an average annual rate of 6%, and during 1966-70 is to increase at a rate of 7%. FIGURE 108 shows the production of important types of processed foods since 1958.

Growth of the food processing industry is dependent largely on the level of agricultural production, but there are nonagricultural resources as well. For example, the processing of fish is an important and growing branch of the industry. Irregularities in statistical reporting and certain institutional changes also have affected the measurement of growth as officially reported. For example, in the industrial* statistics for butter, vegetable oil, and grape wine, production by the kolkhozes is included; for meat, milk products, cheese, and bread, kolkhoz production is excluded.

* See footnote to FIGURE 108 for definition of industrial food categories.

The meat industry is a prime example of rapid growth through institutional change. Extraordinary growth in the meat industry has been achieved in large part by increasing the rate of state procurements of livestock and by converting many collective farms into state enterprises. As a result total production of meat increased by 50% during 1954-60, but industrially processed meat doubled during this period. Similar developments have occurred in the dairy industry and in flour milling. The following tabulation shows state industrial production as a percentage of the total production of particular types of food:

	MEAT	MILK PRODUCTS	BUTTER	FLOUR
1953	38	29	77	75
1958	44	38	85	88
1961	51	45	87	92
1962	51	45	88	n a
1963	53	47	88	n a
1964	50	50	92	n a
1965	52	53	91	n a

Trends in production of vegetable oil and sugar have been affected by developments in foreign trade in foodstuffs. Until 1960, large quantities of oilseeds from Communist China were processed by the Soviet food industry. Since then, imports have been curtailed, and domestic production of oilseeds has been increased in an effort to maintain the planned growth of production of vegetable oil.

Increases in the production of sugar have been possible in recent years because of imports of raw sugar from Cuba. Before 1960, the Soviet sugar industry refined very little imported raw sugar, but during 1960-65 nearly 20% of the inputs of raw sugar in Soviet refineries came from Cuba.

b. MAJOR PROCESSED FOODS

(1) *Meat* — Industrial production of meat, which includes meat produced by state and local industry, increased rapidly during 1952-59 because of an expansion in Soviet livestock production and the institutional changes mentioned above. Since 1959, the lower rate of growth in meat processing, reflects the relative stagnation of agricultural production during this period.

Beef is the most important type of industrially processed meat in the U.S.S.R., however, its relative importance has been declining during the past decade as the production of pork increased. Industrial production of meat by type for the period 1961-65 is shown in the following tabulation, in annual averages:

TYPE	THOUSAND METRIC TONS	PERCENT OF TOTAL
Beef	2,130	45
Pork	1,588	33
Mutton	419	9
Poultry	188	4
Other*	454	10
Total	4,779	100

* Including kidneys, brains, heart, tongue, and the like.

Approved For Release 2008/09/08 : CIA-RDP08S01350R000100030002-2

Approved For Release 2008/09/08 : CIA-RDP08S01350R000100030002-2

The Soviet meat industry in 1965 comprised some 800 packing plants with a combined capacity of 20,500 tons per shift. With the construction of 156 meat and poultry combines and the reconstruction of 195 existing plants during the 7-year plan, the average capacity of plants increased from 22 tons per shift in 1958 to 34 tons in 1965. The principal meat packing centers are located in the Ukraine, and in or near Moscow, Leningrad, Krasnodar, and Rostov. In the construction of new enterprises the trend has been toward smaller plants which are geographically dispersed in order to minimize the cost of transporting livestock, to reduce weight losses of livestock in transit, and to reduce transportation costs of the finished products.

Because of seasonal fluctuations in the supply of livestock brought to slaughter, the packing plants operate far below capacity in the first half of the year and overload their capacity in the last half. The following tabulation shows the percentage distribution of production by quarter in 1965:

Quarters	Percent
January-March	*17*
April-June	*19*
July-September	*27*
October-December	*37*
Total	*100*

(2) *Dairy products* — The Soviet dairy industry also is affected by seasonal fluctuations in production. The percentage distribution (by quarter) of procurements of milk and industrial production of dairy products in 1965 was as follows:

	Milk procurements	Butter	Cheese	Wholemilk products*
January-March	*16*	*14*	*19*	*25*
April-June	*31*	*31*	*28*	*31*
July-September	*36*	*40*	*31*	*26*
October-December	*17*	*15*	*22*	*18*
Total	*100*	*100*	*100*	*100*

* Wholemilk products include fresh milk, sour milk, cream, sour cream, cottage cheese, and cottage cheese products.

Unlike the meat industry, however, the trend in the dairy industry has been toward a larger scale of operation. Many small plants have been closed or combined with other plants. New plants being built to larger scale are capable of using assembly line and automated production techniques. In 1964 there were 6,300 dairy plants with an average capacity of 23 tons of milk per shift, whereas in 1958 there were 7,435 dairy plants with an average capacity of 13 tons of milk per shift. During 1966-70, the Soviets plan to build 165 milk plants, 183 cheese-making plants, 20 milk-canning plants, and 50 butter and dry nonfat milk plants.

The following tabulation shows the assortment of dairy products processed by state and local industry from milk procurements for 1965 and planned for 1970, in thousands of tons except for canned milk, which is in millions of cans:

Commodity	1965 Production	1965 Milk procured
Butter	1,066	24,845
Fresh milk	5,324	10,797 (fresh milk through cottage cheese products)
Sour milk beverages	856	
Cream	28	
Sour cream	397	
Cottage cheese	242	
Cottage cheese products	64	
Cheese	296	147
Canned milk (million cans)	663	658
Ice cream	311	*n a*
Dry milk	105	619
Total milk procurements		38,700

In terms of the amount of milk used, butter is the most important product of the Soviet dairy industry. Of the milk procured by the state in 1965, 64% was processed into butter, 28% was used as wholemilk products, and 4% was made into cheese. According to present plans, by 1970 the share of state procured milk processed into butter will be lowered to 55% and the shares for whole milk and cheese will increase to 31% and 8% respectively. Production of canned milk is to increase 60%, and dried wholemilk 88%. Production of ice cream is to double and dried nonfat milk to increase five times.

The uneven growth in the industrial production of dairy products results in part from inadequate refrigeration and transport facilities. Still the Soviets have been able to claim that the industry has surpassed the United States in the industrial production of butter. The following tabulation shows industrial production of butter in kg. per capita for the two countries for selected years:

Year	United States	U.S.S.R.
1953	4.0	2.0
1957	3.7	3.1
1961	3.6	3.6
1965	3.2	5.1

The Soviet comparisons fail to show, however, that changing dietary habits in the United States are responsible for the substitution of vegetable oils for animal fats. The production of margarine in 1965 amounted to about 4.2 kg. per capita in the United States, compared with 2.9 kg. in the U.S.S.R.

Dairy products are produced throughout the U.S.S.R., but the greatest concentration of processing is in the principal dairying regions of the European U.S.S.R., Ukraine, Belorussia, and the Baltic Republics.

(3) *Sugar* — The Soviet sugar industry has undergone rapid expansion in the past decade. Production during 1961-65 averaged 8.3 million tons annually, compared with 4.7 million tons in 1955-59. The increased production of sugar has been achieved both by increasing the acreage devoted to sugar beets for processing and by the refining of increasing

Approved For Release 2008/09/08 : CIA-RDP08S01350R000100030002-2

Approved For Release 2008/09/08 : CIA-RDP08S01350R000100030002-2

amounts of raw cane sugar from Cuba. Before 1960, imports of Cuban raw sugar were insignificant but now this source accounts for almost a fifth of the total production. The following tabulation shows production from sugar beets domestically grown and from Cuban cane sugar, in thousand tons:

	Production from domestic sugar beets	Refined from raw Cuban cane sugar	Total production
1955-59 (average)	4,570	172	4,742
1960	5,266	1,097	6,363
1961	6,085	2,291	8,376
1962	5,983	1,817	7,800
1963	5,531	688	6,219
1964	7,032	1,177	8,209
1965	8,925	2,111	11,037
1970 (Plan)	10,000	*n a*	*n a*

The rapid expansion of sugar production has enabled the U.S.S.R. not only to increase consumption per capita to a relatively high level of 34 kg. per capita in 1965, but also to build up reserves and to expand the export of refined sugar. Exports during 1961-65 averaged 592,000 tons a year, compared with 199,000 tons in 1958-59.

The production and processing of sugar beets is concentrated in the Ukraine and adjacent oblasts of the R.S.F.S.R. During 1961-65, the Ukraine produced nearly 60% of the total output of sugar and adjacent oblasts accounted for about 25%. Plant capacity for the processing of sugar beets was expanded during the 7-year plan from 295,000 to 535,000 tons a day, an improvement which enabled the industry to shorten the processing season from 183 days to 150 days, thereby significantly reducing storage losses.

(4) *Vegetable oil* — The industrial production of vegetable oil, which includes vegetable oil produced by state and local industry and by collective farms, significantly expanded during 1961-65; average annual production was 37% above that during 1956-60. Increases in production were achieved by expanding the production of oilseeds, by using seeds of a higher oil content, and through technical improvement in the process of oil recovery.

Sunflower seed and cottonseed are the main oilseeds used in vegetable oil processing. Soybeans have not been important in the Soviet vegetable oil industry since 1960, when imports of soybeans from Communist China were curtailed. The 1965 output of vegetable oil by type was as follows:

Source of Oil	Thousand metric tons	Percent of total
Sunflower seed	1,759	*64*
Cottonseed	778	*28*
Flax seed	34	*1*
Other	199	*7*
Total	2,770	*100*

Production of vegetable oil is concentrated in the areas where sunflowers and cotton are produced. The Ukraine and the North Caucasus region of the R.S.F.S.R., both important sunflower growing areas, together accounted for about one-half of the total output of vegetable oil in 1961-65. The Uzbek S.S.R., which produces about two-thirds of Soviet cotton, accounted for 13%.

The vegetable oil industry in the U.S.S.R is a fairly large scale industry. More than 80% of the oilseeds are processed in plants having a production capacity of at least 25 tons per shift. In addition to edible oils, the industry is producing increasingly larger quantities of margarine, soaps, and detergents. The following tabulation shows the output of these commodities in recent years and plans for 1970 (in thousands of tons):

Product	1962	1965	1970 Plan
Vegetable oil	2,114	2,770	*n a*
Soap (40% fat)	1,612	1,777	*n a*
Detergents	50	150	573
Margarine products	515	670	1,200
Drying oil	179	*n a*	200

The industrial sources of vegetable oil produced in the U.S.S.R. for 1961 and 1965 were as follows, in thousands of tons:

	1961	1965
From state procurements of oilseeds	1,414	2,208
Oilseeds custom processed	326	412
Kolkhoz production	75	150
Total industrial production	1,815	2,770

Modernization of the vegetable oil industry has resulted in a gradual changeover from extraction by pressing to the more efficient method of extraction by means of solvents. Forty-three continuous production lines were put into operation in oil processing plants during 1959-64. In addition, 27 plants and departments for solvent extraction capable of processing a total of 13,200 tons of oilseed per day were built. By 1970, 97% of all oilseeds are to be processed by the solvent extraction method as compared with 74% in 1965. Industry officials claim that an extra 760,000 tons of oil from sunflowers were extracted during the 7-year period through the use of the extraction method, whereas this amount would have been lost had the pressing method been used.

(5) *Canned foods* — Industrial canning of foodstuffs is not extensive in the U.S.S.R., relative to the size of the population, and many other food processing techniques such as the freezing of foods, the making of instant and prepared beverages, and the like, are only just coming into use experimentally. Most of the foods sold in Soviet markets still are either fresh, dried, or have been held in cold storage. In 1964, only about 30 standard-sized cans of 400 grams each (or 353 cc.) were produced per person. Fruits and vegetables, including tomatoes and juices, accounted for about two-thirds of all foods canned during 1961-65, and fish, meat, and milk products for the remaining third. Industrial production of canned

Approved For Release 2008/09/08 : CIA-RDP08S01350R000100030002-2

Approved For Release 2008/09/08 : CIA-RDP08S01350R000100030002-2

foods by type and in annual averages for 1961-65 was as follows:

Type of Food	Million cans*	Percent of total
Fruit	1,317	20
Vegetables	1,441	22
Tomatoes	953	15
Juice	583	9
Fish	869	13
Meat and meat-vegetables	711	11
Milk	593	9
Total	6,467	100

* Standard cans of 400 grams (or 353 cc.) capacity.

Fruits and vegetables are usually canned in small plants located near the growing regions in order to minimize transportation costs and to reduce waste due to spoilage.

The canning industry is to be expanded rapidly during the present plan period. Compared with 49 new canneries built during 1959-65, 72 new plants are to be constructed by 1970 so as to enable the industry to double its total output from about 6.5 billion to 13 billion cans of food in 1970.

(6) *Flour and bread* — Flour and bread are produced in all of the union republics, and in each region within the R.S.F.S.R. The geographical distribution of the industry producing flour and bread corresponds more closely to the distribution of the population than does production of most other food items produced. The major flour mills and bakeries are located in large centers of population such as Moscow, Leningrad, and Gor'kiy. Since 1950, enterprises of the flour industry have been drawn more and more into the state industrial system until presently it is virtually state-owned. By 1961, more than 92% of the flour produced was milled at state-owned enterprises, whereas 10 years earlier almost one-third of the industry was outside of the state system.

The U.S.S.R. reports few statistics on the production of bread. In 1958, about 41 million tons of bread reportedly were produced, 15 million tons of which were produced in state-owned factories. Production probably has remained at about the same level or slightly below it as the result of gradual but slight increases in the amounts of meat, milk, fruits, and vegetables added to the Soviet diet in recent years. Even though total production of bread has stayed at about the same level, production at state-owned enterprises increased from 15 million to 20 million tons between 1958 and 1965 as more bakeries were brought into the state system. Home baking of bread has been gradually reduced as the result of rapid urbanization, expansion of public dining facilities, and the restrictions in the sale of flour to households in favor of serving institutional needs. Retail sales of bread and bread products (measured in terms of flour content) through state and cooperative markets increased 21% during 1958-65.

3. Capital investment

Food processing as a part of the consumer goods sector of the Soviet economy traditionally has received a low priority in the allocation of investment funds, industrial materials, and service facilities, and has been dependent for raw materials on an erratic and generally lagging agricultural base. Following restoration of the extensive damage to plants of the food industry during World War II, state investment in food processing as a share of total investment in industry declined but continued at a fairly respectable level throughout most of the 1950's. By 1958, a major increase in the production of food crops necessitated the expansion of facilities for processing these materials.

The 7-year plan thus earmarked substantial state funds for the expansion of the food industry. In 1959 and 1960, state investment in the food industry increased sharply, accounting for 10% of total investment of industry in the latter year. Following this expansion period, state investment declined in absolute amount to a lower level. Since 1960, the investment share of the food industry has remained at about 8% of total industrial investment. The following tabulations shows investment in the food industry for the period 1960-65, in millions of rubles and as a share of total industrial investment:

	Million rubles	Percent		Million rubles	Percent
1960	1,346	10.5	1963	1,166	7.7
1961	1,158	7.8	1964	1,356	8.1
1962	1,148	8.1	1965	1,476	8.2

The plan for 1966-70 calls for an investment of 4 billion rubles over the 5-year period, or an annual average well below that during the first half of the 1960's. During the period 1959-65, about 600 enterprises came into operation in the food industry. Investments, however, have not been evenly distributed throughout the industry. The fishing industry, for example, claims 25% of the productive capital even though it produced only 9% of the gross output of the food industry. The sugar industry is also relatively capital intensive, as may be seen in FIGURE 38.

M. Consumer goods

1. Introduction

a. GENERAL — The level of production of manufactured consumer goods* in the U.S.S.R. has increased appreciably in recent years, but still is below the level needed to meet the requirements of the population for particular commodities, and quality remains a chronic problem. The production per capita of manufactured consumer goods in the

* Does not include processed food products, which are covered in Subsection L. This category covers production of light industry (including textiles, clothing and footwear), tires and industrial rubber products, paper, and consumer durable goods.

Approved For Release 2008/09/08 : CIA-RDP08S01350R000100030002-2

Approved For Release 2008/09/08 : CIA-RDP08S01350R000100030002-2

FIGURE 39. COMPARISON OF SOVIET AND U.S. PRODUCTION OF SELECTED CONSUMER GOODS, 1966

	UNIT	U.S.S.R.	UNITED STATES
Cotton cloth.......	Square meters....	24.2	43.2
Wool cloth.........	....*do*..........	2.2	*1.3
Cloth of manmade fiber and natural silk.	....*do*..........	3.7	17.5
Leather footwear....	Pairs............	2.2	3.3
Hosiery............	....*do*..........	5.5	12.8

* 1965 figure.

U.S.S.R. is still far below that in the Unites States, and the quality is notably low by U.S. standards. FIGURE 39 shows per capita production of selected items, compared with such production in the United States.

The major share of Soviet consumer goods such as textiles, clothing and leather footwear, is produced in large state-owned plants which are under the directions of the Ministry of Light Industry and which generally use mass production methods. Some consumer goods, however, continue to be produced on a small scale by local industry, which now includes the former industrial cooperative enterprises that operated outside the state sector of the economy before 1960. Using local materials and scrap from large scale industry, the plants of local industry produce a wide variety of goods, mainly for local needs. An expansion and improvement of local industry currently is underway in an attempt to increase the supplies of consumer goods and raise the standard of living. A Ministry of Local Industry recently has been created in the R.S.F.S.R. to carry out these objectives.

In addition to manufacturing goods for civilian consumers, Soviet light industry supplies uniforms, footwear, and special-purpose clothing for the armed forces, as well as special protective clothing for hazardous industries and for space and other scientific exploration. Among the products of light industry designed for military use are parachute cloth, tarpaulins and other special fabrics, and ropes and cords made of kapron (nylon).

Other manufactured consumer goods of considerable importance include durable household goods, tires, rubber footwear, and paper. Rubber footwear is produced in the rubber products plants of the Soviet chemical industry. Durable consumer goods, such as washing machines, refrigerators, and other household appliances, are generally produced in the enterprises of heavy industry as subsidiary products, although more and more plants are becoming specialized as these industries develop. In the paper industry, cellulose plants, which are basic to the production of paper and artificial fibers, are of potential strategic importance for the manufacture of explosives as well.

The U.S.S.R. has allocated increasing amounts of investment funds to light industry for plant construction, expansion, modernization, and reequipment in recent years, although light industry still receives only 3% to 4% of total investment. Total capital investment in state and cooperative enterprises of light industry, including both central and noncentral investments, since 1958 are as follows (in million rubles):

1958	339
1960	414
1964	616
1965	671
1959-65	3,568

One of the problems of Soviet light industry in recent years has been the increase in capital costs, as the industry attempts to raise its technological level and to differentiate the product in response to changes in demand. For example, in 1964, according to industry reports, capital grew by more than 9% whereas the growth in production was only 3%; in 1965 the figures were 9% and 4% respectively. The increase in capital cost can be attributed in large part to lags in construction, inadequate support by the machine building plants that produce equipment for light industry, and lack of coordination in planning.

Another serious difficulty experienced by the industry during the 1960's was the resistance of consumers to the purchase of goods of inferior quality. Production goals for some kinds of goods, principally of wool and silk-like fabrics, ready made clothing, and footwear, had to be cut back and unpopular models and designs withdrawn from production. Because of the mounting difficulties in selling goods to the population, and the economic waste in the accumulations of unsalable goods, Soviet planners were obliged to make significant changes in the planning and management of light industry.

Light industry—the garment industry in particular—has been in the forefront in testing and introducing industrial reforms. In 1964, two firms in the garment industry—the Bol'shevicka firm in Moscow and the Mayak firm in Gor'kiy—were chosen to test proposed measures for a general reform that later were to be applied in large part throughout all of industry. The new principles under test in the experiment were: 1) The use of profit as a guide to efficiency, and 2) the planning of production schedules on the basis of contracts let with retail outlets. The firms, thus freed from many of the traditional plans and controls, measured their success in terms of the amount of goods sold and the rate of profit earned. The managers of the firms reported that under these test conditions they were better able to tailor their output to consumer needs and tastes and to increase efficiency by paying bonuses to managers and workers out of profits earned.

b. LABOR FORCE — Soviet light industry, on the whole, is labor-intensive, and employs more produc-

Approved For Release 2008/09/08 : CIA-RDP08S01350R000100030002-2

Approved For Release 2008/09/08 : CIA-RDP08S01350R000100030002-2

tion workers than any other branch of industry except machine building and metalworking. In 1965, light industry employed about 3.7 million workers, or more than 16% of the total industrial labor force. Increases in the number of workers employed since 1955 have been offset to some extent by a gradual reduction in the scheduled work week and by the increase in days off for vacations and sickness.

Although labor productivity in light industry is low compared with other branches of industry, technological improvement, better administration, and training of industrial workers have contributed to a steady increase. The following indexes indicate the growth in man-hours worked and in output per man-hour in light industry since 1950 (1950=100):

	Man-hours worked	Output per man-hour
1958	124	160
1960	130	174
1961	123	189
1962	125	193
1963	126	196
1964	131	197

c. Production and consumption — The textile industry is by far the largest component of light industry, and cotton is its largest branch. Since 1950, the relative shares of textiles other than cotton have increased especially those of manmade fiber, as shown in the following tabulation:

Type	1950	1965
Cotton cloth	*84*	*74*
Wool cloth	*6*	*7*
Cloth of manmade fiber and natural silk	*3*	*11*
Linen	*7*	*8*

During the period 1958-65, the stock of spindles in the textile industry in the U.S.S.R. increased by 26% and looms by 35%, which enabled the industry to increase total output by 32%. Stocks of looms and spindles in the textile industry during this period were as follows (thousand units):

	1958		1965	
	Spindles	Looms	Spindles	Looms
Cotton	10,700	235	12,000	200
Other	800	32	2,500	160
Total	11,500	267	14,500	360

Although generally large percentage increases in the production of the basic types of consumer goods were realized during 1959-65, consumption per capita is still far below that in the United States, and is below that established by the Soviet planners as the rational norm of consumption. This is evident in the following tabulation:

	Actual per capita consumption 1958	Actual per capita consumption 1965	Consumption norms
Textiles (square meters)	*24*	*26*	*58*
Knitwear (pieces)	*2*	*4*	*8*
Hosiery (pairs)	*4*	*6*	*9*
Leather footwear (pairs)	*1.7*	*2.4*	*3.5*

d. Foreign trade — Soviet foreign trade in manufactured consumer goods is small, amounting in 1965 to 8% of total foreign trade turnover. While the share of manufactured consumer goods in exports has remained constant at less than 3% since 1958, imports of manufactured consumer goods have ranged from 14% to 18% in the period from 1958 to 1965, 1963 having been the highest single year. Soviet trade in manufactured consumer goods is mainly with other Communist countries, although trade with non-Communist countries is increasing. Figure 109 shows imports and exports of consumer goods for selected years 1959-65.

2. Textiles

a. Cotton cloth

(1) *Introduction* — Cotton cloth, the principal textile product of the U.S.S.R., currently accounts for nearly three-fourths of the total output of textiles, even though the share of looms used for weaving cotton is only 55% of all looms, a smaller share than in earlier years. This considerable increase in efficiency in cotton cloth production has been achieved as the result of investment in modern automated production equipment and the more efficient use of older equipment.

More than 75% of Soviet cotton cloth is produced in the industrial areas around Moscow and Leningrad, far from the principal cotton-growing areas of the Uzbek S.S.R. and the Transcaucasus region. Most of the older plants are single-operation plants joined together administratively rather than by physical integration of production. This is in contrast to the newer combines, which have been built closer to the sources of raw materials and which perform the full range of textile operations. Some of the newer cotton textile plants are nearly the equal of the more modern plants in the Industrial West.

The largest cotton textile combine in the U.S.S.R. was built after World War II at Kamyshin, in the lower Volga Region. Equipped with more than half a million spindles, it has a daily production capacity of one million linear meters of cloth and is claimed to be the largest plant of its kind in the world. Two other large combines, only slightly smaller in size than the one at Kamyshin, contribute substantially to the supply of cotton cloth. The Barnaul Cotton Combine supplies western Siberia, eastern Siberia, and the Far East with a variety of cotton cloth products. Another large combine is located at Tashkent, the capital and industrial center of the Uzbek S.S.R. Major plants producing cotton textile are listed in Figure 110.

(2) *Production and consumption* — As shown in Figure 40, production of cotton cloth in 1966 amounted to 5,700 million meters, or 74% of total production of cloth, about the same share as in 1958 in spite of the desire of planners to boost the share of output of synthetics. Between 1958 and 1965, cotton

Approved For Release 2008/09/08 : CIA-RDP08S01350R000100030002-2

Approved For Release 2008/09/08 : CIA-RDP08S01350R000100030002-2

FIGURE 40. PRODUCTION OF TEXTILE FABRICS, BY TYPE
*(Millions of square meters)**

YEAR	COTTON	WOOL	LINEN	OTHER**	TOTAL
1958.....	4,300	400	400	700	5,800
1960.....	4,800	400	500	700	6,500
1962.....	4,900	500	500	800	6,700
1963.....	5,100	500	500	800	6,800
1964.....	5,400	500	500	800	7,200
1965.....	5,500	500	600	800	7,300
1966.....	5,700	500	600	900	7,700

* Rounded to nearest hundred million.

** Rayon, synthetic, and silk.

cloth increased at an average annual rate of 3.6%, the highest of the textiles. In 1965, a year of slow growth for all of industry, the increase dropped to 2.5% over 1964, but this rate still was high in comparison with wool and the silk-like fabrics, which dropped below the 1964 level of output. In 1966, following general improvements in planning and management and in supplies of raw cotton, the industry resumed a growth rate equal to the average achieved during the preceding 7 years. The increasing availability of long-staple cotton has permitted improvements in particular types of fabric. In general, the industry has succeeded in broadening the assortment of fabrics and has increased considerably the assortment of special-purpose fabrics such as the various napped fabrics, upholstery materials, and decorative fabrics.

The spinning and weaving operations in the cotton branch are relatively more modern and more efficient than in the other textile branches, except for a few new plants that produce fabrics of wool and synthetic fiber. Eighty percent of the looms that weave cotton reportedly were automatic in 1965, whereas only about half were automatic in 1957. As a result of these and other technological improvements, the quality of cotton cloth is high compared with other Soviet textile products, even though generally of lower quality than such fabrics produced in the Industrial West.

The industry has performed better in serving the quantitative needs of the Soviet people than in pleasing them in quality, variety, and style. Even though customers have declined to buy some of the particular types of cotton textiles, availability overall has increased. For example, production per capita rose from 20.8 square meters in 1958 to 24.5 square meters in 1966, an increase of about 18%. Even at this level of output production per capita was less than half that of the United States in 1965. Furthermore, not all cloth is intended for consumer goods; about one-fifth of the cotton cloth is used for technical and heavy industrial use.

(3) *Foreign trade* — Even though Soviet production per capita of cotton cloth is below the norms set for consumption, the U.S.S.R. continues to be a sizable exporter of raw cotton and also exports some of its cotton cloth. In the years immediately following World War II, the U.S.S.R. began supplying the textile industries of the eastern European Communist countries with a large share of their requirements for raw cotton. This practice has continued to the present, exports still taking from 20% to 25% of Soviet cotton production each year. Meanwhile, the U.S.S.R. imports cotton, mainly from the U.A.R. In 1965, imported Egyptian cotton amounted to 9% of domestic production. Foreign trade in cotton cloth is small compared with domestic production, net exports amounting to less than 3% of domestic production in 1965.

b. WOOL CLOTH

(1) *Introduction* — The wool industry in the U.S.S.R. has both small, antiquated spinning and weaving mills and large and efficient modern combines constructed mainly since World War II.

Much of the industry is in need of modernization. Three major combines were constructed during the Seven Year Plan period (FIGURE 111). The major producers of wool cloth are concentrated in and around Moscow and to a lesser degree in the Ukraine. Altogether these mills account for two-thirds of the total wool cloth production. In an effort to bring part of the industry closer to the sheep-raising regions, woolen mills also have been located in the Caucasus and in Central Asia near to the sources of raw wool.

Wool cloth produced in the U.S.S.R., notoriously unattractive to consumers, is low in quality by Western standards mainly because of the inferior quality of raw wool and also because of the high rate of blending with other fibers. The Soviet wool industry traditionally has resorted to extensive blending with the cheaper fibers, mainly cotton and rayon, in order to extend the supply of wool. For example, fabric containing as little as 30% wool is reported as wool fabric in the U.S.S.R., whereas in the United States, wool cloth must contain at least 50% of natural wool. The increase in availability of wool-like synthetic fibers such as dacron and orlon is now making possible quality improvements in some types of Soviet-produced wool cloth.

The U.S.S.R. is only beginning to produce the more-desirable wool suiting materials of wool and dacron blends which have been in demand in the United States and other countries of the Industrial West since about 1950. One of the first and most prized modern production facilities of the textile industry is the wool and synthetic plant at Kalinin, northwest of Moscow. Machinery for this plant, all U.S.-made, was furnished and installed by Intertext International, Inc. of New York between 1959 and 1963. The purchase of this plant made a major contribution to Soviet textile technology. Through its acquisition, the U.S.S.R. broadened the range of woolen textiles it can produce, introduced a new level of efficiency in textile production, and provided the industry with a

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laboratory for training technicians in advanced textile technology.

Wool cloth production in the U.S.S.R. has suffered both in quantity and quality from inadequacies in the supply of raw wool, one of the reasons why Soviet planners are pressing to provide more of the new synthetic fibers. Much of the raw wool is of coarse quality and the supply is not sufficient to support the expanding wool textile industry. To increase the domestic supply, Soviet officials have appealed to sheepgrowers not only to increase the size of their flocks but to improve the breeds of sheep as a means of increasing the cut per animal. The industry continues to rely heavily on supplies of imported wool of many types. Mongolia, Communist China, and other Asian countries supply most of the common grades of wool, coarse and semicoarse, whereas imports of fine wool come from Australia. Australian wool—in demand by the industry as it strives for higher quality—made up almost 45% of total imports in 1965, compared with 29% in 1961. Soviet imports of washed raw wool totaled 53,000 tons in 1965, an amount equal to about 34% of that produced domestically. In 1962, imports were only 20% of domestic production. Imports of wool cloth are negligible.

(2) *Production and consumption* — Wool cloth is an especially important commodity in the U.S.S.R. because of the severe winter in much of the country, yet the annual output of about one-half billion meters of wool cloth is only 6% to 7% of the total production of cloth (FIGURE 40). Because of planning and production problems, output in 1965 declined below the level of 1962, and amounted to 2 square meters per capita. The decline was temporary, however, and in 1966 output reached a new high of 509 million square meters. Even though wool cloth is still far from plentiful, Soviet consumers refuse to buy the low quality or unattractive fabrics, and inventory buildups have prompted cutbacks in production of these particular types of wool. The following tabulation shows inventory accumulations (by value) at wholesale and retail levels during the Seven Year Plan period (in thousand rubles):

	1958	1960	1962	1964	1965
Retail stores	369	694	907	1,087	904
Wholesale network	185	323	292	528	227
Total	554	1,017	1,199	1,615	1,131

c. CLOTH OF MANMADE FIBER AND NATURAL SILK*

(1) *General* — The production of cloth from manmade fiber and from natural silk ranks second only to cotton in volume. Even so, production of silk was only 11% of total cloth production in 1966. Because this branch of the textile industry has developed from both the natural silk industry and the chemical industry, the plants that manufacture cloth of manmade fibers and natural silk are widely dispersed. Much of the industry is located in the regional vicinities of Moscow and Kalinin. Leningrad and Kiev are also silk-producing centers. Leninabad and Stalinabad in Central Asia are production centers for natural silk.

The first rayon plant in the U.S.S.R. was built by a British industrialist at Mytishchi, a suburb of Moscow, before the revolution. Two rayon plants still in operation were constructed during the first Five Year Plan (1928-1935) by a U.S. company, one at Klin near Moscow and the other at Mogilev in the Belorussian S.S.R. A new silk factory under construction at Orenburg (about 800 miles southeast of Moscow) is scheduled to be the largest plant of its kind. FIGURE 112 lists the major producers of textiles of manmade fibers and natural silk.

(2) *Production* — The production of cloth from manmade fibers and natural silk has increased at a much higher rate than that of any other textile. The output of nearly 870 million square meters in 1966 was about double the output level in 1955. Fabrics of natural silk constitute only a small share of the total, probably less than 5%. Soviet planners since the early years under Khrushchev have emphasized the development of the synthetic fiber industry, in particular the branch that produces the wool-like synthetic fibers of the dacron and orlon types. The desire to produce attractive and durable fabrics of wool and synthetic blends of the types widely sold in Western markets stems not only from the desire to keep abreast in this field of technology and to satisfy the more sophisticated tastes of consumers, but also because the Soviet agricultural sector is not able to produce natural wool in the amounts needed to supply the warm suitings and coat fabrics that the economy requires. Furthermore, the higher quality presently demanded in consumer markets has made some of the lower or coarser grades of wool virtually unusable for clothing fabrics, and thus the demand for synthetic wool-substitutes has become intensified.

In spite of the unfulfilled need for synthetic fibers to supplement or replace natural wool, the largest share of manmade fibers is still rayon, mainly viscose, which is more silk-like in character and not a good substitute for wool even as spun rayon. Of the more than 400,000 tons of manmade fiber produced in 1965 (most of which was processed into consumer goods), only 76,000 tons, or less than one-fifth, was synthetic fiber. The natural raw silk produced in 1965 amounted to less than 3,000 tons. Imports of manmade fibers and yarns, which are substantial, totaled about 67,000 tons in 1965.

The technological processes involved in the production and processing of manmade fibers, in particular the newer types of synthetics, are complex and Soviet officials have devoted relatively little effort to

* This category of cloth consists primarily of fabrics of rayon and synthetic fibers, but also includes a relatively small quantity of natural silk. It has been Soviet practice, however, to report these fabrics together under the single heading "silk cloth."

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research and development in this field. Instead, the development of the industry is based primarily on the imports—mainly from the United States and western Europe—of process technology in the form of equipment or complete plants for production and processing of fibers.

d. Linen cloth

(1) *General* — Until now, the production of linen cloth has not been emphasized in the U.S.S.R. The production of linen is relatively costly and, at the same time, demand for it by Soviet consumers is less than for the other textile materials. Fine linens, such as those found in the Industrial West, are not generally available and coarse linen is not in demand except for the most utilitarian purposes.

In the flax-growing regions in the northern parts of the R.S.F.S.R. there are numbers of small scattered retting and linen works, but nearly two-thirds of the total production of linen comes from mills concentrated in the Central industrial region. Major producers of linen are shown in Figure 113. Construction of especially large combines in the Ukrainian S.S.R. at Rovno and at Zhitomir begun in the early 1960's is now virtually complete. In contrast to the largest existing plants, which are estimated to produce up to 10 million linear meters of cloth annually, the capacity of each of these new combines is planned at 23 million meters annually.

After the revolution, an attempt was made to increase flax production and to develop the linen branch, one of the oldest of the textile industry, but much that was accomplished in developing the industry was destroyed during World War II. In the immediate postwar period, output of linen was limited also by yearly fluctuations in the supply of flax; since that time, minor efforts have been made to increase the agricultural acreage and yields of flax.

(2) *Production* — Production of linen cloth in 1966 was about 590 million square meters and constitutes less than 8% of the total production of textile fabrics (Figure 40). In an attempt to make the industry more productive and to utilize more efficiently the supplies of flax produced domestically, planners are modernizing the industry and experimenting with new materials, such as blends with synthetics. Thus, flax fiber, formerly exported, is now being used by Soviet mills. New types of linen fabrics more desirable in quality and design as clothing and household fabrics are now being produced. However, at least half of the linen produced still is used for various industrial needs, including various kinds of packing and packaging materials and tarpaulins.

3. Apparel

a. Knitwear — The knitwear industry has developed rapidly in the U.S.S.R. since World War II; it is becoming a major branch of Soviet light industry, producing sizable quantities of knitted outer garments, underwear, and hosiery. A number of new plants were built during the 1950's and further expansion has been under way during the 1960's, with large producers now located in many major cities throughout the country. Planners have stressed the development of the knitwear industry because its low investment costs permit it to produce clothing more cheaply than can be done from sewn cloth.

As raw materials, the knitwear industry is using increasing quantities of chemical fibers and relatively smaller quantities of natural fibers. Rayon and the synthetic fibers are rapidly replacing the formerly predominant inputs of cotton and wool. By 1970 the knitwear industry plans to increase its use of chemical fibers to about 75% of the total inputs of fibers.

Even though the output of knitted goods is about double the production level in 1958, the needs of the consumer are still not being satisfied adequately in quantity, quality, or assortment. The industry imports technologically advanced knitting machines from western Europe that can produce knitwear of higher quality and in styles more satisfactory to the consumer. Production of the major types of knitwear is shown in the following tabulation, in million units or pairs:

	Outerwear	Underwear	Hosiery
1958	97	399	888
1960	112	472	964
1962	125	519	1,033
1964	153	640	1,236
1965	188	719	*est* 1,300
1966	221	769	*n a*

b. Sewn garments

(1) *General* — The garment industry in the U.S.S.R. is made up of numerous small enterprises under the control of the local administrative bodies and of a few large factories under the control of the Ministry of Light Industry. The garment industry is especially backward and has almost no modern factories comparable to the more advanced garment factories in the United States. As much as 80% of the equipment used in the garment factories is obsolete. Although the number of large factories controlled by the Ministry is increasing, the largest part of the industry, in terms of output, still is under local industry.

Because of its requirement for skilled and semiskilled labor, the garment industry traditionally has been located in and around Moscow and other large industrial areas. The growth of new industrial cities and the consequent increase in availability of labor in these cities has resulted in a considerable dispersion of the garment industry. Of the 300 new enterprises in light industry to be built during 1965-70, one-half are to be sewing factories. Many of the older clothing factories meanwhile are being reequipped with more modern machinery and equipment.

Approved For Release 2008/09/08 : CIA-RDP08S01350R000100030002-2

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A large amount of U.S. and European machinery of obsolete design is in operation in the Soviet garment industry. Although the U.S.S.R. has the capability of manufacturing equipment for the garment industry, little progress has been made in producing new designs embodying advanced technology. The leading plant supplying machinery to the garment industry is the Podol'sk Machine Building Plant *imeni* Kalinin.

(2) *Production and consumption* — Production of sewn garments for the period 1958-66 is given below in factory wholesale prices, in million rubles:

1958	7,346	1964	9,263
1960	8,737	1965	9,291
1962	9,688	1966	10,100
1963	9,494		

Although the industry has failed to satisfy the needs of the people for clothing of acceptable quality and style, it has increased the level of production significantly. The amount of sewn garments distributed through the retail stores in 1965 was more than four times the 1950 level, and about 55% above the level in 1955. Sales of fabrics on the other hand have declined since 1958, reflecting a trend away from home sewing and toward greater reliance on factory-made clothing.

Clothing made in the U.S.S.R. is notoriously shoddy, reflecting the poor quality of materials and workmanship and the inexperience of designers. Although some improvement is being made, some of the factory-made clothing still is unsalable because of poor sewing, neglect of finishing details, unvaried styling, poor sizing, and the prevalence of defects. Consumer resistance has brought pressure on the industry to improve its organization, administration, and techniques of production.

Imports of garments by the U.S.S.R., which were negligible before the late 1950's, have increased somewhat in recent years; however, net imports in 1965 were still only 3% of Soviet production of garments.

c. FOOTWEAR

(1) *Leather footwear* — The Soviet leather footwear industry is composed of enterprises ranging from small handicraft shops of local industry to large state combines employing as many as 6,000 persons. Production in 1966 totaled 522 million pairs, an increase of 47% over the level in 1958 (FIGURE 41).

The expansion of the leather footwear industry has been limited by shortages of raw materials. Domestic supplies are supplemented by substantial quantities of leathers, hides, and skins from Argentina, Mongolia, and India.

Synthetic materials, many of which are acceptable substitutes for leather in various parts of shoe construction, are being used to some extent. One barrier to a more extensive use of these materials is that the state standards are outdated and do not permit extensive use of synthetics even when these materials are suitable substitutes for leather. Soles of artificial leather reportedly were used on 63% of the footwear produced in 1965, but synthetics are used far less extensively in other parts of the shoe, for example, the inner soles. A shortage of goatskins is depriving the industry of the most desirable material for linings. On the other hand, the state standards fail to stipulate effective tolerances for defects, so that quality is being lowered in other respects.

FIGURE 41. PRODUCTION OF FOOTWEAR
(*Million pairs*)

	LEATHER	RUBBER
1958	356	159
1960	419	166
1962	456	157
1963	463	160
1964	475	165
1965	486	161
1966	522	*na*
1967 Plan	545	*na*

Footwear factories are concentrated to some extent in the Central industrial region but important producers are found also in a number of other large cities in the eastern U.S.S.R. Major producers of leather footwear are identified in FIGURE 114. Despite the dispersion of the industry, the locational pattern for the country as a whole is out of balance with the distribution of the population.

(2) *Rubber footwear* — This class of apparel, consisting of rubber boots, galoshes, and certain types of specialized footwear, is produced by the Soviet chemical industry. Production has remained relatively stable since the mid-1950's, annual output averaging around 160 million pairs (FIGURE 41). Three plants are responsible for the bulk of the production of rubber footwear in the U.S.S.R.: The Red Triangle ("*Krasnyy treugol'nik*) Plant at Leningrad, the Red Hero ("*Krasnyy bogaty*") Plant at Moscow, and the Tomsk Rubber and Rubber Footwear Plant at Tomsk in western Siberia. The rubber footwear industry is one of the most backward with respect to mechanization of production. Moreover, production processes generally are those used for producing industrial rubber goods rather than processes designed particularly for consumer goods. Hand labor is still extensive, and research and development continues to lag.

4. Tires and industrial rubber products

a. TIRES

(1) *Introduction* — Tires are produced in the U.S.S.R. in about 70 sizes, ranging from bicycle and motorcycle tires to heavy-duty truck tires. The industry has grown rapidly but is still unable to meet the demand for its products. By 1970, production is scheduled to rise to 38-40 million tires, an increase of about 50% over the level in 1965. More than

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three-fourths of the increase is to come from expansion and modernization of existing facilities. Heavy-duty tires will continue to predominate in the Soviet assortment, even though more tires for passenger cars will be required to meet the needs of the expanding automobile industry. The share of passenger car tires in total tire production may increase from about one-seventh in 1965 to about one-sixth in 1970. Improvements in tire design and raw materials are planned that would increase tire life by 50% and permit heavier loading of vehicles. As part of the effort to improve quality, production of the new radial cord tires is scheduled to rise from about one million in 1965 to 6 to 7 million in 1970.

(2) *Production* — Production of tires in the U.S.S.R. rose from 14.4 million in 1958 to 26.4 million in 1965, an increase of 83%. Still output in 1965 was about 10% below the original plan, and commissioning of new capacity in 1959-65 was only 64% of that scheduled. The production of tires in the U.S.S.R. in selected years for the period 1958-66 is shown in FIGURE 42.

Most Soviet tires—some 83% in 1965—are made in the R.S.F.S.R., the plant at Yaroslavl' accounting for about one-fourth of the nation's total output. An important factor in the growth of production during the 7-year plan period was the commissioning of large plants at Baku, Dnepropetrovsk, Krasnoyarsk, and Volzhskiy. The highly automated equipment at the Dnepropetrovsk plant and some of the equipment at the Volzhskiy plant were purchased from the Industrial West.

Tire design and the quality of major raw materials (synthetic rubber, cord, and carbon black) has improved somewhat in recent years. For example, cotton cord, an inferior material, is being replaced by rayon and nylon cords. The share of cotton tire cord was reduced from about one-half in 1958 to about 14% in 1965. However, the improvement in tire design and raw materials was less than expected, and this, together with shortages of equipment and skilled labor, prevented the industry from meeting its goal for increased tire life by 50%. An improvement in tire life of one-third was claimed for truck tires and 40% for passenger car tires.

b. MISCELLANEOUS RUBBER GOODS — Besides tires, the U.S.S.R. produces about 40,000 varieties of rubber goods, the most important of which are industrial belting, hose, rubberized fabrics, and parts for automobiles, aircraft, and agricultural vehicles. Because of a shortage of industrial rubber goods, some requirements have been satisfied by only 25-30%. In addition, the quality of many rubber products has been substandard, limiting the service life of parts of automobiles, tractors, and other vehicles. The continued use of outmoded and inefficient equipment is in part responsible for keeping the volume and quality of goods below requirements. As a result of inadequate domestic production, much conveyor and drive belting has had to be imported in recent years. To alleviate the present shortages production of industrial rubber goods is scheduled to rise 60% during 1966-70 and a concomitant improvement in quality is to be achieved by the use of improved materials and equipment.

FIGURE 42. SOVIET PRODUCTION OF TIRES*
(*Million*)

	1958	1960	1963	1965**	1966
Truck and bus	10.6	11.9	14.2	16.7	*na*
Tractor and agricultural	1.2	1.5	2.8	3.1	*na*
Passenger car	1.6	2.2	3.1	3.7	*na*
Motorcycle and scooter	1.0	1.6	2.5	2.9	*na*
Total	14.4	17.2	22.6	26.4	27.7

* Excludes aircraft and bicycle tires.

** Breakdown computed on basis of preliminary plan.

In 1959-65, the production of industrial rubber goods increased 70%, as compared with a planned growth of 140%. The increase in output resulted chiefly from the expansion and renovation of existing enterprises. New rubber goods plants that were commissioned during 1959-65 included those at Barnaul, Kishinev, and Volzhskiy. Other large facilities are located at Moscow, Leningrad, Svedlovsk, Kursk, and Kazan'. Indexes of output, planned and actual, of important rubber articles during 1959-65 are shown in the following tabulation (1958=100):

	PLAN	ACTUAL
Conveyor belting	187	160
V-belts	310	230
Hoses	240	90
Molded and nonmolded articles	330	170

5. Paper and paperboard

a. GENERAL — Even though the U.S.S.R. contains one-fourth of the forest area of the world and has the potential to produce more wood pulp than the United States and Canada combined, Soviet production of paper in 1966 was less than one-fifth of that of the United States and paperboard less than one-tenth.

The U.S.S.R. has made substantial progress in expansion of the pulp and paper industry in spite of acute growing pains; however, the demand for paper of all kinds far outruns the capacity to produce it, and little presently is exported. Even though production of paper in 1966 was nearly 57% above the 1958 level, and paperboard probably about double, the industry consistently lags behind planned levels and fails to provide enough paper and paper products of even the most basic types. Paperboard is not used extensively in the U.S.S.R. as a packaging material, but planners are striving to raise rapidly the present output levels.

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The failure of the U.S.S.R. to develop its pulp and paper industry is due mainly to its traditionally low priority, but recently Soviet planners have seen the need to give greater attention to the industry to meet the increasing internal requirements for both pulp and paper and to develop an export market for pulp. Because of poor planning and administration throughout the industry and because of delays in getting new capacity into operation, there have been recurrent shortages of pulp, paper, and paperboard, even for domestic use.

The U.S.S.R. still lags behind the United States and Canada in technology for the paper industry even though Soviet research and development is advanced and modern machinery is being imported, mainly from the Scandinavian countries. The difficulties the industry faces, therefore, are related less to technological factors than to administrative efficiency. Industry officials were severely critical of planning and administrative authorities under the *sovnarkhoz* system, but the industry's problems have persisted even under the new Ministry of Timber, Pulp, Paper and Woodworking which was established in late 1965. Shortages of materials—pulp wood and the intermediate products, pulp and cellulose—constitute a major bottleneck to continuous operation of the paper mill. New pulp mills are far behind schedule and some of the older mills have been slow to adopt improved methods for producing wood pulp. Reportedly the supply of pulp wood often lags behind the industry's requirements by thousands of tons. For example, the phasing-in of a new paper mill at the Krasnoyarsk plant has been activated, but the new pulp mill to supply it was not ready to operate. Furthermore, at some of the new plants power facilities are reportedly inadequate to maintain full operation.

The greater part (more than two-thirds) of the Soviet paper industry is located in the northwest, central, and Urals regions of the R.S.F.S.R.; however, the industry is gradually shifting eastward into Siberia. Presently, extremely large complexes—a new concept in complete integration of production of pulp, cellulose, paper, and paperboard—are being built in Siberia near the vast resources of pulp wood and water. These complexes, having capacities of 800,000 to 900,000 tons of pulp and paper a year, are located at Kotlas, Archangel, Syktyvkar, and Bratsk. Locations of the major plants of the paper and paperboard industry are given in FIGURE 115.

b. PRODUCTION — Soviet production of paper in 1966 was more than 3.5 million tons. During the 7-year plan period (1959-65) production of paper increased nearly 50% and paperboard 84%. The present 5-year plan (1966-70) calls for an annual production by 1970 of 5 million tons of paper and more than 4 million tons of paperboard.

The following tabulation shows Soviet output of paper and paperboard in recent years (thousand tons):

YEAR	PAPER	PAPERBOARD
1958	2,169	788
1959	2,247	844
1960	2,334	893
1961	2,494	951
1962	2,665	1,003
1963	2,760	1,093
1964	2,900	1,220
1965	3,231	1,449
1966	3,551	*n a*

c. CONSUMPTION — Per capita consumption of paper and paperboard in the U.S.S.R., although increasing, is only about one-tenth of that of the United States. In 1965, Soviet consumption of paper and paperboard averaged 44 pounds per person, compared with 443 pounds in the United States. By 1970, Soviet consumption per capita will reach 77 pounds, if production goals are reached. Paper for book printing and for school supplies continues to receive priority. Paper is not widely used for food packaging and wrapping materials, and disposable paper products are virtually unknown in Soviet consumer markets.

d. FOREIGN TRADE — Soviet net exports of pulp and paper amount to about 10% of total production, or a combined weight of less than a million tons, according to specialists from the Industrial West who toured the industry in 1966. Exports of newsprint, estimated to range between 80,000 and 100,000 tons a year, go mainly to the eastern European Communist countries, particularly Hungary and Bulgaria. In spite of the increasing demands of the Soviet economy for paper and paper products, Soviet officials expect that exports of pulp and paper will increase proportionately with increases in output throughout the planning period ending in 1970. Such increases in pulp and paper exports, even if they were to enter world trade, would not be likely to influence the markets significantly because the Soviet products are, in general, not of the type being traded. Soviet capability to export newsprint for at least the next decade probably will be small, and Soviet wood pulp generally is more suitable for producing paperboard than for market pulp of the types and grades in demand in world trade.

6. Durable consumer goods

a. INTRODUCTION — The production of durable consumer goods, including household appliances, furniture, and other personal belongings (such as bicycles, watches, cameras, etc.), is increasing steadily but unevenly and is meeting more nearly the needs of Soviet consumers than in past years. Planners presently are pushing the production of household refrigerators and washing machines in an effort to satisfy increasing consumer demand. Already available in

Approved For Release 2008/09/08 : CIA-RDP08S01350R000100030002-2

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fairly adequate numbers are radios, television sets, and watches. Sewing machines also are readily available, but consumers have refused to buy many of the models that are poorly designed and constructed, and production of these types has been cut back to avoid inventory buildups.

The production of consumer durables, particularly household appliances, until recently has been poorly organized and administered, and has not been sufficiently specialized. Appliances typically have been produced in machine building plants primarily concerned with the production of heavy equipment. The Moscow Motor Vehicle Plant *imeni* Likhachev (ZIL), for example, produces refrigerators, washing machines, and bicycles. Even plants under the Ministry of the Defense Industry are required to produce appliances and other durable goods as part of their annual plans. Plants that produce refrigerators and washing machines are listed in FIGURES 116 and 117. Some improvement in organization and management of the industry may result from the creation in September 1966 of an all-Union Ministry which is to oversee the production of household appliances in addition to machinery for the light and food industries.*

Production techniques for consumer durables, with the exception of watches, compares unfavorably with those of the United States, and the products are generally inferior in quality and design. For example, refrigerators have small storage capacity relative to weight and size. There are few automatic washing machines, and models most commonly produced have roller wringers. Vacuum cleaners are bulky and often inefficient. Appliances frequently breakdown, repair services are grossly inadequate, and spare parts are difficult to obtain.

The Soviet clock and watch industry is impressively efficient. Several large factories make up the core of the horological industry that has grown rapidly in volume of output. For example, the Penza State Watch Plant in the Middle Volga region produces about 4,000,000 watches a year. Total production of clocks and watches increased from about 8,000,000 in 1950 to more than 32,000,000 in 1966, making the U.S.S.R. a major world producer of timepieces. The workmanship has been judged high by U.S. technicians, and Soviet watches have become an important commodity in world trade, with exports of over 5,000,000 units in 1965.

b. PRODUCTION AND CONSUMPTION — Durable consumer goods, except for furniture and sewing machines, have come into quantity production in the U.S.S.R. largely since 1950. Although production of durable goods has increased rapidly in recent years (FIGURE 43), many commodities still are not available to the average household. With family incomes rising, Soviet planners are under pressure to increase the availability of the kinds of goods consumers want and will buy. Accordingly, the availability of television sets and washing machines is to double in the next 5 years compared with the past 5 years, the availability of refrigerators is to more than triple, and furniture is to increase by 50% in value of output.

These goals are impressive, but even if they are attained, stocks of durable goods held by households will remain far below levels in western Europe. For instance, in West Germany 65% of the households had refrigerators and 43% had washing machines by the end of 1962, whereas by the end of 1965 only about 1% of Soviet households had refrigerators and only about 20% had washing machines. Only in stocks of radios has the U.S.S.R. reached the level of western Europe. The gap between U.S. and Soviet stocks of consumer durables is even wider, as FIGURE 44 makes evident.

Sewing machines are produced mainly at the Podol'sk Machinery Plant *imeni* Kalinin, built in 1901 by the Singer Manufacturing Company, and operated by that firm until confiscated by the Soviet Government in 1918. The Podol'sk plant is still the major producer of sewing machines. Because of pressure

* The official title is, "The Ministry of Machine-Building for Light and Food Industries and Household Appliances of the U.S.S.R."

FIGURE 43. PRODUCTION OF SELECTED DURABLE CONSUMER GOODS
(*Thousands of units*)

	1955	1960	1961	1962	1963	1964	1965	1966
Bicycles and motor bikes	2,900	2,800	2,900	3,100	3,352	3,623	3,873	4,048
Cameras	1,000	1,800	1,400	1,300	1,431	1,166	1,052	1,419
Clocks and watches	19,700	26,000	26,000	26,100	27,090	28,682	30,570	32,400
Electric household appliances:								
Irons	5,300	5,000	7,100	8,400	8,654	6,905	3,649	*na*
Refrigerators	200	500	700	800	911	1,134	1,675	2,304
Stoves	4,600	6,900	7,800	8,900	9,126	6,727	6,054	*na*
Teapots and perculators	500	100	200	200	249	284	495	*na*
Washing machines	100	900	1,300	1,800	2,282	2,861	3,430	3,869
Vacuum cleaners	100	500	500	600	727	764	800	901
Radios	4,000	4,200	2,200	4,300	4,796	4,766	5,160	5,800
Televisions	500	1,700	1,900	2,200	2,473	2,927	3,655	4,415
Sewing machines	1,600	3,100	3,300	3,300	2,604	1,564	800	1,025

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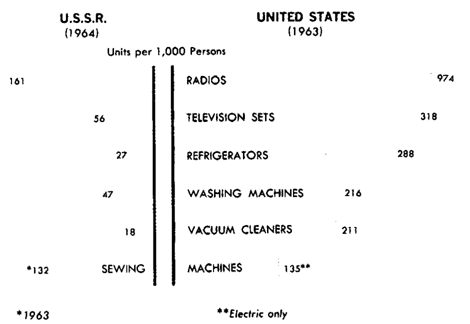

FIGURE 44. HOUSEHOLD STOCKS OF SELECTED CONSUMER DURABLES, U.S.S.R. 1964 COMPARED WITH U.S. 1963

in the 7-year period and earlier to increase output, quality has consistently been sacrificed and much of the product has failed to sell. From a peak production of 3.3 million in 1961 and 1962, output was drastically reduced and by 1966 only 800,000 units were produced.

Soviet production of furniture, although still inadequate to meet current need, is increasing fairly rapidly. In value of output, furniture production more than doubled during 1959-65, reflecting increases in both quantity and quality of production. The building of new apartments has continually increased the demands for furniture, and shortages persist. Production of major items of furniture in recent years is shown in FIGURE 45. The U.S.S.R. also imports furniture from various European countries; about 8% as much furniture was imported as was produced in 1965.

The U.S.S.R. also exports a limited number of consumer durables, mainly to the eastern European Communist countries. The following tabulation shows 1965 exports (in thousands of units):

Sewing machines	52	Television sets	86
Refrigerators	29	Bicycles	155
Washing machines	4	Watches and clocks	5,115
Vacuum cleaners	115	Cameras	305
Radios	376		

Imports are confined mainly to sewing machines of modern design and furniture from Finland and the industrial countries of eastern Europe.

FIGURE 45. PRODUCTION OF FURNITURE
*(Millions of pieces)**

	1958	1960	1964	1965
Tables	4.5	6.5	9.6	10.4
Chairs	22	29	35	35
Drawer chests	0.5	1.0	2.2	2.4
Upholstered furniture	1.9	2.7	2.3	2.1
Metal	12.3	13.4	12.4	11.6

* Exclusive of furniture produced in sets. In 1965 39,000 sets were produced.

N. Construction

1. Introduction

Construction-installation work accounts for the largest share of capital investment in the U.S.S.R. The building of state housing, industrial and other state facilities, private housing, and collective farm construction accounted in 1965 for nearly 60% of total capital investment.* About 5.6 million workers and employees were occupied directly in construction-installation work, or about 7.3% of total employment by the state in 1965.** In addition, 1.6 million workers were employed in subsidiary, on-site producing agencies and in agencies servicing construction sites. Thus, total employment in construction during 1965 averaged more than 7.2 million workers, or 9.4% of total employment in state enterprises.

Construction under the state sector continues to increase, and by 1965 had accounted for 85% of total Soviet construction. In 1965, about 89% of construction work under the state sector was performed by the contract method.*** During the period 1961 to 1965 collective farm construction amounted to 8% to 10% of total construction. Construction of private housing during this period declined from about 10% to 6% of the total.

2. Organization

The Soviet construction industry underwent major reorganizations in 1957, 1962, and 1967. Before 1957, the industry was administered by seven central construction ministries specializing in particular types of industrial construction, such as electric power or coal mining. The effect of the 1957 reorganization was to reestablish the administration of

* Unless otherwise indicated, ruble values in this subsection are in terms of 1955 prices for materials and 1956 wage rates (adjusted for overhead, installation and design work introduced between 1958 and 1962). These values also reflect the currency reform of 1 January 1961. The principal components of Soviet capital investment are: 1) Investment in construction-installation work, and 2) investment in both fixed and mobile machinery and equipment. Other components account for less than 10% of capital investment. Construction-installation work includes the construction of buildings, roads, bridges, and other structures, and installing machinery and equipment, but excludes the value of the machinery and equipment itself. For brevity, the term construction-installation work" is frequently shortened to "construction work."

** The data on employment under the state sector are given in average annual terms and exclude workers and employees on collective farms, military personnel, the part-time labor expended by the populace on construction of roads and private housing and other less significant categories.

*** In construction by the contract method the client contracts for construction with a state construction organization. As an alternative, the enterprise may elect to use the economic method (*khozyaystvennyy sposob*), by which it acquires building materials and equipment and, using its own or hired labor, performs the job itself.

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FIGURE 46. NUMBER OF INDEPENDENT CONTRACT CONSTRUCTION FIRMS, ACCORDING TO SUBORDINATION ON SELECTED DATES

SUBORDINATION	1 JULY 1955	1 JULY 1958	1 MAR 1960	1 AUG 1961	1 MAY 1963	1 JAN 1965	1 JAN 1966
Total U.S.S.R.	8,240	8,883	9,752	9,568	9,911	10,676	11,612
Subordinate to ministries and departments of U.S.S.R.	7,800	1,528	1,628	1,669	2,454	2,925	4,064
Subordinate to councils of ministries of Union republics	440	7,355	8,124	7,899	7,457	7,751	7,548
Of which subordinate to:							
Regional economic councils	0	2,806	3,224	3,456	390	440	*na*
Ministries and departments	155	3,262	3,651	3,131	6,455	6,558	*na*
Local Soviets	285	1,287	1,249	1,312	612	753	*na*

construction primarily along territorial lines. The central construction ministries, except those for transport and electric power, were abolished and republic ministries of construction were set up in most of the Union republics. A number of construction organizations were transferred to republic ministries or to the newly established regional economic councils (*sovnarkhozy*), as reflected in FIGURE 46.

Under the 1957 organization, many departmental barriers were eliminated and management brought closer to actual construction operations. However, under this type of organization, the *sovnarkhozy* became both customer and contractor, an arrangement that engendered new problems and inefficiencies. A further reorganization in November 1962 established the construction industry as an independent branch of the Soviet economy, with only a few construction organizations remaining subordinate to the *sovnarkhozy*—in effect, a move that largely controverted the reorganization of 1957. Heading the organization was the State Council of Construction, U.S.S.R., which assumed the name of the previous organization, *Gosstroy*. In contrast to the staff-advisory position it held previously, *Gosstroy* assumed broad functions and responsibilities and thus essentially became the operating head of the Soviet construction industry.

In February 1967, the construction industry was again reorganized by the creation of four new Union-republic ministries: The Ministry of Construction of Heavy Industrial Enterprise, the Ministry of Industrial Construction, the Ministry of Construction, and the Ministry of Rural Construction. This latest change appears to be an attempt to amalgamate the regional and functional organizations. The Ministry of Construction of Heavy Industrial Enterprises is to direct work in those oblasts, krays, and republics where there is concentrated construction for the ferrous and nonferrous metallurgy and the coal industries. Similarly, the Ministry of Industrial Construction will be in charge where construction for the chemical, petrochemical, and oil refining industries is concentrated and the Ministry of Construction where work for the machine building, light, and food industries is concentrated. The Ministry of Rural Construction will direct the building program in rural areas throughout the country. These various ministries will be responsible also for construction of an auxiliary nature such as housing, and public and commercial buildings. The construction of transportation facilities, electric power stations and power lines, gas and oil pipelines, and land improvement and water resources remains with previously established ministries. The Ministry of Installation and Special Construction Work also retains countrywide responsibility for installation of equipment. *Gosstroy* will be reorganized but probably will be limited to overall planning of construction, establishment of norms, and research and development. The organization of the Soviet construction industry as of March 1967 is shown in FIGURE 47.

The contract organizations and installation organizations, the principal operating units, are classified

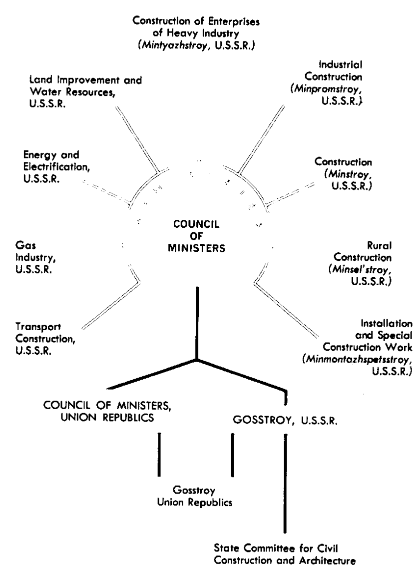

FIGURE 47. CENTRAL ADMINISTRATIVE STRUCTURE FOR THE CONSTRUCTION INDUSTRY, 1967

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as either general or specialized. General construction organizations usually serve as the general contractor, and specialized organizations do installation and electrical work, earthmoving, laying of water and sewer lines, and other specialized work, usually on a subcontract basis. During the past 5 years, the number of general construction organizations has remained relatively constant but the number of specialized organizations has increased almost 40%. In 1965, the general construction organizations numbered 5,482 and the specialized organizations, 6,130.

3. Volume of construction work

The volume of construction in the U.S.S.R. in 1965 was substantially more than double that of 1955, as shown in the value data contained in FIGURE 48. During 1956-60, an average annual rate of increase of over 13% was achieved, the state sector increasing at a slightly faster rate. Between 1961 and 1963, however, total construction increased at an average annual rate of less than 2% even though state construction increased at almost 4% per annum, and private housing construction declined by approximately one-third per annum. During 1964-65 the industry rallied, however, and achieved an average annual increase of over 7.5%.

a. COMPARISON WITH THE UNITED STATES — The value of construction in the U.S.S.R. in 1955 was less than one-third of that in the United States. By 1960, it had increased to almost 60%, but fell off somewhat during 1962-63. By 1965 Soviet construction again had risen to almost 60% of U.S. construction (FIGURE 49). (U.S. values expressed in 1965 dollars were converted to ruble terms by using a ruble-dollar ratio of 0.66 to 1, a ratio which takes quality differences into account.)

b. HOUSING — Despite the long standing housing shortage in the U.S.S.R. and perennial pledges by officials to alleviate it, construction of housing has progressed relatively slowly in recent years (FIGURE 118), and the Seven Year Plan (1959-65) was fulfilled

FIGURE 48. VOLUME OF CONSTRUCTION-INSTALLATION WORK
(Billion new rubles in 1955 prices)

	STATE SECTOR	COLLECTIVE FARM CONSTRUCTION	PRIVATE HOUSING CONSTRUCTION	TOTAL VOLUME
1955......	9.9	1.5	1.4	12.8
1956......	11.2	1.6	1.5	14.3
1957......	12.8	1.6	2.0	16.4
1958......	14.9	1.7	2.7	19.3
1959......	16.9	2.2	3.1	22.2
1960......	19.1	2.2	2.7	24.0
1961......	19.8	2.2	2.4	24.4
1962......	20.6	2.1	2.0	24.7
1963......	21.4	2.1	1.8	25.3
1964......	22.8	2.4	1.7	26.9
1965......	24.8	2.8	1.7	29.3

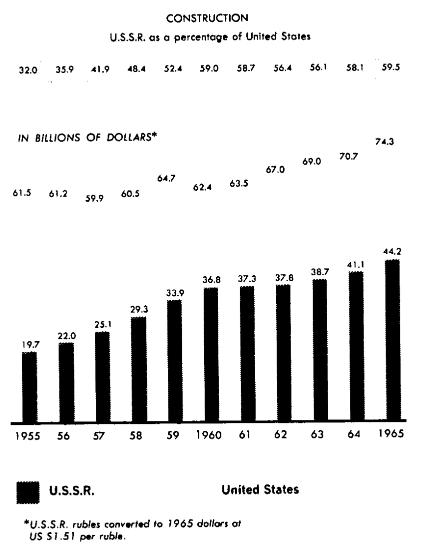

FIGURE 49. COMPARISON OF VALUE OF CONSTRUCTION: U.S.S.R. AND U.S.

by only 75%. The annual plan for housing construction has not been fulfilled since 1959. Although state housing construction increased 20% in urban areas and 10% in rural areas, housing constructed by individuals fell sharply during the 7-year plan period. Only about half as much housing was built by individuals in urban areas in 1965 as in 1959, two-thirds as much was built in rural areas by workers on state farms and other related organizations, and less than half as much was built by collective farm organizations, collective farmers, and the educated class living in rural areas. Factors contributing to the decline in individual housing construction are the failure to allocate land for individual use, governmental restrictions on loans to individuals, and the difficulty in obtaining building materials.

The 5-year plan for 1966-70 calls for maintaining the level of housing construction by individual workers and collective farmers at approximately the level acheived in 1965. Housing constructed by the state and by cooperatives, therefore, must increase approximately one-third if the 5-year plan is to be achieved. In 1966 less than 90% of the annual plan for housing construction was achieved, and unless a higher priority is given, the 5-year plan for new housing will not be fulfilled.

c. QUALITY OF CONSTRUCTION — Soviet construction and construction materials are generally of poor quality. Western technicians report that with few exceptions Soviet construction does not meet U.S. inspection standards. Even basic structural features—foundation, walls, and roof—often require extensive

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repairs soon after completion. The finish work, especially on outside and inner wall surfaces and flooring, is particularly poor, and plumbing and wiring often is crude. Pressure on the industry to reduce costs and simultaneously to increase the volume of construction constitutes a major barrier to improvements in quality.

In contrast to the quality of construction in general, several high priority projects are very well built. Construction work at the Bratsk hydroelectric power project, the Irkutsk aluminum plant, and the Moscow subway extensions demonstrates that Soviet builders, when called upon, are capable of high-quality work.

4. Industrialization of construction

a. Introduction — The Soviet term "industrialization of construction" is not limited to the mechanization of construction work itself, but includes also the use of standard designs, precast concrete components, and other components and materials that are prefabricated. Widespread industrialization of construction theoretically would raise the productivity of labor, reduce the cost and duration of projects, and lengthen the working season for many types of construction.

Industrialization already has resulted in a shortening of the time required for project completion. Soviet officials estimate that the average duration of construction projects in 1957 was 12% less than was required in 1954, and that during 1959-60, average time was again reduced by 15%. Still, time spent on Soviet construction projects is excessive compared with similar projects in the United States and western Europe. Even the new norms for completion schedules put into effect in August 1966 are 5% to 10% greater than in the United States 10 to 15 years ago, and Soviet builders usually exceed these norms. In housing construction in the U.S.S.R. in 1965, for example, the actual time taken to build a house was twice that stated by the norms.

b. Equipment — In the 10-year period 1955 through 1965, the number of construction machines available to the Soviet industry* increased significantly. The end-of-year inventories of four basic types of construction equipment were as follows:

	Excavators	Scrapers	Bulldozers	Mobile cranes
	1,000 units			
1955	17.5	9.3	16.1	28.9
1959	32.8	11.5	34.6	48.7
1960	36.8	12.2	40.5	55.0
1961	43.5	13.0	47.5	62.0
1962	49.5	13.8	51.0	67.0
1963	56.5	15.8	56.0	71.5
1964	63.3	18.6	61.6	77.2
1965	69.2	20.1	68.5	83.3

* Data on construction equipment in this subsection refer to that used only in construction and exclude that used in other sectors of the economy; for example, in mining and lumbering.

Even though the amount of equipment provided the construction industry has increased rapidly, there are numerous deficiencies in the design, manufacture, and maintenance of this equipment. Many machines are small and underpowered, compared to Western models. For example, in highway and railroad construction, where large volumes of earth are moved, the average size of excavator buckets measures only 0.72 cubic meters or about half the U.S. size. An increase in the production and use of larger and more powerful machines has been delayed because prices of the larger machines are disproportionately high.

Criticism about the design and quality of Soviet construction machines is directed toward their low ratio of power to weight, low lifting capacities, poor hydraulic systems, and susceptibility to breakdowns resulting from poor design and low-quality steel. In 1965 it was reported that downtime of certain machines had risen 15% in 3 years because of the poor quality. Problems caused by the use of equipment that is susceptible to breakdowns are aggravated by shortages or repair facilities and spare parts. For example, in 1966 requirements for spare parts for excavators reportedly were satisfied by only about 30%.

In addition to these problems, construction machinery is incorrectly distributed and poorly utilized in many construction organizations. In various construction organizations in 1965, about one-third of the working time of basic construction machines was lost because machines were scattered among the organizations and because work scheduling was poorly planned.

Although mechanization in construction* in the U.S.S.R. expanded considerably during the 7-year plan, 1959-65 (Figures 119 and 120), the amount of hand labor remains higher than planned. During the 5-year period, 1960-64, the number of manual laborers decreased only 5% even though Soviet plans called for a decrease each year of 4-5%. In 1965, nearly two-thirds of the total work force in construction were manual laborers. The Soviet Minister of Construction, Road, and Communal Machine Building stated in 1966 that even though 97% of all earthwork is mechanized, about half the workers employed in earthwork are used on the remaining 3%.

* Soviet terminology for mechanization in construction employs two terms: simple mechanization and complex mechanization. In simple mechanization, machines replace hand labor only in part. In mechanization of earthwork, for example, excavation and loading operations may be mechanized, while hauling and unloading may be done by hand. In complex mechanization of construction, however, all the basic operations are mechanized. For example, in complex mechanization of concrete work, the concrete is mixed, transported and placed by machine, whereas hand labor is used in building and setting forms, in tying reinforcing steel, and in concrete finishing. Thus complex mechanization is comprehensive but not complete mechanization.

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FIGURE 50. USE OF STANDARD DESIGNS IN CONSTRUCTION
(Percent of total volume of construction)

	1959	1960	1961	1962	1963	1964	1965
Total for the economy	56	60	63	65	66	66	67
Industrial construction	34	37	42	45	46	47	48
Construction of objects of transportation and communications	69	71	76	76	76	73	76
Construction of agricultural enterprises	88	75	75	77	80	82	83
Housing construction	83	88	93	94	95	94	95

c. USE OF STANDARD DESIGNS — The use of standard designs, an important part of the program for industrialization of Soviet construction, has increased steadily, as shown in FIGURE 50. Standard designs are used extensively in housing construction and agricultural enterprises, but in industrial construction they are used in less than half of the total volume.

In theory, there are numerous advantages in the use of standard designs. The time required, and thus the cost, for designing projects and preparing drawings is reduced; a large number of structural and other building components can be prefabricated; the seasonal aspect of construction is reduced; and more rapid erection and installation of building components at the site is possible. In practice, however, these advantages are far short of being realized. Some standard designs prove uneconomical by failing to take local conditions into account. Local plants responsible for the construction materials may not be capable of producing the components called for in the standard plans. Furthermore, in recent years the design planning organizations have been widely criticized for failure to provide new estimates and designs on time, for careless work, and for high cost of design work.

d. USE OF PRECAST CONCRETE — The extensive use of components of precast reinforced concrete is one of the distinctive characteristics of Soviet construction. By using these components, the economy saves scarce building materials, particularly steel and lumber. Production of precast concrete components is carried on year around as opposed to the seasonal aspect of conventional methods. Other gains lie in reduction of labor at the construction sites, lower construction costs, better quality control, and shorter construction time.

There are three methods for using concrete in construction in the U.S.S.R.: 1) pouring concrete in place (with or without reinforcement) as the structure is erected, 2) producing reinforced concrete components in the desired shapes and sizes in a plant or at a casting yard onsite and then erecting them, and 3) making prestressed precast concrete components for subsequent assembly on the site. Prestressed concrete parts are made by pouring concrete around reinforcing steel that is set in a form and stressed under tension. After the concrete has developed the required minimum strength, external tension on the reinforcing steel is released, and contraction of the reinforcement compresses the concrete. Prestressing gives the precast components greater supporting capacity and greater resistance to cracking than does simple steel reinforcement.

The Soviet construction industry is using more precast and prestressed concrete for greater efficiency and economy. Substitution of precast concrete for metal structurals in one-story industrial buildings, according to official Soviet studies, reduces the weight of metals used by an average of 50%, and reduces the cost of construction by 10% to 15%. Rapid transition from poured-in-place concrete to precast concrete has received much official attention in connection with the emphasis on industrialization of construction. Labor at the construction site is reduced by 50% and even more if precast concrete components are used instead of concrete poured in place.

Because of a government decree of 1954 which placed rigid restrictions on the use of steel in construction, the production and use of precast concrete in Soviet construction grew rapidly, replacing the use of lumber and structural steel to a considerable extent. In 1965, the production of precast concrete items was more than three times the production in 1958, and the use of precast concrete per million rubles of construction-installation work almost doubled (FIGURE 51).

5. Cost of construction

Even though industrialization in Soviet construction has been developed in recent years, the cost structure of Soviet construction has not changed greatly (FIGURE 52). Cost of materials continues to comprise the largest share of the construction-installation costs at an almost constant 55% of the total. The cost of construction labor fell almost 20% during 1958-65; however, the cost of equipment operators and their machines (maintenance and amortization or rental cost), although relatively small in total construction costs, increased almost 50%. These shifts can be explained by the more extensive

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FIGURE 51. USE OF PRECAST REINFORCED CONCRETE AND CONCRETE STRUCTURALS

YEAR	ALL PRECAST PRODUCED	VOLUME OF CONSTRUCTION-INSTALLATION BY STATE AND COLLECTIVE FARMS	PRECAST CONCRETE STRUCTURALS USED PER MILLION RUBLES CONSTRUCTION-INSTALLATION WORK
	Million cubic meters	*Billion rubles*	*Thousand cubic meters*
1958......	19.5	16.6	1.2
1959......	25.5	19.1	1.3
1960......	32.4	21.3	1.5
1961......	38.9	22.0	1.8
1962......	45.7	22.7	2.0
1963......	50.3	23.5	2.1
1964......	55.3	25.2	2.2
1965......	63.1	27.6	2.3

use of factory-made materials and a greater degree of mechanization.

For planning the construction program the U.S.S.R. uses a system of "estimate costs" as a basis of estimating payment to the contractor, and for measuring changes in the volume of construction work. Unit estimate costs have been relatively stable since 1952. Even though prices of materials were lowered substantially in mid-1955, wage rates were increased 6 months later and more than offset the saving. The actual cost of construction-installation work to the contractor has declined about 11% since 1952. Because the estimate costs, i.e. contract payments, remained stable and costs to the contractor declined, the contract construction industry was able to improve its financial position from one of loss in the years prior to 1965 (246 million rubles in 1952 and 36 million in 1955) to one of profit in 1965 (1,605 million rubles).

6. Labor

The number of personnel employed in Soviet construction from 1950 through 1965 is shown in FIGURE 121. Between 1950 and 1960, total employment in construction increased 60%, but employment in construction-installation work alone almost doubled. During 1960-65, both total employment and employment in construction-installation work increased by about 10%. The following tabulation shows changes in the structure of the labor force for construction (in percent):

	1950	1960	1965
Total	*100.0*	*100.0*	*100.0*
Employment in construction-installation work	*63.7*	*78.4*	*77.8*
Employment in subsidiary production at the construction site*	*16.4*	*6.7*	*22.2* (combined)
Employment in subsidiary services**	*19.9*	*14.9*	

* Such as precasting concrete components and other construction material.

** Such as the supply of housing communal services, transportation, warehousing, and guard services.

Labor turnover is higher in the construction sector than in any other major economic activity in the U.S.S.R., as a result, the industry has had difficulty in building up a large permanent cadre. Construction organizations annually lost more than half of the workers on their rolls according to official estimates. Many of those who leave are key workers who have had years of experience in construction but seek employment outside the industry because of unfavorable working conditions and shortages of housing and domestic services.

Only 15% of the wage earners in Soviet construction in 1965 were paid an hourly rate; the remaining 85% worked on a unit rate system and were paid a fixed rate whether or not the output norms were fulfilled.

The system of salaries and bonuses for engineering-technical workers on construction projects, introduced in 1957, was designed to raise basic salaries and to relate them to fulfillment of the monthly work plans. For example, salaries of construction superintendents were raised 36% to 50% and those of foremen 38% to 42%. In 1960, *Gosstroy* established an improved pay scale of greater uniformity which eliminated a number of departmental variations. Moreover, a uniform system of premium payments was introduced for engineering-technical workers and other salaried employees; one which made the payment and size of premiums contingent on the completion of projects on or ahead of schedule.

Increases in mechanization and the use of prefabricated building components during the 1950's were responsible in large part for substantial gains

FIGURE 52. PERCENTAGE DISTRIBUTION OF COSTS OF CONSTRUCTION

COST	1958	1959	1960	1961	1962	1963	1964	1965
Construction materials............	*54.7*	*55.7*	*56.3*	*55.4*	*56.0*	*55.9*	*55.8*	*55.6*
Basic wages......................	*20.3*	*19.5*	*18.9*	*18.8*	*18.0*	*17.4*	*16.9*	*16.5*
Operating costs for construction and machinery and equipment........	*5.6*	*6.0*	*6.2*	*6.6*	*6.9*	*7.6*	*8.0*	*8.3*
Other direct costs................	*4.3*	*4.2*	*4.1*	*4.1*	*3.9*	*3.7*	*3.7*	*3.8*
Overhead cost....................	*15.1*	*14.6*	*14.5*	*15.1*	*15.2*	*15.4*	*15.6*	*15.8*
Total.........................	*100.0*	*100.0*	*100.0*	*100.0*	*100.0*	*100.0*	*100.0*	*100.0*

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in labor productivity: an average annual rate of over 8.5% was achieved during this period. The change in 1960 to a shorter work day and work week, however, resulted in considerably smaller increases in labor productivity in terms of output per worker per year—only about 5% during 1961-65. In hourly terms, however, the average annual rate of increase was approximately 7%.

7. Construction programming

a. Planning — Dispersion of limited resources among too many projects is a weakness of long standing in the Soviet construction industry. The construction program often is too ambitious for the amount of resources available. As a result, projects generally extend beyond scheduled completion dates, and resources are "frozen" in place until the projects are finally finished. This failing has caused increasing concern among planning officials as the construction program grows larger and more complex.

Even though in recent years the official policy has been to complete priority projects underway and to limit the number of new starts, practice has failed to conform. Priority projects are included in annual plans, but not enough resources are allocated to them to permit their completion in the scheduled time period. In addition, local interests have caused projects of lower priority to be pushed at the expense of higher priority projects of national interest.

b. Materials supply — Growth in the U.S.S.R.'s construction sector has tended to exceed increases in the production of building materials. In late 1966, editorials in *Izvestiya* and *Pravda* complained that the national economy suffered from shortages of cement, glass, asbestos-cement pipe, roofing materials, and finishing materials. From 1962 to 1964 basic wall materials were in short supply (Figure 122). Production of all types of wall materials declined in 1962 and 1963, and although the decline was halted in 1964, production in that year still was lower than in 1961.

In the drive to industrialize construction, large panels of precast reinforced concrete are being used to construct walls instead of the more conventional bricks and stone. Investment in brick plants was halted and production of bricks, natural stone blocks, and small wall blocks leveled off or declined. Production of precast reinforced concrete panels was increased during this period, but the increase was considerably less than planned and did not make up for the reduction, in conventional wall materials. Recognizing the continuing need for bricks and blocks, production subsequently was increased. In 1965, bricks still made up more than three-fourths of all wall materials produced and large precast reinforced concrete panels less than one-tenth.

The problem of loss and breakage in the distribution and handling of construction materials intensifies the problem of supply. Nearly 10% of the cement produced is lost in handling and transportation and another 10% is wasted because of the use of dirty and ungraded aggregates in producing concrete. Losses of windowglass in transportation, storage, and in construction sometimes amount to as much as one-fourth of total output.

c. Unfinished construction projects — Unfinished construction projects in the U.S.S.R. are valued according to the amount of funds invested in projects that are incomplete and thus have not been commissioned as operative. The value of unfinished construction projects includes construction-installation work accomplished, expenditures for design, equipment, and similar items, but excludes expenditures on unfinished private housing and collective farm construction. The value of unfinished construction is used as a rough measure of the size of investment frozen in unfinished industrial projects. From 1955 to 1965 the volume of unfinished construction almost doubled, but as a percentage share of total state capital investment, it declined (Figure 53).

8. Current problems

Poor planning in construction is a major problem in the U.S.S.R. The design and planning organizations do not finish their work on schedule and often turn out plans that are incomplete and inaccurate. When data are lacking or misleading, the investment planned for individual plants is often inadequate to permit completion in the time stipulated by the norms. As an illustration, the Ul'yanovsk Leather Footwear Combine, begun in 1954, reportedly was only a little more than half finished in mid-1966. Poor scheduling and organization of work at construction sites is also a problem. Failure to provide equipment and materials as needed and to schedule tasks in the proper sequence leads to delay and loss of work time for both men and machines. In fact, such loss of work time is one of the major causes

Figure 53. VALUE OF UNFINISHED CONSTRUCTION IN STATE SECTOR

YEAREND	BILLION RUBLES*	PERCENTAGE INCREASE ABOVE PRECEDING YEAR	PERCENTAGE OF TOTAL STATE CAPITAL INVESTMENT FOR THE YEAR
1955	15.0	6	93
1956	16.0	7	86
1957	17.6	10	83
1958	17.5	−1	73
1959	19.0	9	71
1960	21.4	13	71
1961	24.8	16	78
1962	26.1	5	77
1963	26.2	0	73
1964	27.1	3	69
1965	29.6	9	69

* Based on roughly comparable prices.

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of high labor turnover. Most construction organizations are paid every 10 days for the amount of work put in place during that period; thus it is financially advantageous to do work that requires little labor and much material rather than labor-intensive work such as finishing. To solve this problem, it has been proposed that the contractor be paid when the project is completed or, in the case of large projects, when a specified phase of the project is completed, but this plan is not yet in effect.

Shortages of materials are also a chronic problem. In late 1966 the construction sites of the U.S.S.R. reportedly lacked 10% to 15% of the required wall materials, and there were shortages of soft roofing, asbestos-cement pipe, and ceramic materials. On the retail market, cement, roofing materials, and facing tiles were in short supply. Despite these shortages, plans for expanding the construction materials industry have been unfulfilled for many years. Unless there is improvement in the construction materials industry, its constraint on construction will worsen.

Despite numerous exhortations to improve the quality of construction, little progress has been made. In the R.S.F.S.R. alone in 1966 some 30,000 construction and installation workers were engaged full-time in elmininating faulty work, at an annual wage cost of 35 million rubles. The quality of construction in housing has been especially low. More than one-half the dwellings erected in the last few years have been appraised as barely satisfactory. In mid-1966 A. N. Kosygin, Chairman of the Council of Ministers, U.S.S.R. called for a serious examination of quality in residential construction.

O. Statistical data

This subsection consists of detailed statistical data in tabular form in general order of reference in the text.

FIGURE 54. PRODUCTION OF MAJOR TYPES OF MANUFACTURED GOODS

PRODUCT	UNIT	1958	1960	1964	1965	1966	U.S.S.R. AS PERCENT OF U.S., 1965
Machinery and equipment:							
Grain combines	Thousand units	65.0	59.0	83.6	85.8	92.0	*228*
Electric motors	Million kilowatts	13.7	17.6	26.0	26.9	28.1	*na*
Generators	....*do*	5.2	7.9	12.8	14.4	13.4	*93*
Mainline locomotives	Thousand units	1.1	1.7	2.1	2.1	2.1	*117*
Metalcutting machine tools	....*do*	138	156	184	186	191	*275*
Metal forming machine tools	....*do*	26	30	34	35	38	*82*
Metallurgical equipment	Thousand metric tons	176	218	241	242	252	*na*
Motor vehicles*	Thousand units	511	524	603	616	675	*6*
Tractors	....*do*	220	239	329	355	382	*131*
Turbines	Million kilowatts	6.6	9.2	13.3	14.6	15.2	*95*
Chemicals and allied products:							
Mineral fertilizers	Million metric tons	12.4	13.9	25.6	31.3	35.8	*58*
Synthetic rubber	....*do*	0.3	0.3	0.5	0.6	*na*	*31*
Caustic soda (92%)	....*do*	0.7	0.7	1.1	1.3	1.4	*20*
Sulfuric acid (100%)	....*do*	4.8	5.4	7.6	8.5	9.4	*38*
Plastics	....*do*	0.2	0.3	0.7	0.8	1.0	*15*
Rayon and synthetic fibers	....*do*	0.2	0.2	0.4	0.4	0.5	*27*
Tires	Million units	14.4	17.2	24.4	26.4	27.7	*15*
Paper	Million metric tons	2.2	2.3	2.9	3.2	3.6	*19*
Textiles:							
Cotton	Billion square meters	4.3	4.8	5.4	5.5	5.7	*59*
Linen	....*do*	0.4	0.5	0.5	0.5	0.6	*na*
Rayon, synthetic and silk	....*do*	0.7	0.7	0.8	0.8	0.9	*44*
Wool	....*do*	0.4	0.4	0.5	0.5	0.5	*167*
Commercially processed foods:							
Butter	Million metric tons	0.7	0.7	0.8	1.1	1.0	*na*
Sugar	....*do*	5.4	6.4	8.2	11.0	9.7	*228*
Meat	....*do*	3.4	4.4	4.1	5.2	5.7	*27*
Vegetable oil	....*do*	1.5	1.6	2.2	2.8	2.7	*65*
Leather footwear	Million pairs	356	419	475	486	522	*77*
Durable consumer goods:							
Radios	Million units	3.9	4.2	4.8	5.2	5.8	*20*
Refrigerators	....*do*	0.4	0.5	1.1	1.7	2.2	*36*
Sewing machines	....*do*	2.7	3.1	1.6	0.8	1.0	*na*
Television sets	....*do*	1.0	1.7	2.9	3.7	4.4	*33*
Washing machines	....*do*	0.5	0.9	2.9	3.4	3.9	*79*

* Of which about half are passenger cars. In 1966 about one-third was passenger cars.

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FIGURE 55. MAJOR PRODUCERS OF AGRICULTURAL MACHINERY, 1966

LOCATION	PLANT NAME	CHIEF PRODUCTS	REMARKS
Bezhetsk 57°47′N.; 36°42′E.	Bezhetsk Agricultural Machine Building Plant.	Flax harvesting combines; flax pullers; flax threshing machines.	The major Soviet producer of machinery used in flax growing.
Dnepropetrovsk 48°27′N.; 34°59′E.	Dnepropetrovsk Agricultural Machine Building Plant.	Beet harvesting combines; beet loaders.	Produces almost all of Soviet beet harvesting combines.
Frunze 42°54′N.; 74°36′E.	Frunze Agricultural Machine Building Plant *imeni* Frunze.	Tractor pickup balers and rakes.	Produces a major share of Soviet production of tractor rakes. One of the major Soviet producers of pickup balers.
Gomel' 52°25′N.; 31°00′E.	Gomel' Agricultural Machine Building Plant.	Ensilage harvesting combines; tractor trailers.	Accounted for about 98% of Soviet production of ensilage harvesting combines in 1965.
Kherson 46°38′N.; 32°36′E.	Kherson Combine Plant *imeni* Petrovskiy.	Corn harvesting combines; tractor trailers; irrigation equipment.	Produced the bulk of the corn harvesting combines in 1965.
Kirovograd 48°30′N.; 32°18′E.	"*Krasnaya Zvezda*" ("Red Star") Agricultural Machine Building Plant.	Tractor-powered sowing and planting machines for small grains, corn, and other crops.	Produced about 50% of all tractor-powered sowing and planting machines in 1965.
Krasnoyarsk 56°01′N.; 92°50′E.	Krasnoyarsk Combine Plant	Self-propelled grain and rice combines; tractor drills.	Produced about 16% of self-propelled grain combines in 1965.
L'vov 49°50′N.; 24°00′E.	L'vov Agricultural Machine Building Plant.	Machines for combatting plant pests and diseases; fodder steamers.	Apparently sole producer of tractor-drawn duster-sprayers; major producer of fodder steamers.
Lyubertsy 55°41′N.; 37°53′E.	Lyubertsy Agricultural Machine Building Plant *imeni* Ukhtomskiy.	Machines for harvesting leguminous crops; mowing machines; hay stackers; sugar cane harvesters.	Major producer of mowing machines.
Novosibirsk 55°02′N.; 82°55′E.	Siberian Agricultural Machine Building Plant.	Grain drills; harrow-plows; disc harrows.	Second to the plant in Kirovograd in production of sowing and planting machinery.
Odessa 46°28′N.; 30°44′E.	Odessa Agricultural Machine Building Plant *imeni* October Revolution.	Tractor-powered plows	Produced about 43% of the tractor-powered plows in 1965.
Rostov 47°14′N.; 39°42′E.	Rostov Agricultural Machine Building Plant.	Self-propelled grain combines; mounted grain combines for self-propelled chassis.	Produced about 83% of self-propelled grain combines in 1965.
Do	"*Krasnyy Aksay*" Agricultural Machine Building Plant.	Tractor-powered cultivators	Produced about 60% of tractor-powered cultivators in 1965.
Rubtsovsk 51°30′N.; 81°15′E.	Altay Agricultural Machine Building Plant.	Tractor-powered plows; plow shares; plow mold-boards.	Produced about 49% of tractor-powered plows in 1965.
Ryazan' 54°38′N.; 39°44′E.	Ryazan' Agricultural Machine Building Plant.	Potato harvesting combines, sorters, cultivators, and diggers.	Major producer of machinery for potato growing.
Syzran' 53°11′N.; 48°27′E.	Syzran' Combine Plant	Tractor drills; feed distribution units.	Produced about 15–16% of tractor drills in 1965.
Tashkent 41°20′N.; 69°18′E.	Uzbek Agricultural Machine Building Plant.	Tractor-powered cotton planters.	Sole producer of tractor-powered cotton planters. Also furnishes malleable iron for machine building plants in Uzbek S.S.R.
Do	Tashkent Agricultural Machine Building Plant.	Cotton pickers	Sole producer of cotton pickers.
Voronezh 51°38′N.; 39°12′E.	Voronezh Agricultural Machine Building Plant.	Grain cleaning machines; grain sorters and graders.	Probably accounted for almost all of the 24,100 grain cleaning machines produced in 1965.

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FIGURE 56. EXPORTS OF AGRICULTURAL MACHINERY* BY VALUE AND DESTINATION
(Thousands of foreign exchange rubles)

COUNTRY OF DESTINATION	1960	1961	1962	1963	1964	1965	TOTAL 1960–65	
							Value	Percent
Communist countries:								
Albania	765	228	0	0	0	0	993	*0.3*
Bulgaria	9,811	10,177	13,585	15,965	9,819	14,949	74,306	*25.2*
Communist China	2,743	297	13	261	155	2,216	5,685	*1.9*
Cuba	17	34	2,071	6,055	10,863	5,324	24,364	*8.3*
Czechoslovakia	2,291	10,684	4,061	9,744	23,084	26,421	76,285	*25.9*
East Germany	259	1,581	220	467	332	431	3,290	*1.1*
Hungary	13,902	6,391	7,512	12,113	15,661	12,822	68,401	*23.2*
Mongolia	5,499	6,128	6,365	3,494	3,622	2,695	27,803	*9.4*
North Korea	140	15	1	**	**	**	156	*0.1*
North Vietnam	69	16	59	37	0	2	183	*0.1*
Poland	1,808	1,089	1,617	1,057	724	1,050	7,345	*2.5*
Rumania	429	256	156	80	98	87	1,106	*0.4*
Yugoslavia	176	1	2	43	45	64	331	*0.1*
Total, Communist countries	37,909	36,897	35,662	49,316	64,403	66,061	290,248	*98.4*
Total, non-Communist countries	315	356	251	594	1,712	1,460	4,688	*1.6*
Grand total	38,224	37,253	35,913	49,910	66,115	67,521	294,936	*100.0*

NOTE—Figures may not add to totals because of rounding.

* Including spare parts.

** Export of agricultural machinery was dropped as a separate category in official trade handbooks; exports assumed to be negligible.

FIGURE 57. IMPORTS OF AGRICULTURAL MACHINERY,* BY VALUE AND ORIGIN
(Thousands of foreign exchange rubles)

COUNTRY OF ORIGIN	1960	1961	1962	1963	1964	1965	TOTAL 1960–65	
							Value	Percent
Bulgaria	5,227	7,319	13,107	10,412	20,793	23,483	80,341	*43.2*
Czechoslovakia	842	**1,049	841	**1,193	1,201	1,975	7,101	*3.8*
East Germany	349	5,571	10,713	18,915	30,408	27,346	93,302	*50.1*
West Germany	5	2	0	315	119	45	486	*0.3*
United States	2,108	29	102	271	0	118	2,628	*1.4*
Other	94	98	0	44	547	1,467	2,250	*1.2*
Total	8,625	14,068	24,763	31,150	53,068	54,434	186,108	*100.0*

* Including spare parts.

** Apparently includes a small quantity of tractors and/or tractor spare parts.

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FIGURE 58. MAJOR TRACTOR PRODUCTION AND ASSEMBLY PLANTS, 1965

PLANT	LOCATION	PRODUCTS	REMARKS
Bryansk Motor Vehicle Plant (*Bryanskiy Avtomobil'nyy Zavod—BAZ*).	Bryansk............. 53°15'N.; 34°22'E.	T–180, 180-hp. and D–804 180-hp. crawler tractors.	Estimated 1965 production: 1,000.
Chelyabinsk Tractor Plant (*Chel'yabinskiy Traktornyy Zavod—ChTZ*).	Chelyabinsk......... 55°10'N.; 61°24'E.	T–100M, 108-hp., crawler tractor; DET–250, 265-hp., diesel-electric crawler tractor.	Estimated 1965 production: T–100M, 24,750; DET–250, 350. The T–130, 130-hp. diesel crawler was to supersede T–100M in 1967 or 1968.
Dnepropetrovsk State Machine Building Plant #186, (*Dnepropetrovskiy Gosudarstvennyy Mashinostroitel'nyy Zavod—GMZ*).	Dnepropetrovsk...... 48°17'N.; 34°59'E.	Diesel Belarus wheeled tractors, MTZ–5MS and MTZ–5LS.	Estimated 1965 production: 30,000. Part of a complex which also makes guided missiles and refrigerators. Approximate employment on tractors, 13,000.
Khar'kov Tractor Assembly Plant (*Khar'kovskiy Traktorosborochnyy Zavod—KhTSZ*).	Khar'kov............ 50°00'N.; 36°15'E.	T–16, 16-hp. self-propelled chassis (light wheeled tractor).	Estimated 1965 production: 13,000.
Khar'kov Tractor Plant (*Khar'kovskiy Traktornyy Zavod imeni Ordzhonikidze—KhTZ*).	Khar'kov............	T–74, 75-hp. crawler tractors; DT–20M 20-hp. wheeled tractor.	Estimated 1965 production: 50,000 crawler tractors and 25,300 wheeled tractors. Estimated employment, 30,000.
Kishinev Tractor Assembly Plant (*Kishinevskiy Traktorosborochnyy Zavod—KTSZ*).	Kishinev............ 47°00'N.; 28°50'E.	T–54V, 50-hp. garden-vineyard crawler tractor.	Estimated 1964 production: 4,600.
Leningrad Kirov Machine Building Plant (*Leningradskiy Mashinostroitel'nyy Zavod imeni Kirova*).	Leningrad........... 59°55'N.; 30°15'E.	Kirovets–700 tractor, 220-hp., wheeled, all-purpose.	Estimated 1965 production: 2,800. Plant was being reconstructed and expanded in 1966. Reportedly 220 automated and semi-automated machine tools to be installed. Estimated employment, 16,000. Also produces the BTR–50p armored personnel carrier.
Lipetsk Tractor Plant (*Lipetskiy Traktornyy Zavod—LTZ*).	Lipetsk............. 52°37'N.; 39°35'E.	T–38M narrow-tracked 48-hp. crawler; T–40A 40-hp. wheeled tractor.	Estimated 1965 production: T–40A 32,500; T–38M, 7,500. Estimated employment, 10,000.
Minsk Tractor Plant (*Minskiy Traktornyy Zavod—MTZ*).	Minsk.............. 53°54'N.; 27°34'E.	Diesel Belarus wheeled tractors MTZ–52 4-wheel drive; MTZ–50 55-hp.	Estimated 1965 production: 70,200. The 4-wheel drive MTZ–82 and MTZ–80 are to supersede the MTZ–52 and MTZ–50 series. Estimated employment, 13,000.
Onega Tractor Plant (*Onezhskiy Traktornyy Zavod—OTZ*).	Petrozavodsk........ 61°49'N.; 34°20'E.	TDT–55 60-hp. logging crawler tractor.	Estimated 1965 production: 1,900. Plant has under development the P–49 amphibious tractor. Estimated employment, 2,000.
Altai Tractor Plant (*Altayskiy Traktornyy Zavod—ATZ*).	Rubtsovsk........... 51°30'N.; 81°15'E.	T–4 diesel 110-hp. crawler tractor; TDT–75 75-hp. logging crawler tractor; DT–54A and DT–55A crawler tractors.	Estimated 1965 output: TDT–75, 9,800; DT–54A/55A, 15,100; T–4, 1,000. The DT–54A and 55A may have been superseded in production in 1966 by the T–4.
Uzbek Tractor Plant (*Uzbekskiy Traktornyy Zavod—UTZ*).	Tashkent............ 41°20'N.; 69°18'E.	T–28Kh3, 40-hp. wheeled tractor.	Estimated 1965 production: 16,800. About 8,000 employees.
Vladimir Tractor Plant (*Vladimirskiy Traktornyy Zavod—VTZ*).	Vladimir............ 56°10'N.; 40°25'E.	T–28 and T–28Kh3, 40-hp. wheeled tractors.	Estimated 1965 production: 6,700. Plant to be rebuilt during the seventh Five Year Plan. Estimated employment, 10,000.
Volgograd Tractor Plant (*Volgogradskiy Traktornyy Zavod—VGTZ*).	Volgograd........... 48°45'N.; 44°25'E.	DT–75 diesel 75-hp. crawler tractor; DT–75B/75K marsh and steep-slope tractors respectively.	Estimated 1965 output: 41,000. Plant was under reconstruction in 1966; output to be increased 40% and subsequently doubled. A third electronic computer has been commissioned. In 1967, plant was to start serial production of a 90-hp. tractor and is to start testing a 150-hp. model. Approximate employment, 25,000. Also produces the PT–76 amphibious light tank.

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FIGURE 59. MAJOR PRODUCERS OF MACHINE TOOLS, 1966

LOCATION	PLANT NAME	PRINCIPAL PRODUCTS AND REMARKS
Gor'kiy 56°20'N.; 44°00'E.	Gor'kiy Milling Machine Plant	Largest producer of milling machines in U.S.S.R.
Leningrad 59°55'N.; 30°15'E.	Leningrad Machine Tool Plant *imeni* Sverdlov.	Horizontal boring mills and profile milling machines.
Moscow 55°45'N.; 37°35'E.	Moscow *"Krasnyy Proletariy"* ("Red Proletarian") Machine Tool Plant.	Largest lathe producer in U.S.S.R.; including engine, copying, and vertical multispindle lathes.
Moscow	Moscow Ordzhonikidze Machine Tool Plant	Multispindle automatic lathes and transfer lines.
Novosibirsk 55°02'N.; 82°55'E.	Novosibirsk Heavy Machine Tool and Hydraulic Press Plant *imeni* Yefremov.	Large horizontal boring mill; large double housing and edge planers, and hydraulic presses.
Ulyanovsk 54°20'N.; 48°24'E.	Ulyanovsk Heavy and Large Single-Design Machine Tools Plant.	Producer of large special-purpose machine tools.

FIGURE 60. PRODUCTION OF MACHINE TOOLS FOR RECENT YEARS AND 1970 PLAN
(*Units*)

TYPE	1958	1960	1962	1964	1965	1966	1965 (PLAN)	1970 PLAN
Metalcutting	138,290	155,922	176,908	183,791	185,000	191,000	190,000 to 200,000	220,000 to 230,000
Metalforming	26,200	29,900	33,400	34,400	34,400	38,300	36,200	50,000 to 52,000
Automatic and semi-automatic lines	88	174	199	230	213	*na*	250 to 271	426

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FIGURE 61. MAJOR PRODUCERS OF ELECTRIC POWER EQUIPMENT, 1967

LOCATION	PLANT	PRODUCTS	REMARKS
Khar'kov 50°00'N.; 36°15'E.	Khar'kov Electrical Machinery Plant (KhEMZ).	Synchronous generators, electric motors, DC generators, explosion-proof motors.	A major producer of large motors and generators for metallurgical, mining, and chemical industries.
Do	Khar'kov Heavy Electrical Equipment Plant *imeni* Lenin (*Elektroyazhmash*).	Turbogenerators of 200 mw. and 300 mw. capacity, drive units for diesel locomotives.	Second largest producer of generators in the country. Built a 500 megawatt turbogenerator in 1966.
Do	Khar'kov Turbine Plant *imeni* S.M. Kirov.	Steam turbines, certain types of hydraulic and gas turbines.	Second largest turbine plant in the country. One of first enterprises in U.S.S.R. to operate under new economic system. Produced a steam turbine of 500 megawatt capacity in 1966.
Leningrad 59°55'N.; 30°15'E.	Electric Power Equipment Plant (*Elektrosila*).	Turbo- and hydrogenerators, heavy electrical machinery.	The largest producer of generators in the country. Produces 44% of turbogenerators and 78% of hydrogenerators.
Do	Electrical Apparatus Plant (*Elektroapparat*).	High voltage electrical equipment, transformers, circuit breakers.	The leading producer of high voltage equipment in the country.
Do	Nevskiy Machine Building Plant *imeni* V.I. Lenin.	Steam and gas turbines, large compressors, castings and forged parts for other plants.	The main producer of gas turbines.
Do	Leningrad Metal Plant (LMZ).	Steam and hydraulic turbines; special types of gas turbines.	The oldest and largest turbine plant in the country. Hydraulic turbine of 508 megawatt capacity and steam turbines of 300 megawatt capacity are in series production. Built a steam turbine of 800 megawatts in 1966. Test stand for turbines up to 1,000 megawatts is under construction.
Do	Northern Cable Plant	Insulated power cable, telephone and telegraph cable, field wire.	Second largest producer of wire and cable in the U.S.S.R.
Moscow 55°45'N.; 37°35'E.	Moscow Cable Plant	Insulated power cable, telephone and telegraph cable; aircraft, automotive and transformer wire.	Largest cable and wire plant in the U.S.S.R.
Do	Moscow Electrical Equipment Plant *imeni* V.V. Kuybyshev.	Power transformers	Second largest transformer plant in the U.S.S.R.
Novosibirsk 55°02'N.; 82°55'E.	Novosibirsk Turbogenerator Plant.	Turbo- and hydrogenerators.	Plant began production in 1954.
Perm 58°00'N.; 56°15'E.	Kama Cable Plant	High voltage cable	Large, new plant began partial production in 1962. Plant is highly automated and mechanized.
Podol'sk 55°26'N.; 37°33'E.	Podol'sk Machine Building Plant *imeni* Ordzhonikidze (ZIO).	Steam boilers; pipeline equipment; petroleum equipment; heat exchangers.	One of the major producers of steam boilers, up to 950 tons of steam per hour.
Taganrog 47°12'N.; 38°56'E.	Red Boilermaker Plant (TKZ).	Steam boilers; water purification equipment; coal pulverizers.	Largest boiler plant in the U.S.S.R.; produces medium and large capacity steam boilers for thermal powerplants. Produced a boiler with a capacity of 2,500 tons of steam per hour in 1966.
Yerevan 40°11'N.; 44°30'E.	Armenian Electrical Machine Building Plant *imeni* V.I. Lenin.	Small generators; mobile power generating units; power transformers.	This plant is the leading Soviet producer of mobile generating sets.
Zaporozh'ye 47°49'N.; 35°11'E.	Zaporozh'ye Transformer Plant.	Power and current transformers; autotransformers; high voltage switchgear.	The largest transformer producer in the U.S.S.R. The plant specializes in the production of heavy-duty, high-voltage transformers, up to 417 megawatt ampere capacity.

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FIGURE 62. IMPORTANT PRODUCERS OF COAL MINING MACHINERY*

LOCATION	PLANT NAME	PRINCIPAL PRODUCTS	REMARKS
Aleksandrovsk......... 59°09′N.; 57°33′E.	Aleksandrovsk Machine Building Plant.	Electric mine locomotives, rock loaders, belt conveyors.	Plant specializes in the production of mine locomotives.
Anzhero-Sudzhensk.... 56°07′N.; 86°00′E.	Anzhero-Sudzhensk "*Svet Shakhtera*" ("Miner's Light") Coal Mining Machinery Plant.	ShBM-1 development combines, coal combines, KSA-1, KSA-2, and KSA-3 conveyors, heavy-duty development drills.	
Donetsk.............. 48°00′N.; 37°48′E.	Donetsk Machine Building Plant.	Mine hoists, winches, ore-crushing equipment, metal mine supports, ventilators, crushers. Large cutter-loader combines.	Exports hoists. Specialization in production of mine hoists and winches.
Druzhkova............ 48°37′N.; 37°33′E.	Toretsk Machine Building Plant.	Electric mine locomotives, mine cars, EPM-1 and PMS-1 coal and rock loaders, yielding supports, metal supports. Development of M-87T and KM-97 support systems.	Largest coal mine machinery plant. Formerly specialized in production of mine locomotives, but is converting to production of support systems and remotely operated longwall face systems.
Gorlovka............. 48°10′N.; 38°04′E.	Gorlovka Coal Mining Machinery Plant *imeni* Kirov.	Equipment complex K-52M, all types of coal combines: KTsTG, LGD-1, KKP-2, BK-52, 2K-52, KTsT, and Kirovets. Coal cutters and loaders, other coal mining equipment, spare parts.	One of the largest and oldest plants. Produces equipment for export.
Kamensk-Shakhtinskiy. 48°21′N.; 40°19′E.	Kamensk Machine Building Plant.	Equipment complexes KM-9, MK-97, and KM-9D, mechanized mine supports, and ventilator systems.	As of 1958, production of mine ventilator systems for the coal industry was to be concentrated at this plant.
Karaganda............ 49°50′N.; 73°10′E.	Karaganda Coal Mining Machinery Plant *imeni* Parkhomenko.	Coal combines, 3-ton dump cars, coal preparation and ore crushing equipment, metal support systems.	Plant's estimated labor force, over 2,000 persons. Plant produces equipment for export.
Kharkov.............. 50°00′N.; 36°15′E.	Kharkov "*Svet Shakhtera*" ("Miner's Light") Coal Mining Machinery Plant.	Coal loaders, rock loaders, coal combines, new KN-1 and KN-2 development combines, many different models of scraper conveyors, including SP-48, SP-63, and S-53. Other coal mining equipment and spare parts.	One of the largest and oldest plants, employing several thousand workers.
Kiselevsk............. 53°58′N.; 86°42′E.	Kiselevsk Coal Mining Machinery Plant.	Mine cars, winches, centrifugal pumps, yielding supports OKD.	
Konotop.............. 51°44′N.; 31°42′E.	Konotop "*Krasnyy Metallist*" ("Red Metal Worker") Electrical Equipment Plant.	Electric drills, ventilators, conveyor belts, cable winches, remote control electrical instruments (signalling, blocking, and control devices) for automation of coal mining equipment.	
Kopeysk.............. 55°10′N.; 61°38′E.	Kopeysk Machine Building Plant *imeni* Kirov.	KMP-1, KMP-2, and KMP-3 coal cutters, ripping and development combines, mine pumps, and other miscellaneous equipment.	Produces equipment for export. Labor force (estimated) over 3,000.
Krasnyy Luch......... 48°08′N.; 38°56′E.	Krasnyy Luch Machine Building Plant.	Rock loaders, ore-crushing and concentrating equipment, KLA-250, KLA-220, and KLB-2 conveyors, mine cars, drills, coal cutter parts.	
Kutaisi............... 42°15′N.; 42°40′E.	Kutaisi "*Gornyak*" ("Miner") Mining Machinery Plant.	Electric mine cars, high-speed shaft-sinking equipment, high-pressure pumps, 3-ton mine cars, metal mine supports.	
Laptevo.............. 54°29′N.; 37°42′E.	Laptevo Coal Mining Machinery Plant.	Belt conveyors, narrow gage electric locomotives, GNL-30 coal loaders, pumps, mechanized shield support Mosbass KM-4, miscellaneous mining equipment.	
Leningrad............ 59°55′N.; 30°15′E.	Leningrad "*PneVmatika*" ("Pneumatics") Machinery Plant.	Numerous types of pneumatic drills and hammers, pneumatic motors for rock loaders and combines.	Produces drills for export.

Footnotes are at end of table.

Approved For Release 2008/09/08 : CIA-RDP08S01350R000100030002-2

Approved For Release 2008/09/08 : CIA-RDP08S01350R000100030002-2

FIGURE 62. IMPORTANT PRODUCERS OF COAL MINING MACHINERY* (*Continued*)

LOCATION	PLANT NAME	PRINCIPAL PRODUCTS	REMARKS
Lugansk 48°34′N.; 39°20′E.	Lugansk Coal Mining Machinery Plant *imeni* Parkhomenko.	Crushers, coal-rock separators, coal and ore concentrating equipment, screening equipment. Developing M–87T support system.	Plant specializes in the production of coal preparation equipment.
Malakhovka 55°39′N.; 38°00′E.	Malakhovka Experimental Plant of the State Planning and Design Institute for Coal Mining Machinery (*Giprouglemash*).	Develops experimental models and lots of combines, conveyors, support systems, and coal loaders. Developed new A–3 support equipment complex. Now developing pilot models of KM–87E and KM–87A remotely operated longwall face systems and the BK–2 development combine.	Well-equipped plant principally concerned with the production of prototypes developed by the institute. Employs over 1,000 persons.
Novosibirsk 55°02′N.; 82°53′E.	Novosibirsk "*Trud*" ("Labor") Experimental Plant of the State Planning, Design, and Testing Institute for Coal Mining Machinery (*Giprouglemash*).	Pneumatic drills for strip mining, PKG development combines, miscellaneous mining machinery.	
Novocherkassk 47°24′N.; 40°06′E.	Novocherkassk Coal Mining Machinery Plant.	Shaft-sinking equipment, rock loaders, drilling equipment.	
Novo-Kuznetsk 53°44′N.; 87°10′E.	Kuznetsk Machine Building Plant.	Hydraulic-powered coal cutting and conveying equipment, new PKG development combines.	Main assembly plant for PKG combines receiving subassemblies and parts from other plants.
Skopin 53°50′N.; 39°32′E.	Skopin Machine Building Plant.	Specializes in production of scraper conveyors and LP–45 and L–50 reloaders.	Estimated average annual production, more than 3,000 units.
Uzlovaya 53°59′N.; 38°10′E.	Uzlovaya Mining Equipment Plant.	Shaft-sinking equipment, winches, hydraulic conveyor shifters GP–1M and GP–2M, mine cars, drills, mine support systems DKMT, A–3, and AF–15.	
Yasinovataya 48°08′N.; 37°51′E.	Yasinovataya Machine Building.	ShBM–2 development combines, PGA–3 shaft sinking units, winches, and hoists.	

* Except for certain transport and preparation and cleaning equipment, the products listed are mainly for underground mining.

FIGURE 63. PRODUCTION OF SELECTED TYPES OF COAL MINING EQUIPMENT
(*Units*)

TYPE OF MACHINE OR EQUIPMENT	1960	1961	1962	1963	1964	1965
Coal cutters	350	40	120	115	130	202
Combines	881	742	834	967	971	998
Electric mine locomotives*	3,921	3,453	2,956	2,755	2,215	2,411
Rock loaders*	2,471	2,175	2,318	2,404	2,138	2,177

* Rock loaders and mine locomotives are also used extensively in the underground mining of metallic ores and other minerals. The share of the total production eventually used in the coal industry is not known.

Approved For Release 2008/09/08 : CIA-RDP08S01350R000100030002-2

Approved For Release 2008/09/08 : CIA-RDP08S01350R000100030002-2

FIGURE 64. INVENTORY OF MAJOR TYPES OF UNDERGROUND COAL MINING MACHINERY AND EQUIPMENT

(Units as of end of year)

TYPE OF MACHINE OR EQUIPMENT	1960	1961	1962	1963	1964	1965
Heavy duty development drills	1,425	1,515	1,638	1,769	1,923	1,855
Combines:						
Coal combines	4,249	4,253	4,075	4,275	4,411	4,364
Development combines	601	633	586	574	546	524
Conveyors:						
Belt conveyors	12,860	13,188	12,980	13,795	14,179	13,788
Scraper conveyors	43,624	45,256	40,008	45,179	48,141	45,311
Coal cutters (heavy)	3,798	3,180	2,479	2,291	1,857	1,513
Loaders:						
Coal loaders	1,135	*na*	1,088	1,346	1,488	1,629
Rock loaders	5,434	5,151	4,733	4,803	4,770	4,541
Mine locomotives (electric)	16,254	16,779	16,153	16,514	16,695	16,116

FIGURE 65. EXPORTS OF MAJOR TYPES OF COAL MINING EQUIPMENT, BY DESTINATION

(Units)

DESTINATION	TYPE OF MACHINE	1960	1961	1962	1963	1964	1965
Bulgaria	Coal and rock loaders	0	0	15	47	41	25
Czechoslovakia	Coal combines	13	30	35	12	0	9
	Development combines	3	10	14	0	0	0
	Coal and rock loaders	2	101	109	78	112	150
Hungary	Coal and rock loaders	31	20	7	6	22	19
Poland	Coal combines	10	2	24	37	17	29
Other	Coal combines	0	5	1	1	7	4
	Development combines	0	0	0	0	0	0
	Coal and rock loaders	32	50	68	11	55	130
Total	Coal combines	23	37	60	50	24	42
	Development combines	3	10	14	0	0	0
	Coal and rock loaders	65	171	199	142	230	324

FIGURE 66. EXPORTS OF MAJOR TYPES OF COAL MINING EQUIPMENT, BY VOLUME AND VALUE

(Units and thousands of foreign exchange rubles)

TYPE OF MACHINE	1960		1961		1962		1963		1964		1965	
	Units	Value	Units	Value	Units	Value	Units	Value	Units	Value	Units	Value
Coal combines	33	352	37	777	60	1,239	50	1,007	24	450	42	1,039
Development combines	3	120	10	432	14	560	0	0	0	0	0	0
Coal and rock loaders	65	330	171	647	199	805	142	648	230	947	324	1,260

Approved For Release 2008/09/08 : CIA-RDP08S01350R000100030002-2

Approved For Release 2008/09/08 : CIA-RDP08S01350R000100030002-2

FIGURE 67. MAJOR PRODUCERS OF OILFIELD EQUIPMENT

LOCATION	PLANT	MAJOR PRODUCTS	REMARKS
Baku 40°23′N.; 49°51′E.	Machine Building Plant *"Bakinskiy rabochiy"* ("Baku Worker").	A large line of oil drilling and refining equipment including pumping units (jacks), hoists, pumps, crown and traveling blocks.	Chief producer of beam type pumping units. Plant has undergone considerable modernization and retooling. Labor force probably over 2,000.
Do	Drilling Equipment Plant *imeni* Kirov.	Bits of many types, tool joints, electric perforators.	Produces annually about 250,000 tool joints and 150,000 bits, including jet bits.
Do	Machine Building Plant *imeni* F. Dzerzhinskiy.	Various types of pumps for the oil industry, including deep-well pumps, new hydraulic plunger pumps, and automatic breakout tongs and slips.	Produces about 80% of deep-well pumps. Plant equipment and technology are being modernized.
Do	Machine Building Plant *imeni* Leytenant Shmidt.	Wellhead equipment, sucker rods, portable rigs, and rig accessories.	The oldest oilfield equipment plant. Extensive modernization since 1959. Threefold increase in production was scheduled during the Seven Year Plan.
Do	Kishly Machine Building Plant *imeni* Narimanov.	Turbodrills, well-servicing units; small prospecting drilling rigs.	One of the largest plants in Baku. Large-scale modernization program completed in mid-1960's.
Do	Petroleum Equipment Plant *imeni* Volodarskiy.	Tool joints, elevators, and miscellaneous well-servicing equipment.	A leading producer of tool joints and elevators.
Drogobych 49°21′N.; 23°30′E.	Drogobych Machine Building Plant.	Rock drill bits	A major producer and exporter of bits.
Groznyy 43°20′N.; 45°42′E.	Machine Building Plant *"Krasnyy Molot"* ("Red Hammer").	Well-servicing equipment, truck-mounted hoists, sand pumps; refining equipment.	A leading producer of refining equipment.
Ishimbay 53°28′N.; 56°02′E.	Ishimbay Machine Building Plant.	Lightweight slush pumps, portable masts for well-servicing units, pumping units, and possibly portable rigs.	Famous for designing and manufacturing the *"Ufimets"* portable rig for slim-hole drilling.
Khar'kov 50°00′N.; 36°15′E.	Khar'kov Electrical Machinery Plant.	Electric motors, electrodrills	A leading producer of electric bottom-hole motors. Also an assembly plant for electrodrills.
Kungur 57°25′N.; 56°57′E.	Kungur Machine Building Plant.	Turbodrills and turbodrill components, portable rigs.	Largest Soviet producer of turbodrills. Undergoing expansion and modernization.
Moscow 55°45′N.; 37°35′E.	Machine Building Plant *"Borets."*	Pumps and compressors and their components.	Specializes in pumps and compressors for the refining industry. Probably produces most of the electric bottom-hole pumps.
Pavlovskiy 57°50′N.; 54°51′E.	Pavlov Machine Building Plant *imeni* Myasnikov.	Turbodrills	Produces turbodrills of advanced design. Foreign buyers include U.S. company, Dresser Industries.
Sverdlovsk 56°51′N.; 60°36′E.	Ural Heavy Machinery Plant *imeni* Sergo Ordzhonikidze.	Oilfield equipment, excavators for open-pit mining and large shaft-sinking units.	Produces about 80% of all the Soviet heavy drilling rigs. Labor force between 16,000 and 18,000.
Verkhniye-Sergi 56°39′N.; 59°33′E.	Verkhniye-Sergi Machine Building Plant.	All types of coring and non-coring rock bits in many sizes, including the diamond bit.	Produces about 40% of total Soviet output of bits. Expansion and modernization underway. Said to be the most modern plant of its kind in U.S.S.R.
Volgograd 48°45′N.; 44°25′E.	Machine Building Plant *"Barrikady"* (also called Drilling Equipment Plant *"Barrikady"*).	Medium and heavy drilling rigs.	Probably accounts for 20% of Soviet drilling rig production; may also produce some military equipment.

Approved For Release 2008/09/08 : CIA-RDP08S01350R000100030002-2

Approved For Release 2008/09/08 : CIA-RDP08S01350R000100030002-2

FIGURE 68. FOREIGN TRADE IN OILFIELD EQUIPMENT
(Value in thousands of foreign exchange rubles)

TYPE OF EQUIPMENT	1960		1962		1963		1964		1965	
	Units	Value	Units	Value	Units	Value	Units	Value	Units	Value
Exports:										
Portable drilling rigs, core drills, and small drilling units	248	3,703	356	7,139	404	6,404	343	4,698	269	3,647
Heavy drilling rigs	14	2,393	14	2,579	2	355	1	177	...	...
Mud pumps	67	124	38	107	79	223	67	153	49	112
Turbodrills and electrodrills	242	1,522	323	1,959	202	909	70	413	95	730
Cementing units	16	462	29	656	32	696	38	659	15	381
Drill bits (tri-cone)	21,500	3,725	19,000	2,662	13,300	1,839	14,800	2,162	9,200	1,389
Pump jacks	113	1,052	281	2,646	*na*	*na*	*na*	*na*	*na*	*na*
Deepwell pumps	2,235	620	652	534	48	11	70	35	90	27
Well pulling and servicing units	31	590	18	530	9	296	7	123	7	158
Seismic stations	19	1,026	8	296	9	304	7	306	6	265
Well logging units	26	1,163	12	307	32	1,150	11	567	8	480
Other geophysical equipment	...	1,317	...	2,033	...	1,828	...	1,195	...	928
Emergency drilling equipment (fishing tools, jars, junk baskets)	...	844	...	742	...	653	...	670	...	652
Spare parts	...	2,227	...	3,002	...	3,277	...	3,866	...	2,980
Other (miscellaneous)	......	5,503	......	4,072	......	3,708	......	3,015	......	4,007
Total	......	26,271	......	29,264	......	21,653	......	18,039	......	15,756
Imports:*										
Heavy drilling rigs	14	3,571	34	9,222	25	6,809	47	11,548	33	9,763
Blowout preventors	84	763	142	1,284	168	1,783	157	1,575	226	2,301
Cementing units	6	156	26	677	13	338	23	897	42	1,603
Drill bits (tri-cone)	700	156	26,400	4,048	28,700	4,937	40,600	6,796	20,300	3,029
Pump jacks	*na*	*na*	143	1,459	182	1,831	143	1,438	82	790
Other (miscellaneous)	......	460	......	4,499	......	2,622	......	2,040	......	4,128
Total	......	5,106	......	21,189	......	18,320	......	24,294	......	21,614

* About 96% of equipment imported comes from Rumania.

Approved For Release 2008/09/08 : CIA-RDP08S01350R000100030002-2

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FIGURE 69. MAJOR PRODUCERS OF CHEMICAL EQUIPMENT, 1965

LOCATION	PLANT	PRODUCTS
Balashikha 55°49′N.; 37°58′E.	Machine Building Plant *imeni* 40 Letiya	Oxygen and nitrogen plant; krypton equipment.
Chirchik 41°29′N.; 69°35′E.	Central Asian Chemical Machinery Plant *imeni* Frunze.	Compressors, filters, pumps, blowers, heat exchangers, crystallizers, condensers, and others.
Dnepropetrovsk 48°27′N.; 34°59′E.	Dnepropetrovsk Machine Building Plant *imeni* Artem.	Mixers, pumps, and instruments for paper, lumber, and other industries.
Kiev 50°26′N.; 30°32′E.	Kiev "*Bol'shevik*" Machine Building Plant.	Machinery and instruments for rubber-processing, chemical, metallurgical, and other industries.
Leningrad 59°55′N.; 30°15′E.	Leningrad "*Ekonomayzer*" ("Economiser") Machine Building Plant.	Gas turbines, turbopumps, blowers, and hydraulic presses.
Do	Leningrad Machine Building Plant *imeni* Karl Marx.	Equipment for the production of artificial and synthetic fibers and textile machinery.
Do	Leningrad "*Metallist*" ("Metal Worker") Machine Building Plant.	Presses for plastics, vulcanizers, driers, pumps, autoclaves, mixers, and pigment grinders.
Do	Nevskiy Machine Building Plant *imeni* Lenin.	Turbines, compressors, and blowers.
Moscow 55°45′N.; 37°35′E.	Moscow "*Borets*" ("Champion") Machine Building Plant.	Pumps, compressors, and petroleum equipment.
Do	Moscow Pump Plant *imeni* Kalinin	Pumps and compressors.
Do	Moscow Compressor Plant	Compressors, pumps, and refrigeration equipment.
Penza 53°13′N.; 45°00′E.	Penza Chemical Machinery Plant	Vulcanizers, gas-separation, heat-exchangers, and equipment for rubber and plastic products.
Ruzayevka 52°49′N.; 66°57′E.	Ruzayevka Chemical Machine Building Plant.	Oil-vapor high vacuum units, autoclaves, booster pumps, and reactors.
Snezhnoye 48°01′N.; 38°50′E.	Snezhnoye Chemical Machine Building Plant.	Equipment for production of mineral fertilizer, synthetic fiber, and oil refining.
Sumy 50°54′N.; 34°48′E.	Sumy Machine Building Plant *imeni* Frunze.	Pumps, compressors, filters, centrifuges, and driers.
Sverdlovsk 56°51′N.; 60°36′E.	Ural Chemical Machine Building Plant	Electrolyzers, autoclaves, driers, filters, ball mills, columns, and other chemical equipment.
Tambov 52°43′N.; 41°27′E.	Tambov Chemical Machinery Plant	Vertical reduction units, vulcanizers, heat exchangers, and other chemical equipment.

FIGURE 70. IMPORTS OF CHEMICAL EQUIPMENT,* BY VALUE

(*Millions of foreign exchange rubles*)

	1958	1959	1960	1961	1962	1963	1964	1965
Total	45.5	103.8	167.0	171.0	141.8	190.2	186.4	187.4
Eastern European Communist countries	28.0	33.7	44.2	50.5	62.8	78.6	84.5	87.9
Of which:								
Czechoslovakia	10.8	13.2	21.9	**25.0	**29.9	**45.0	47.1	43.8
East Germany	15.8	18.0	16.6	**15.0	**20.0	**16.0	15.5	16.0
Non-Communist countries***	17.5	70.1	122.8	120.5	79.0	111.6	101.9	99.5
Of which:								
France	3.3	6.5	15.9	16.6	16.3	11.9	4.5	12.1
Italy	0	6.0	20.6	25.3	13.0	26.1	5.9	15.1
Japan	0	1.0	3.6	7.6	3.8	16.4	4.6	5.9
United Kingdom	5.7	30.1	35.3	37.2	16.0	27.2	26.7	39.3
West Germany	4.9	20.0	37.4	18.7	7.7	17.1	52.9	16.5

* Data may not include pumps and compressors for use in chemical processes.

** Estimated.

*** Data are preliminary for individual nonbloc countries for the years 1961–64.

Approved For Release 2008/09/08 : CIA-RDP08S01350R000100030002-2

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FIGURE 71. MAJOR PRODUCERS OF LOCOMOTIVES AND RAILROAD CARS, 1965

LOCATION	PLANT NAME	CHIEF PRODUCTS	IMPORTANCE
Bryansk 53°15'N.; 34°22'E.	Bryansk Machine Building Plant *imeni Krasnyy Profintern.*	Power trains, diesel-electric switch engines of 1,000–2,000 hp.	Produces pilot models of freight cars. Assembles diesel switches and power trains.
Chesnokovka 56°52'N.; 35°55'E.	Altai Railroad Car Plant	Mainline and narrow gage box-cars.	Accounts for about 5% of production of freight cars.
Kalinin 56°52'N.; 35°55'E.	Kalinin Rolling Stock Building Plant.	Passenger coaches, with seats or compartments.	Important producers of passenger cars and trucks (bogies). Designing and testing functions.
Khar'kov 50°00'N.; 36°15'E.	Khar'kov Transport Machinery Plant *imeni* Malyshev.	Diesel locomotives	Second most important producer of diesel locomotives.
Kolomna 55°05'N.; 38°47'E.	Kolomna Locomotive Building Plant *imeni* Kuybyshev.	Diesel locomotives and mobile power stations.	Least important of three major producers of diesel locomotives.
Kremenchug 49°04'N.; 33°25'E.	Kryukov Railroad Car Plant	Open top cars, tank cars, special freight cars of heavy capacity.	Accounts for 10–15% of freight car production.
Leningrad 59°55'N.; 30°15'E.	Yegorov Railroad Equipment Plant.	Passenger cars, mail and baggage cars.	Important producer of regular mainline passenger equipment.
Lugansk 48°34'N.; 39°20'E.	Lugansk Order of Lenin Diesel Locomotive Building Plant *imeni* October Revolution.	Diesel locomotives, diesel switchers, and transporters.	Major producer of mainline diesel locomotives, about 60% of total.
Mytishchi 55°55'N.; 37°46'E.	Machine Building Plant *imeni* Kalinin.	Multiple unit and subway cars.	Builds all metal cars for subways in Moscow, Leningrad, and Kiev.
Nizhniy Tagil 57°55'N.; 59°57'E.	Ural Freight Car Plant	Freight cars of all types. Heavy capacity cars.	Most important producer of freight cars in the U.S.S.R.
Novocherkassk 47°25'N.; 40°06'E.	Novocherkassk Electric Locomotive Building Plant.	Electric locomotives	Major producer of electric locomotives, shifting to AC types.
Riga 56°57'N.; 24°06'E.	Riga Railroad Car Plant (*Vairogs*).	Passenger cars, multiple unit cars, electric passenger trains, diesel passenger trains.	Important developer and producer of permanently coupled passenger train sets.
Tiflis 41°42'N.; 44°45'E.	Tiflis Electric Locomotive Building Plant *imeni* Lenin.	Electric locomotives	Second producer of electric locomotives, almost entirely DC types.
Zhdanov 47°06'N.; 37°33'E.	Zhdanov Heavy Machinery Plant *imeni* Il'yich.	Tank cars	Produces over 90% of the tank cars built in the U.S.S.R.

FIGURE 72. CHARACTERISTICS OF MAJOR SOVIET MAINLINE LOCOMOTIVES

DESIGNATION	FIRST YEAR OF MANUFACTURE	POWER	WHEEL ARRANGEMENT*	HORSEPOWER	SERVICE WEIGHT	DESIGN SPEED
					Mt.	*Km./Hr.*
TE-3	1953	Diesel electric	C–C	2,000	126	100
TE-7	1956	....*do*	C–C	2,000	126	140
2 TE-10L Ukraine	1962	....*do*	C–C+C–C	6,000	126	100
TE-40	1963	....*do*	C–C	3,000	126	100
TEP-10	1963	....*do*	C–C	3,000	126	140
TEP-60	1960	....*do*	C–C	3,000	126	160
M-62	1965	....*do*	C–C	2,000	126	100
VL-8	1953	Electric DC	B–B+B–B	5,200	184	100
VL-60	1957	Electric AC	C–C	5,500	138	100
VL-80	1962	....*do*	B–B+B–B	8,500	184	110

* The letters B, C, and D indicate the arrangement of the axles per truck (weight bearing unit). Thus C–C is a six-axle section having two trucks of three axles each.

Approved For Release 2008/09/08 : CIA-RDP08S01350R000100030002-2

Approved For Release 2008/09/08 : CIA-RDP08S01350R000100030002-2

FIGURE 73. MAJOR PRODUCERS OF METALLURGICAL EQUIPMENT, 1966

LOCATION	PLANT	PRINCIPAL TYPES OF METALLURGICAL EQUIPMENT PRODUCED	REMARKS
Alma-Ata 43°15′N.; 76°57′E.	Alma-Ata Heavy Machine Building Plant (AZTM).	Wire-drawing and tube-drawing mills; equipment for coke batteries; blast furnaces, and rolling mills; presses and mechanical hammers.	Produces most of the metallurgical equipment manufactured in the Kazakh S.S.R. Has produced a number of wire-drawing mills for export to eastern European bloc countries, Yugoslavia, and India.
Dnepropetrovsk 48°27′N.; 34°59′E.	Dnepropetrovsk Metallurgical Equipment Plant (DZMO).	Equipment for coke batteries; blast, open-hearth and electric furnaces; components for continuous casting installations and rolling mills.	Probably produces the widest range of metallurgical equipment of any plant in the industry.
Elektrostal′ 55°47′N.; 38°28′E.	Elektrostal′ Heavy Machine Building Plant (EZTM).	Pipe and tube mills, structural and bar mills, liquid friction bearings for rolling mills.	Largest producer of pipe and tube mills in the U.S.S.R.
Irkutsk 52°16′N.; 104°20′E.	Irkutsk Heavy Machine Building Plant *imeni* Kuybyshev (IZTM).	Equipment for blast furnaces and open-hearth furnaces, wire-drawing mills; components and auxiliary units for rolling mills.	Manufactures most of the metallurgical equipment produced in the east Siberia region.
Kramatorsk 48°43′N.; 37°32′E.	Novo Kramatorsk Heavy Machine Building Plant (NKMZ).	Hot strip, slabbing and cold wide strip mills; large capacity cranes and ladles; mixers and shears.	Second largest producer of metallurgical equipment in the U.S.S.R. Also a major producer of heavy equipment for other industries.
Do	Staro-Kramatorsk Heavy Machine Building Plant *imeni* Ordzhonikidze (SKMZ).	Cold narrow strip mills, including multiroll (Sendzimir-type) mills; auxiliary equipment for processing strip and sheet, such as levelers, shears, trimming lones, and sheet stackers; auxiliary equipment for pipe mills.	
Novosibirsk 55°02′N.; 82°55′E.	Novosibirsk Electrothermal Equipment Plant.	Electric smelting furnaces, heating treating furnaces, electric furnaces for smelting aluminum.	Produces some equipment for export.
Orsk 51°12′N.; 82°55′E.	Yuzhno Ural'skiy (South Ural) Heavy Machine Plant (YUZTM).	Equipment for coke batteries and blast furnaces, oxygen converters, steel-pouring ladles, continuous casting installations, blooming mills, and billet mills.	Produces other heavy industrial machinery.
Sverdlovsk 56°51′N.; 60°36′E.	Ural Heavy Machine Building Plant *imeni* Ordzhonikidze (*Uralmashzavod*—UTZM).	Blast furnace equipment, blooming mills, billet mills, plate mills, rail and structural mills, cold rolling mills, pipe and tube rolling mills, wheel rolling mills, and continuous casting equipment.	Largest producer of metallurgical equipment in the U.S.S.R. Also a major producer of heavy equipment for other industries, including excavators, oilfield equipment, mining and ore concentrating equipment.

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FIGURE 74. EXPORTS OF METALLURGICAL EQUIPMENT,* BY DESTINATION
(Metric tons, and thousands of foreign exchange rubles)

PRODUCT AND DESTINATION	1961		1962		1963		1964		1965	
	Weight	Value	Weight	Value	Weight	Value	Weight	Value	Weight	Value
Blast furnace equipment:										
Bulgaria	73	44	335	199	1,512	910	2,200	1,163	588	358
Unknown	......	......	6	8	14	13	533	51	401	80
Steel smelting equipment:										
Sweden	......	......	......	......	......	......	......	......	387	31
Rolling mill equipment:										
Bulgaria	1,168	745	1,943	1,529	1,471	1,024	2,435	1,787	1,653	891
Communist China	601	391	......	......	275	285	57	69	......	.....
Cuba	......	......	......	......	......	......	410	455	23	41
Czechoslovakia	28	80	19	25	34	127	13	87	37	67
East Germany	392	264	354	239	4	9	20	68	583	193
France	......	......	......	......	......	......	25	13	71	47
Hungary	100	501	900	462	1,300	753	1,000	1,120	1,100	553
India	......	......	1,300	503	1,600	954	1,300	574	3,600	1,383
North Korea	800	237	800	233	200	92	......	......	......	.....
Poland	1,189	1,241	1,349	1,148	1,682	1,083	2,131	2,279	337	445
Rumania	3,600	1,527	3,400	1,327	3,600	1,616	3,800	2,348	1,000	690
Turkey	......	......	14	5	16	8	16	10	12	7
Yugoslavia	745	179	608	326	43	19	369	151	858	399
Unknown	877	2	313	179	375	7	......	7	26	22
Wire-drawing equipment:										
Unknown	......	......	......	......	38	40	10	22	......	.....
Total	9,573	55,211	11,341	6,183	12,164	6,940	14,319	10,204	10,678	5,207

* Excludes exports of equipment for complete enterprises financed under technical assistance programs.

FIGURE 75. IMPORTS OF METALLURGICAL EQUIPMENT, BY ORIGIN
(Metric tons, and thousands of foreign exchange rubles)

PRODUCT AND ORIGIN	1961		1962		1963		1964		1965	
	Weight	Value	Weight	Value	Weight	Value	Weight	Value	Weight	Value
Blast furnace equipment:										
East Germany	600	550	100	81	......	......	......	......	......	....
Steel smelting equipment:										
Austria	......	......	......	......	......	......	17,200	15,222	6,300	10,115
Rolling mill equipment:										
Austria	100	222	......	4	1,300	808	12	190	7	21
Czechoslovakia	13,100	15,422	17,500	22,349	22,300	28,007	10,500	25,019	21,300	34,947
East Germany	10,000	13,527	14,400	22,665	17,700	27,407	18,900	32,688	19,700	31,414
France	1,400	4,943	500	1,348	......	......	40	270	120	672
United Kingdom	......	......	190	562	196	853	3	5	......	....
Hungary	......	......	300	322	3,500	5,328	3,300	5,673	6,000	9,866
Poland	......	......	......	......	......	......	3,534	3,507	3,852	3,306
West Germany	6	25	535	1,208	75	197	13	71	13	47
Unknown	......	......	......	......	629	611	......	346	......	34
Wire-drawing equipment:										
East Germany	1,500	2,698	1,500	2,744	2,900	5,060	1,300	4,186	4,100	5,234
Hungary	100	193	300	634	400	363	100	148	300	137
Unknown	......	......	......	......	......	......	......	......	......	....
Total	26,806	37,480	35,325	51,917	49,000	68,634	62,902	87,325	61,622	95,793

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FIGURE 76. PRODUCTION OF SELECTED MAJOR TYPES OF CONSTRUCTION EQUIPMENT
(*Units*)

TYPE OF EQUIPMENT	1958	1960	1963	1965	1966
Bulldozers	11,260	12,850	18,481	20,040	21,910
Cranes, total	11,583	9,996	14,731	15,487	17,120
Truck cranes	6,867	6,335	9,902	10,599	12,120
Cranes mounted on pneumatic tires	475	835	762	1,238	1,261
Tower cranes	4,241	2,826	4,067	*3,160	*3,189
Excavators, total	10,145	12,589	17,863	21,600	23,449
Single bucket	9,169	11,622	16,508	19,867	21,511
Multibucket	976	967	1,355	1,733	1,938
Motor grader	2,663	3,135	4,039	4,178	4,393
Scrapers	2,660	3,094	5,470	7,267	7,374

* Includes only cranes with a capacity of 5 tons or over.

FIGURE 77. TRADE IN PRINCIPAL CATEGORIES OF CONSTRUCTION EQUIPMENT
(*Thousand rubles*)

	1958		1960		1964		1965	
	Exports	Imports	Exports	Imports	Exports	Imports	Exports	Imports
Excavators and roadbuilding equipment	22,669	3,533	32,927	4,424	46,721	30,512	68,651	38,175
Equipment for producing construction materials	1,324	68,042	1,327	69,695	1,356	37,266	1,335	47,493
Total	23,993	71,575	34,254	74,119	48,077	67,778	69,986	85,678

FIGURE 78. EXPORTS OF SOVIET MOTOR VEHICLES, BY TYPE AND DESTINATION*

DESTINATION	TRUCKS			PASSENGER CARS			BUSES			MOTORCYCLES		
	1963	1964	1965	1963	1964	1965	1963	1964	1965	1963	1964	1965
Communist countries:												
Bulgaria	5,197	4,393	2,942	3,989	3,741	5,455	130	81	294	13,174	21,784	16,834
Communist China	1,487	788	2,406	556	1,077	3,369	0	0	0	60	85	164
Cuba	2,084	4,010	1,251	1,207	1,029	470	213	114	1	0	0	0
Czechoslovakia	0	0	0	6,122	6,046	3,632	0	0	0	0	0	0
East Germany	532	695	346	4,727	8,245	7,773	0	0	0	39	0	2
Hungary	1,626	2,059	979	3,899	3,722	4,744	0	0	0	533	267	753
Mongolia	590	493	165	200	255	210	40	5	65	0	0	0
North Vietnam	446	32	503	22	67	280	21	0	0	0	138	10
Poland	1,434	1,405	606	2,489	2,922	3,022	0	0	0	3,742	502	3
Rumania	904	321	37	2,211	2,531	2,672	0	5	7	100	33	5
Yugoslavia	131	389	324	1,141	2,141	2,500	72	231	1	0	0	0
Non-Communist countries:												
Afghanistan	218	72	535	658	403	397	0	20	11	0	0	0
U.A.R.	4,643	2,801	2,951	731	694	873	98	107	78	0	2	33
Finland	215	500	185	3,100	6,200	6,200	0	0	0	200	200	200
Guinea	132	549	319	43	62	107	0	0	0	0	0	0
Indonesia	1,494	360	679	1,035	90	414	116	43	11	0	0	0
Iran	0	20	20	78	226	69	0	0	0	101	100	380
Iraq	32	474	326	150	641	425	2	0	0	5	75	347

* Excluding vehicles shipped under assistance programs.

Approved For Release 2008/09/08 : CIA-RDP08S01350R000100030002-2

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FIGURE 79. PRODUCERS OF CIVILIAN MOTOR VEHICLES, 1965

LOCATION	PLANT	PRODUCTS	REMARKS
Gor'kiy 56°20'N.; 44°00'E.	Gor'kiy Motor Vehicle Plant (GAZ).	Trucks (2-, 2.5-, and 4-ton) including cargo trucks and truck-tractors. Cars: 7-passenger Chayka, 5-passenger Volga, and the GAZ-22 station wagon.	Largest vehicle plant in U.S.S.R. Estimated production: 153,400 trucks and 48,450 passenger cars. Present expansion program is to cost about 125 million rubles. Plant is scheduled to produce 75,000 passenger cars annually by 1970. Aluminum engines are supplied by the Zavolzhye Engine Plant. Estimated employment, 55,000. Plant is testing the 7-ton GAZ-33.
Kremenchug 49°04'N.; 33°25'E.	Kremenchug Motor Vehicle Plant (KrAZ).	7-, 12-, and 19-ton trucks: cargo, truck-tractor, and dump trucks.	Estimated production: 10,100 trucks. A new shop containing 182,970 square feet has been constructed and will be used to manufacture parts. Estimated employment 12,000.
Kurgan 55°26'N.; 65°18'E.	Kurgan Autobus Plant (KUAZ).	20-seat bus	Estimated production: 8,100 buses. Buses are built on the GAZ-53 chassis.
Kutaisi 42°15'N.; 42°40'E.	Kutaisi Motor Vehicle Plant (KAZ).	3.5-ton cement carrier and dump trucks; truck tractor with 8-ton towing capacity; 5-, 11.5-ton cargo trucks.	Estimated production: 10,000 trucks. Approximate employment, 12,000.
Likino-Dulevo 55°44'N.; 38°58'E.	Likino Bus Plant (LIAZ)	32-passenger bus	Estimated production: 8,300 buses. The plant has successfully tested the 110-passenger bus, the LIAZ-677.
Lutsk 50°45'N.; 25°20'E.	Lutsk Machine Building Plant (LuMZ).	Refrigerator trucks, grocery trucks, and a 14-passenger vehicle.	Estimated production: 1,500.
L'vov 49°50'N.; 24°00'E.	L'vov Bus Plant (LAZ)	32-, and 41-passenger buses.	Estimated production: 6,400. The plant was to produce 6,700 buses in 1966, and 9,000 a year by 1970. Testing of the LAZ-696 (120 passengers) and the LAZ-698 (90 passengers) has been completed.
Miass 54°59'N.; 60°06'E.	Ural Motor Vehicle Plant (URAL).	3.5-5-, and 7.5-ton cargo trucks.	Estimated production: 34,400. Plant to double production during the Five Year Plan (1966-70). The 7.5-ton dump truck Ural-377V successfully tested in 1966. The 6 x 6 Ural-375 is for military use.
Minsk 53°54'N.; 27°34'E.	Minsk Motor Vehicle Plant (MAZ).	7-ton cargo truck; truck-tractor of 16.5-ton towing capacity; 7-ton dump truck; timber carrier; 4-ton cargo truck; airport vehicle; 24-ton 8 x 8 MAZ-535; and 15-17-ton 8 x 8 MAZ-543.	Estimated production: 21,580 trucks. Estimated employment: 20,000. A new truck-tractor (MAZ-516) having a towing capacity of 25 tons has been tested. Expansion of the plant nearing completion in 1965. Floor space to be nearly doubled.
Moscow 55°45'N.; 37°35'E.	Moscow Motor Vehicle Plant	4.5-, 5-ton cargo trucks, 10-ton, 8 x 8 ZIL-135 special purpose vehicle; ZIL-111 automobile; 17-passenger bus ZIL-118.	Estimated production: 93,500 trucks and 200 cars. Estimated employment: 70,000. Large numbers of chassis are furnished to other plants. Cumulative production of ZIL-130 was 160,000 by December 1966. Production to be increased by 50% during 1966-70 plan. Quantity production of the 6 x 6 ZIL-131 to start in late 1967. Based on the ZIL-135, the plant has developed the three axle ZIL-E167 (two 180 hp. engines).
Do	Moscow Small-Displacement Automobile Plant (MZMA).	Moskvich 4-passenger car and station wagon.	Estimated production: 80,600. Estimated employment: 13,000. Planned output of 350,000 by 1970 will require modernization and expansion of the plant.

Approved For Release 2008/09/08 : CIA-RDP08S01350R000100030002-2

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FIGURE 79. PRODUCERS OF CIVILIAN MOTOR VEHICLES, U.S.S.R., 1965 (*Continued*)

LOCATION	PLANT	PRODUCTS	REMARKS
Mytishchi........... 55°55'N.; 37°46'E.	Mytishchi Machine Building Plant (MMZ).	4.5-ton dump trucks. Also produces semitrailers and a truck-tractor.	Estimated production: 34,500. Chassis are received from the Moscow Likhachev Plant. The trade mark is ZIL–MMZ.
Pavlovo............ 55°57'N.; 43°04'E.	Pavlovo Bus Plant *imeni* Zhdanov (PAZ).	Assembles 22- and 23-seat buses.	Estimated production: 7,500. The 45-passenger bus PAZ–672 was scheduled for production in late 1966 or early 1967.
Riga............... 56°57'N.; 24°06'E.	Riga Bus Plant (RAF)........	Microbuses: 10-seat Latvia and the 0.8 ton RAF–977K panel truck.	Estimated bus production: 1,700. The RAF–977K uses Volga parts. Also called Riga Experimental Bus Plant.
Saransk............. 54°11'N.; 45°11'E.	Saransk Motor Vehicle Plant (SAZ).	2.25- and 3.2-ton dump trucks and tank trailers.	Estimated production: 14,600. Chassis are from the Gor'kiy Motor Vehicle Plant.
Ul'yanovsk.......... 54°20'N.; 48°24'E.	Ul'yanovsk Motor Vehicle Plant (UAZ).	0.5-ton jeep; panel truck, ambulance, 0.8-ton cargo truck, 8–10-seat microbuses.	Estimated production: 38,870 (including 31,000 jeeps, 3,500 buses and 4,370 trucks). Engines are probably received from the Zavolzhye Engine Plant. Estimated employment: 15,000. Output of 130,000 vehicles planned for 1970.
Zaporozh'ye......... 47°49'N.; 35°11'E.	Zaporozh'ye "*Kommunar*" Automobile Plant (ZAZ).	Four-passenger Zaporozhets; 0.4-ton Tselina all-purpose truck; a small 0.25-ton 4 x 4 truck.	Estimated production: 40,600. Serial production of the ZAZ–966 to start in 1967. Plan calls for 150,000 cars to be produced annually by 1970.
Zhodino............ 54°06'N.; 28°21'E.	Belorussian Motor Vehicle Plant (BeLAZ).	27-ton BeLAZ–540 dump truck.	Estimated production: 1,500. The 360 hp. single axle BeLAZ–531 is still under test. Output of 40-ton dump trucks is still in trial series. Trucks of 65–85-tons are being tested. A 110-ton truck with gas turbine is being developed.

Approved For Release 2008/09/08 : CIA-RDP08S01350R000100030002-2

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FIGURE 80. PRODUCERS OF ARMORED AND SPECIALIZED MILITARY VEHICLES, 1966

LOCATION	PLANT	PRODUCT	REMARKS
Gor'kiy 56°20'N.; 40°00'E.	Gor'kiy Motor Vehicle Plant (GAZ.)	AT–P armored prime mover, MAV–46 amphibious jeep, GAZ–47 tracked amphibious troop/cargo carrier, the BRDM armored scout car and BRDM AT missile launcher vehicle.	Estimated production 1966: 1,200 prime movers, 1,000 amphibious jeeps, 400 troop/cargo carriers, 2,900 scout cars and launch vehicles.
Khar'kov 50°00'N.; 36°15'E.	Khar'kov Transport Machine Plant No. 75 *imeni* Malyshev.	T–55 medium tank and AT–T heavy prime mover.	Estimated 1966 production: 900 tanks and 400 prime movers. Also builds diesel locomotives and possibly submarine diesel engines.
Kurgan 55°26'N.; 65°18'E.	Kurgan Machine Construction Plant (KMZ).	AT–59 medium prime mover	Estimated 1966 production: 1,200 prime movers.
Kutaisi 42°15'N.; 42°40'E.	Kutaisi Motor Vehicle Plant (KAZ).	BTR–60p amphibious armored personnel carrier (and modifications) probably made here.	Estimated 1966 production: 2,000 BTR–60p's. This factory does experimental work on vehicles similar to the BTR–60p. See FIGURE 79 for additional information on this plant.
Leningrad 59°55'N.; 30°15'E.	Leningrad Kirov Machine Building Plant.	BTR–50p armored amphibious personnel carrier and modifications, snow vehicles, and probably amphibious chassis for free rocket launchers.	Estimated 1966 production: 500 BTR–50p's. See FIGURE 55 for tractor production.
Moscow 55°45'N.; 37°35'E.	Moscow Motor Vehicle Plant *imeni* Likhachev (ZIL).	Makes chassis for the BAV–485, 6 x 6 amphibious truck. May make the complete vehicle.	Estimated 1966 production: 700 BAV–485. Bodies are fitted either here or at Mytishchi Machine Building Plant in the Moscow suburb. See FIGURE 79 for other details on this plant.
Mytishchi 55°55'N.; 37°46'E.	Mytishchi Machine Building Plant (MMZ).	K–61 tracked amphibious troop/cargo carrier.	Estimated 1966 production: 1,000 K–61. See FIGURE 79 for additional information on this plant.
Nizhniy Tagil 57°55'N.; 59°57'E.	Ural Railroad Car Plant No. 183.	T–62 medium tank	Estimated 1966 production: 1,000 T–62's. Research and development center for medium tanks.
Omsk 55°00'N.; 73°24'E.	Railroad Repair and Tank Plant No. 174 *imeni* Voroshilov.	T–55 medium tank	Estimated 1966 production: 600 T–55's. Plant formerly produced the ZSU–57–2 self-propelled antiaircraft gun.
Volgograd 48°45'N.; 44°25'E.	Volgograd Tractor Plant	PT–76 light amphibious tanks	Estimated 1966 production: 400 PT–76's. See FIGURE 58 for additional information.
Yaroslavl' Motor Plant. 57°37'N.; 39°52'E.	Yaroslavl' Motor Plant	AT–L light prime mover. Also makes engines for trucks and tractors.	Estimated 1966 production: 500 AT–L's.

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Approved For Release 2008/09/08 : CIA-RDP08S01350R000100030002-2

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Figure 81. ESTIMATED PRODUCTION OF AIRCRAFT, BY TYPE
(*Units*)

TYPE	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966
Grand total*	4,525	3,200	2,750	2,950	2,650	2,200	1,500	1,800	1,700	1,850
Bombers	400	250	100	100	75	65	90	155	115	95
Heavy	40	25	58	43	19	12	12	12	12	12
Medium	300	200	25	8	10	25	45	40	45	45
Light/attack	20	0	0	25	35	30	35	105	60	40
Patrol	35	30	10	10	15	0	0	0	5	10
Fighters	1,700	650	400	600	650	800	700	900	900	1,000
Transports	800	600	575	575	525	350	275	275	325	400
Heavy	1	2	6	6	6	8	6	3	2	5
Medium	35	170	265	260	205	245	230	235	220	135
Light	475	130	0	1	4	10	35	35	55	85
Small	300	300	300	300	300	100	0	5	40	180
Trainers	725	550	350	350	350	200	15	40	50	50
Reconnaissance**	0	5	40	60	60	60	25	35	15	0
Helicopters	550	750	950	1,000	1,000	700	375	375	300	235
Comm./utility	350	375	350	250						

* To preclude misinterpretation of the degree of accuracy feasible, data have been rounded and totals shown may not equal the sum of their components.

** Includes only those aircraft whose primary design function is reconnaissance. Reconnaissance versions of operational bomber and fighter-type aircraft are included in those respective categories.

Approved For Release 2008/09/08 : CIA-RDP08S01350R000100030002-2

Approved For Release 2008/09/08 : CIA-RDP08S01350R000100030002-2

FIGURE 82. ESTIMATED PRODUCTION OF SELECTED AIRCRAFT NOT IN PRODUCTION AFTER 1961

TYPE	DATES OF PRODUCTION	CUMULATIVE TOTAL
Bombers:		
BEAST	1946–49	2,150
BAT	1946–50	3,030
BOSUN	1950–53	360
BULL	1947–53	1,810
BEAGLE	1949–57	5,285
BADGER	1953–59	1,480
BISON	1953–61	170
MALLOW	1958–61	40
MADGE	1952–58	220
Fighters:		
FRITZ/FANG	1946–51	2,670
FEATHER	1947–49	610
FANTAIL	1948–49	120
FAGOT	1948–53	12,510
FLORA	1949–51	930
FRESCO	1952–57	12,850
FARMER	1954–58	1,860
FLASHLIGHT	1954–57	550
Transports:		
CAB	1940–53	5,000
COACH	1946–49	500
CRATE	1953–58	1,130
CAMEL A	1956–60	110
CAMEL B	1958–60	95
CAT	1958–60	110
CAMP	1958–61	200
Trainers:		
MIDGET	1949–58	3,700
MOOSE	1947–55	4,000
Helicopters:		
HAT	1957–59	150
HOG	1958–61	370
HORSE	1957–61	115
Comm./utility:		
CREEK	1954–60	2,000

Approved For Release 2008/09/08 : CIA-RDP08S01350R000100030002-2

Approved For Release 2008/09/08 : CIA-RDP08S01350R000100030002-2

Figure 83. AIRFRAME PLANTS

Plant and number	Location °'N.	Location °'E.	Floorspace 1,000 sq. ft.	Floorspace Percent of total	Product	Remarks
Arsenyev Airframe Plant 116	44 09	133 15	1,400	2.3	Clod	Also involved in missile production.
Gor'kiy Airframe Plant 21	56 20	43 52	2,800	5.2	Fishbed	
Irkutsk Airframe Plant 39	52 22	104 12	2,400	4.4	Brewer	Little evidence of the current status of activity.
Kazan Airframe Plant 22	55 52	49 07	3,400	6.3	Blinder Classic	Production of Blinder B estimated to have started in 1966. Classic series production started in 1966.
Kazan Airframe Plant 387A	55 48	49 03	1,450	2.7	Hound	Hound production rate is decreasing.
Kazan Airframe Plant 387B	55 51	49 02			Hip	
Kharkov Airframe Plant 135	50 02	36 16	1,450	2.7	Crusty	Production was expected to reach one per month by fall 1967. Cookpot production ended in 1966.
Kiev Airframe Plant 473	50 28	30 23	2,150	4.0	Coke	
Komsomolsk Airframe Plant 126	50 35	137 06	3,050	5.4	Fitter	Also involved in missile production.
Kuybyshev Airframe Plant 18	53 13	50 18	3,450	6.4	Bear	Cleat production ended in 1965; however, a few more Cleats may be produced.
Leningrad Airframe Plant 272/458	59 59	30 18	1,150	1.8	Unknown	May have produced a few preseries Magnum/Mantis aircraft in 1961–62.
Moscow Airframe Plant 23	55 45	37 29	3,900	5.9	Hook	
Moscow Airframe Plant 464	55 56	37 31	700	1.3	An–2M	
Moscow Airframe Plant 30	55 47	37 33	3,500	6.6	Coot Fishbed Mongol	Production of the May, an ASW model of the Coot, was expected to start sometime in 1967.
Novosibirsk Airframe Plant 153	55 04	82 59	3,550	6.6	Firebar	
Omsk Airframe Plant 166	54 57	73 26	2,550	4.7	Unknown	
Orenburg Airframe Plant 47	51 48	55 08	2,150	4.0	Unknown	Product unknown. May be involved in missile production.
Rostov Airframe Plant 168	47 15	39 43	1,550	2.2	Hook Harke	
Saratov Airframe Plant 292	51 30	45 57	2,350	4.3	Unknown	Production of Mangrove ended in 1963. Also involved in missile production.
Taganrog Airframe Plant 86	47 12	38 52	2,200	4.1	Mail	
Tashkent Airframe Plant 84A	41 20	69 16	3,900	7.0	Cub	
Tashkent Airframe Plant 84B	41 18	69 19			Cock	Cock series production started in 1966.
Tbilisi Airframe Plant 31	41 40	44 53	1,750	3.2	Mongol	Also involved in missile production.
Ulan Ude Airframe Plant 99	51 51	107 44	1,400	2.9	Unknown	Mandrake production ended 1965.
Voronezh Airframe Plant 64	51 38	39 15	3,250	6.0	Fiddler Cub	Cub phased out in early 1966.

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FIGURE 84. AIRCRAFT ENGINE PLANTS

PLANT AND NUMBER	LOCATION		FLOORSPACE		PRODUCT	REMARKS
			Million sq. ft.	Percent of total		
	° ′N.	° ′E.				
Kazan Aircraft Engine Plant 16	55 51	49 07	2.7	*8.9*	RD–3M	Replacement production; possibly producing the BLINDER engine.
Kuybyshev Aircraft Engine Plant 24	53 12	50 16	3.3	*10.9*	NK–8	Probably minimum production of the NK–8.
					NK–12MV	Probable NK–144 SST engine prototype production.
Leningrad Aircraft Engine Plant 466	59 59	30 22	1.0 (both plants)	*3.3* (both plants)	VK–1	Replacement production.
					RD–9B	*Do.*
Leningrad Aircraft Engine Plant 117	59 59	30 20				
Moscow Aircraft Engine Plant 45	55 46	37 43	2.2	*7.3*	Type 31F	
					AL–7RV	Possibly phased out of production.
Moscow Aircraft Engine Plant 500	55 50	37 27	2.0	*6.6*	R–11F2–300	
					AM–5	
Omsk Aircraft Engine Plant 29	54 57	73 26	3.2	*10.6*	ASh–82T	
					ASh–82V	
Perm Aircraft Engine Plant 19	57 59	56 15	3.8	*12.6*	D–20P	
					D–20P–R125	
					D–25 (TV–2VM)	
					TB–2–117	
					AI–20M	
Rybinsk Aircraft Engine Plant 36	58 03	38 49	2.7	*8.9*	Type 31F	May be producing BLINDER engine.
Ufa Aircraft Engine Plant 26A	54 48	56 07	4.3 (both plants)	*14.2* (both plants)	RD–9B	
					R–11F2–300	
Ufa Aircraft Engine Plant 26B	54 48	56 04				
Voronezh Aircraft Engine Plant 154	51 40	39 11	2.8	*9.3*	AI–14RF	
					ASH–62IR	
Zaporozhye Aircraft Engine Plant 478	47 50	35 12	2.2	*7.3*	AI–20M	
					AI–24	
					AI–26V	

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Figure 85. MERCHANT VESSEL COMPLETIONS BY OTHER COMMUNIST COUNTRIES FOR THE U.S.S.R.

Country and building period	Type of vessel: Cargo and/or passenger			Tanker			Special types			Total		
	Number	g.r.t.	d.w.t.	Number	g.r.t.	d.w.t.	Number	g.r.t.	d.w.t.	Number	g.r.t.	d.w.t.
Bulgaria, 1951–67	13	13,000	2,600	24	89,841	139,200	0	....	....	37	102,841	141,800
East Germany, 1949–67	149	783,048	816,000	0	....	....	*1,036	564,963	315,200	1,185	1,348,011	1,131,200
Hungary, 1946–67	148	178,250	177,700	0	....	....	0	....	....	148	178,250	177,700
Poland, 1950–67	239	1,063,274	1,345,200	12	87,306	122,100	**169	431,693	308,200	420	1,582,275	1,775,500
Rumania, 1963–67	8	24,741	30,900	0	....	....	0	....	....	8	24,741	30,900
Yugoslavia, 1964–67	10	112,870	142,000	15	228,750	312,000	0	....	....	25	341,620	454,000
Total	567	2,175,183	2,514,400	51	405,897	573,300	1,205	996,656	623,400	1,823	3,577,736	3,711,100

* Includes 932 trawlers under 1,000 g.r.t. in size, totaling 305,828 g.r.t./168,100 d.w.t.

** Includes 121 trawlers under 1,000 g.r.t. in size, totaling 80,270 g.r.t./57,200 d.w.t.

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FIGURE 86. PRINCIPAL SURFACE COMBATANT VESSEL AND SUBMARINE COMPLETIONS*

TYPE OF VESSEL	CLASS	DURATION OF PROGRAM	NUMBER OF VESSELS COMPLETED	WHERE BUILT	REMARKS
Guided missile frigate	*Kashin*	1964–	10	Leningrad, Nikolayev	Equipped with SAM and powered by gas turbines.
Do	*Kynda*	1962–65	4	Leningrad	Equipped with SSM–SAM.
Guided missile destroyer	*Krupnyy*	1959–61	8	Leningrad, Nikolayev, Komsomolsk.	
Do	*Kildin*	1958	4	*do*	
Destroyer	*Kotlin*	1954–58	27	*do*	
Destroyer escort	*Riga*	1952–58	64	Kaliningrad, Nikolayev, Komsomolsk.	
Escort submarine chaser	*Petya*	1960–	25	Kaliningrad, Khabarovsk, Sevastopol.	Combined diesel and gas turbine propulsion.
Do	*Mirka*	1963–	18	Kaliningrad	
Long-range attack submarine	F	1958–	45	Leningrad	
Medium-range attack submarine.	R	1958–62	20	Sevastopol, Severodvinsk	
Cruise missile diesel submarine	J	1963	12	Leningrad, Gor'kiy	
Ballistic missile diesel submarine	G	1958–62	23	Severodvinsk, Komsomolsk	
Nuclear attack submarine	N	1958	15	Severodvinsk	
Cruise missile nuclear submarine	E	1960–	29	Komsomolsk, Severodvinsk	
Ballistic missile nuclear submarine.	H	1959–62	7	Severodvinsk	

* Excludes minor warfare combatants such as subchasers, motor torpedo boats, guided missile patrol boats, mine warfare types, support ships, and other small craft.

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FIGURE 87. ESTIMATED PRODUCTION OF EXPLOSIVES, 1966*
(*Metric tons*)

TYPES	QUANTITY
Military high explosives**	101,900
Trinitrotoluene	43,100
RDX	39,600
Ammonium nitrate	16,000
Other***	3,200
Propellants**	267,600
Single-base	133,800
Nitrocellulose	127,800
Other***	6,000
Double-base	26,700
Nitrocellulose	16,000
Nitroglycerin	7,200
Other***	3,500
Total for military high explosives and propellants.	396,200
Industrial explosives:	
Dynamites	84,100
Nitroglycerin	52,200
Potassium nitrate†	22,700
Nitrocellulose	2,500
Other***	6,700
Ammonites	84,100
Ammonium nitrate	66,400
Trinitrotoluene	17,700
Bellites	16,800
Ammonium nitrate	11,300
Dinitrobenzene	4,800
Trinitroxylene	700
Total for industrial explosives	185,000
Grand total for all explosives	581,200

* Roughly equivalent to consumption because imports, exports and stockpiling are negligible.

** The products listed may be used directly as explosives or as input materials in making other explosives.

*** Nonexplosive fillers.

† Probably includes some sodium nitrate.

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FIGURE 88. ESTIMATED CONSUMPTION OF EXPLOSIVES RAW MATERIALS, 1966
(*Metric tons*)

CATEGORY	AMMONIA	NITRIC ACID	SULFURIC ACID	GLYCERIN	COTTON	TOLUENE	BENZENE
Propellants	*61,400 to 68,900	*209,000 to 235,300	*105,600 to 154,700	4,400	**133,200	......	....
Military high explosives	53,400	93,600	***1,800 to 13,100	......	....	23,100	....
Industrial explosives	74,300	130,800	2,100	22,200	1,500	8,500	2,900
Total	189,100 to 196,600	433,400 to 459,700	109,500 to 169,900	26,600	134,700	31,600	2,900

* Depending on whether cotton linters or wood pulp is used to produce nitrocellulose.

** Maximum input, if all nitrocellulose had been produced from cotton linters; actual figure is lower since some woodpulp is known to have been used.

*** Depending on process used to produce cyclonite (RDX).

FIGURE 89. MAJOR PRODUCERS OF INTERMEDIATES, EXPLOSIVES, AND PROPELLANTS, 1966

LOCATION	PLANT NAME	CHIEF PRODUCTS	REMARKS
Aleksin 54°31'N.; 37°05'E.	Aleksin Chemical Combine No. 100.	TNT, picric acid, propellants, nitroglycerin, and probably nitrocellulose.	Capacity estimated at 17,000 metric tons of all types of explosives. Estimated 1966 production, 2,000 metric tons of high explosives and 6,000 metric tons of propellants.
Berezniki 59°24'N.; 56°46'E.	Voroshilov Bereniki Chemical Combine.	TNT, thermite, picric acid, ecrasite, cresylite, possibly nitrocellulose and nitroglycerin.	Capacity estimated at 40,000 metric tons of all types of explosives. Estimated 1966 production, 5,500 metric tons of high explosives and 6,600 metric tons of propellants. Some intermediates may be sent to Kirov Chemical Combine No. K98 at Kakamsk.
Chapayevsk 52°58'N.; 49°41'E.	Plants No. 15 and 309	Picric acid, PETN, RDX, TNT, tetryl, lead azide, mercury fulminate, propellants, nitrocellulose, nitroglycerin, and nitrobenzene.	Capacity is estimated at 26,000 metric tons for all types of explosives. Estimated 1966 production, 4,000 metric tons of high explosives and 4,500 metric tons of propellants. It is believed that Plant No. 15 is producing explosives and filling ammunition. Plant No. 309 is producing mercury fulminate and lead azide, priming and detonating compositions, and is loading primers and detonators.
Chelyabinsk 55°10'N.; 61°24'E.	Plant No. 254	TNT, tetryl, black powder, propellants (probably single-base), nitrocellulose and nitroglycerin.	Productive capacity estimated at 40,000 metric tons for all types of explosives. Estimated 1966 production, 9,400 metric tons of high explosives and 7,500 metric tons of propellants.
Dolinskoye 49°40'N.; 72°42'E.	....*na*	Industrial explosives, military high explosives, and possibly propellants.	Capacity estimated at 19,000 metric tons for all types of explosives. Estimated 1966 production, 1,500 metric tons of high explosives and 6,300 metric tons of propellants.
Donetsk 48°00'N.; 37°48'E.	Plant No. 107	High explosives and propellants.	Capacity estimated at 9,000 metric tons for all types of explosives. Estimated 1966 production, 1,000 metric tons of high explosives and 2,000 metric tons of propellants.
Dzerzhinsk 56°14'N.; 43°32'E.	Explosives and Chemical Plant.	TNT, tetryl, RDX, PETN, picric acid, nitrobenzene, black powder, propellants, nitrocellulose, and ammonal.	Capacity estimated at 40,000 tons for all types of explosives; 1966 production, 1,200 tons of high explosives and 8,500 metric tons of propellants.
Fedorovka 48°13'N.; 38°58'E.	Petrovskiy Plant No. 59	Black powder, propellants, nitrocellulose, nitroglycerin, nitronaphthalene, dynamites, and possibly TNT.	Capacity estimated at 15,000 metric tons for all types of explosives; 1966 production, 300 metric tons of high explosives and 5,000 metric tons of propellants.

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FIGURE 89. MAJOR PRODUCERS OF INTERMEDIATES, EXPLOSIVES, AND PROPELLANTS, 1966 *(Continued)*

LOCATION	PLANT NAME	CHIEF PRODUCTS	REMARKS
Gorlovka 48°18′N.; 38°03′E.	Plant No. 64	TNT, ammonites, and possibly RDX and PETN.	Capacity estimated at 18,000 metric tons of high explosives. Estimated 1966 production, 5,000 metric tons of high explosives.
Kamensk-Shakhtinskiy 48°21′N.; 40°19′E.	Chemical Combine No. 101	Propellants, nitroglycerin, nitrocellulose, and possibly high explosives.	Capacity estimated at 55,000 tons for all types of explosives and 5,000 tons of nitroglycerin. Estimated 1966 production, 8,000 metric tons of high explosives and 10,600 metric tons of propellants.
Kazan′ 55°45′N.; 49°08′E.	Plant No. 673	TNT, RDX, PETN, mercury fulminate, propellants, nitrocellulose, nitroglycerin, and black powder.	Capacity estimated at 35,000 metric tons for all types of explosives. Estimated 1966 production, 1,500 metric tons of high explosives and 16,000 metric tons of propellants.
Kemerovo 55°20′N.; 86°05′E.	"Rocket" Plant No. 392	TNT, mercury fulminate, black powder and ammonium nitrate mixtures, propellants, nitrocellulose, and nitroglycerin.	Capacity estimated at 35,000 metric tons for all types of explosives; 1966 production, 5,000 metric tons of high explosives and 5,500 metric tons of propellants.
Krasnoyarsk 56°01′N.; 92°50′E.	Zlobino Explosives Plant	Black powder and propellants	Capacity estimated at 10,000 metric tons of propellants; 1966 production estimated at 6,000 metric tons.
Leningrad 59°55′N.; 30°15′E.	Okhta Chemical Combine	TNT, black powder, propellants, nitrocellulose, industrial explosives, and percussion caps.	Capacity estimated at 96,000 metric tons for all types of explosives; 1966 production, 15,500 metric tons of high explosives and 30,000 metric tons of propellants. Combine is located in several different sections of Leningrad.
Nizhniy Tagil 57°55′N.; 59°57′E.	Ammunition Loading Plant No. 56.	High explosives and propellants.	Capacity estimated at 17,000 tons for all explosives. Estimated 1966 production, 500 metric tons of high explosives and 5,500 metric tons propellants.
Pavlograd 48°31′N.; 35°52′E.	Plant No. 55	TNT, propellants, nitrocellulose for rocket launchers, and antitank weapons.	Capacity estimated at 10,000 metric tons. Estimated 1966 production, 1,000 metric tons of high explosives and 3,000 metric tons of propellants.
Rezh 57°23′N.; 61°24′E.	Rezh Explosives Plant	Propellants and black powder	Capacity estimated at 15,000 metric tons for all types of explosives; 1966 production, 1,500 metric tons of high explosives and 4,500 metric tons of propellants.
Roshal′ 55°40′N.; 39°51′E.	Kosyakov Chemical Plant No. 14.	Propellants	Capacity estimated at 20,000 metric tons; estimated 1966 production, 9,000 metric tons.
Sel′tso 53°22′N.; 34°06′E.	Plant No. 121	Propellants, picric acid, and ammonites.	Capacity estimated at 10,000 metric tons for all types of explosives. Estimated 1966 production, 4,000 metric tons of propellants.
Solikamsk 59°39′N.; 56°46′E.	Solikamsk Explosives Plant	Propellants	Capacity estimated at 10,000 metric tons. Estimated 1966 production, 4,000 metric tons of propellants.
Tambov 52°43′N.; 41°27′E.	Kotovsk "Red Bolshevik" Chemical and Explosives Plant No. 204.	Propellants, nitrocellulose, nitroglycerin, and dynamites.	Capacity estimated at 25,000 metric tons for all types of explosives; 1966 production, 3,000 metric tons of propellants.
Zakamsk 57°59′N.; 55°57′E.	Kirov Combine No. K98	TNT, propellants, nitrocellulose, nitroglycerin, and black powder.	Capacity estimated 88,000 tons for all types of explosives; 1966 production, 14,500 tons of high explosives and 16,000 tons of propellants. Plant is divided into seven areas.

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FIGURE 90. PRODUCERS OF AMMUNITION AND MAJOR COMPONENTS, 1966

LOCATION	NAME	CHIEF PRODUCTS AND REMARKS
Barnaul, 53°22'N.; 83°45'E.	Plant No. 17	Small-arms ammunition.
Buzhaninovo, 56°24'N.; 38°18'E.	Plant No. 11	Important producer of hand grenades, fuzes, and rockets.
Chapayevsk, 52°58'N.; 49°41'E.	Plant No. 15	Filling of artillery shells and production of fuzes.
Chelyabinsk, 55°10'N.; 61°24'E.	Plant No. 254	Hand grenades.
Donetsk, 48°00'N.; 37°48'E.	Plant No. 107	Filling of bombs, artillery, and mortar shells.
Dzerzhinsk, 56°14'N.; 43°32'E.	Plant No. 80	One of the most important plants for filling of artillery shells, mortar shells, and bombs.
Frunze, 42°54'N.; 74°36'E.	Plant No. 60	Small-arms ammunition.
Karaganda, 49°50'N.; 73°10'E.		Filling of mines, bombs, and rockets.
Kemerovo, 55°20'N.; 86°05'E.	Plant No. 606	Aircraft ammunition and primers for artillery ammunition.
Do	"Rocket" Plant No. 392	Filling of artillery shells, mines, bombs, and rockets.
Kopeysk, 55°07'N.; 61°37'E.	Plant No. 114	Loading of artillery and mortar shells.
Leningrad, 59°55'N.; 30°15'E.	Plant No. 522	Filling of artillery ammunition.
Lugansk, 48°34'N.; 39°20'E.	Plant No. 270	Small-arms ammunition.
Lyubertsy, 55°41'N.; 37°51'E.	Plant No. 711	*Do.*
Nizhniy Tagil, 57°55'N.; 59°57'E.	Plant No. 56	Filling of artillery shells, mortar shells, and rockets.
Novosibirsk, 55°02'N.; 82°55'E.	Plant No. 188	Small-arms ammunition.
Do	Combine No. 179	Artillery shells and rocket bodies. Largest shell plant in eastern and western Siberia.
Omsk, 55°00'N.; 73°24'E.	Plant No. 513	Aircraft ammunition.
Perm', 58°00'N.; 56°15'E.	Combine K98	One of the largest explosives enterprises in the U.S.S.R. Fills bombs and artillery shells.
Rezh, 57°23'N.; 61°24'E.	Plant No. 552	Manufacture and loading of grenades. Built since World War II.
Sel'tso, 53°22'N.; 34°06'E.	Plant No. 121	Loading of mortar, artillery, and rocket shells.
Tula, 54°12'N.; 37°37'E.	Plant No. 176	Important producer of artillery cartridge cases.
Ul'yanovsk, 54°20'N.; 48°24'E.	Plant No. 3	Small-arms ammunition.
Verkhnyaya Tura, 58°22'N.; 59°49'E.	Plant No. 72	Antisubmarine rockets, mortar, and artillery shells.
Yuryuzan, 54°52'N.; 58°26'E.	Plant No. 38	Small-arms ammunition.
Zelenodolsk, 55°51'N.; 48°33'E.	Plant No. 184	Aircraft ammunition and artillery cartridge cases.

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FIGURE 91. PRODUCERS OF INFANTRY WEAPONS, 1966*

LOCATION	NAME	CHIEF PRODUCTS	REMARKS
Izhevsk............. 56°51′N.; 53°14′E.	Plant No. 74...........	7.62-mm assault rifles...	Supplies rifle components to Plant No. 622 at Tula. Has produced meteorological rockets. Estimated 1966 production, 150,000 rifles.
Do...........	Plant No. 524..........	7.62-mm machineguns...	Estimated 1966 production, 3,000 7.62-mm machineguns.
Kovrov............. 56°25′N.; 41°18′E.	Small Arms Plant No. 2 (*imeni Degtyarev*).	....*do*................	Estimated 1966 production, 32,500 machineguns.
Kuybyshev......... 53°12′N.; 50°09′E.	Small Arms Plant No. 525 (*Kuybyshevskiy*).	....*do*................	Estimated 1966 production is 3,000 machineguns.
Tula............... 54°12′N.; 37°37′E.	Plant No. 536..........	7.62-mm assault rifles...	Estimated 1966 production, 40,000 rifles. Also produces sporting rifles.
Do...........	Plant No. 622..........	Produces and assembles 7.62-mm assault rifles.	Receives rifle components from Plant No. 74 at Izhevsk. Estimated 1966 production, 40,000 rifles.

* Although none of these plants has been identified as producing infantry antitank weapons (the RPG-2, RPG-7, SPG-82, B-10, and B-11), some or all may have produced or be producing them.

FIGURE 92. PRODUCERS OF ARTILLERY, 1966

LOCATION	PLANT NAME	PRODUCTS	REMARKS
Perm'.............. 58°00′N.; 56°15′E.	Armament Plant No. 172..	122-mm howitzer.....	One of the oldest and largest artillery plants. Estimated 1966 production, 500 122-mm howitzers. May be involved in missile program.
Sverdlovsk.......... 56°51′N.; 60°36′E.	Plant No. 9..............	122-mm howitzer and ASU-85s.	At one time part of Uralmash. Has made a variety of field guns. Estimated 1966 production, 300 122-mm howitzers and 95 ASU-85s.
Tula............... 54°12′N.; 37°37′E.	Plant 535................	Light artillery; probably makes new 23-mm ZU-23 antiaircraft gun.	Also has made mortars and aircraft guns. Estimated 1966 production, 400 23-mm ZU-23, and output is expected to increase.
Yurga.............. 55°42′N.; 84°51′E.	Armament Plant No. 75...	122-mm howitzer.....	Has made a variety of field guns. Estimated 1966 production, 200 pieces.

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FIGURE 93. PRODUCTION OF MISSILES, BY MODEL

SYSTEM	CUMULATIVE PRODUCTION THROUGH 1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	TOTAL CUMULATIVE PRODUCTION
Surface-to-Surface:												
Ballistic												
SS-1 (SCUD) and variants	1,000	150	200	300	200	140	240	240	240	240	240	3,190
SS-2 (SIBLING)	630	100	...	...	...	...	...	...	...	...	...	730
SS-3 (SHYSTER) / SS-4 (SANDAL)	100	250	360	360	360	360	310	...	...	...	...	2,100
SS-5 (SKEAN)	...	...	...	...	25	50	85	120	30	...	...	310
SS-6	...	5	15	35	50	50	45	...	...	...	...	200
SS-7 (SADDLER)	...	...	...	...	10	50	150	180	160	50	...	600
SS-8 (SASIN)	...	...	...	...	5	20	20	25	25	5	...	100
SS-9	...	...	...	...	...	...	5	10	25	35	60	135
SS-10	...	...	...	...	...	...	...	5	10	45	...	60
SS-11	...	...	...	...	...	...	...	...	5	45	150	200
SS-12	...	...	...	...	...	...	...	5	20	45	80	150
SS-X-1 (SCAMP)	...	...	...	...	...	...	...	...	...	...	...	*
SS-X-2 (SCROOGE)	...	...	...	...	...	...	...	...	...	...	...	*
SS-X-3 (SAVAGE)	...	...	...	...	...	...	...	...	...	...	...	**
Naval												
SS-N-1	13	37	70	115	150	150	150	75	...	...	...	760
SS-N-2 (STYX)	10	40	125	225	225	225	225	225	225	170	170	1,865
SS-N-3/SSC-1 (SHADDOCK)	...	5	20	30	40	240	360	360	360	360	360	2,135
SS-N-4	...	10	20	40	70	110	120	120	30	...	...	520
SS-N-5	...	...	...	...	...	10	30	35	35	35	35	180
SS-NX-1 (SARK)	...	...	...	...	...	...	...	...	...	...	...	*
SS-NX-2 (SERB)	...	...	...	...	...	...	...	...	...	...	...	*
Cruise												
SSC-1 (SHADDOCK)	(See Naval—SS-N-3/variants)											
SSC-2a (SALISH)	10	50	230	250	250	250	250	110	...	...	...	1,400
SSC-2b (SAMLET)	75	100	200	300	300	250	185	...	...	...	...	1,400
Antitank												
AT-1 (SNAPPER)	...	...	...	...	...	...	...	...	...	...	...	40,000
AT-2 (SWATTER)	...	...	...	...	...	...	...	...	...	...	...	150,000
AT-3 (SAGGER)	...	...	...	...	...	...	...	...	...	...	...	50,000
Air-to-Surface***												
AS-1 (KENNEL)	100	90	90	90	40	20	40	60	80	100	100	810
AS-2 (KIPPER)	...	10	30	60	90	90	90	90	60	60	40	620
AS-3 (KANGAROO)	...	10	20	30	30	30	30	30	30	30	30	270
AS-4 (KITCHEN)	...	...	...	...	...	...	...	...	...	...	...	*

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Defensive:													
Surface-to-air													
SA-1 (GUILD)	16,800	....	....	....	....	....	....	....	....	....	....	16,800	
SA-2 (GUIDELINE)	....	1,000	5,200	7,650	7,300	7,800	5,800	7,800	7,400	6,800	4,000	....	
"S" Band	....	(1,000)	(5,200)	(7,650)	(7,200)	(3,000)	(1,000)	(1,000)	(600)	....	....	(26,650)	
SA-2 (GUIDELINE)	....	....	....	....	....	....	....	....	....	....	....	....	60,750
"C" Band/SA-N-2	....	....	....	....	(100)	(4,800)	(4,800)	(6,800)	(6,800)	(6,800)	(4,000)	(34,100)	
SA-3 (GOA)/SA-N-1	4	21	65	310	1,450	1,450	1,500	1,150	1,100	1,000	750	8,800	
SA-4 (GANEF)	....	....	....	....	....	....	....	....	....	R & D	400	400+	R & D
GRIFFON	....	....	....	....	....	....	....	....	....	....	....	....	
TALLINN Missile (SA-5)	....	....	....	....	....	10	15	100	150	500	1,000	1,775	
Antimissile													
ABM-X-1	....	....	....	....	....	....	....	....	....	....	....	*	
ABM-X-2 (GALOSH)	....	....	....	....	....	....	....	....	....	....	84	84	
SA-2 (GUIDELINE)	100	600	2,400	6,000	9,000	8,400	8,600	7,400	7,200	7,200	7,200	64,100	
Air-to-air													
AA-1 (ALKALI)	....	....	....	....	....	....	....	....	....	....	....	*na*	
AA-2 (ATOLL)	....	....	....	....	....	....	....	....	....	....	....	*na*	
AA-3 (ANAB)	....	....	....	....	....	....	....	....	....	....	....	*na*	
AA-4 (AWL)	....	....	....	....	....	....	....	....	....	....	....	*na*	
AA-5 (ASH)	....	....	....	....	....	....	....	....	....	....	....	*na*	

* No series production, but an unknown quantity of R&D models has been produced.

** It has been estimated that the SAVAGE equates to the KY-5/6 vehicle. If this is so, then about 10 R&D models have been produced.

*** There is no firm evidence of ASM production.

Approved For Release 2008/09/08 : CIA-RDP08S01350R000100030002-2
Approved For Release 2008/09/08 : CIA-RDP08S01350R000100030002-2

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FIGURE 94. MISSILE AIRFRAME ASSEMBLY PLANTS

PLANT NAME	COORDINATES		PRODUCT	REMARKS
	° ′N.	° ′E.		
Arsenyev Airframe Plant 116....	44 08	133 15	STYX (SS–N–2)...............	Also engaged in aircraft production.
Dnepropetrovsk Missile Development and Production Center (DMDPC).	48 26	34 59	SCUD A (SS–1b), SCUD B (SS–1c), SHYSTER (SS–3), SANDAL (SS–4), SKEAN (SS–5), SADDLER (SS–7), SS–9, SS–12, and possibly SS–11.	Main series production facility for ballistic missiles in U.S.S.R. Acts as "lead plant" to farm out series production.
Ivankovskiy Guided Missile Plant.	56 45	37 07	KENNEL (AS–1), possibly SALISH (SSC–2a), possibly SAMLET (SSC–2b).	Probable leading design authority for ASMs.
Komsomolsk Airframe Plant.... Ordzhonikidze 126	50 35	137 05	SS–N–3/SHADDOCK (SSC–1)...	Also engaged in aircraft production.
Leningrad Arms and Tank Plant. Bolshevik 232	59 51	30 28	Possibly SS–N–4, and SS–N–5.	Product association is a tentative assessment.
Moscow Airframe Plant........ Dolgoprudnaya 464	55 55	37 31	Possibly GUIDELINE (SA–2)....	Also engaged in aircraft production. If it produced missiles, that production has now ceased.
Moscow Guided Missile Plant... Tushino 82	55 50	37 27	GUILD (SA–1), GUIDELINE (SA–2), GOA (SA–3/SA–N–1).	Probably the major production facility for SAMs.
Moscow Guided Missile Plant... Reutovo 67	55 45	37 52	SS–N–3/SHADDOCK (SSC–1)...	Probable design center for aerodynamic systems. May be engaged in advanced weapons research and design.
Moscow Missile and Space Development Center. Kaliningrad 88 (MMSDC).	55 55	37 48	SCUNNER (SS–1), SIBLING (SS–2), SS–6, SS–8, and SS–10.	The principal design center for all ballistic missiles. Also design center for space boosters and vehicles. Limited production of all ballistic missiles designed there, as well as series production on those in Column 4.
Saratov Airframe Plant 292.....	51 29	45 57	GUIDELINE (SA–2), GOA (SA–3/SA–N–1), SS–N–3/SHADDOCK (SSC–1).	Also engaged in aircraft production.
Tbilisi Airframe Plant 31.......	41 39	44 52	KIPPER (AS–2), probably KANGAROO (AS–3).	Also engaged in aircraft production. It is unknown if any missile production is still carried on at this facility.
Zlatoust Armament Plant 66.....	55 06	59 42	SCUD B (SS–1c)..............	Acted as a subsidiary of DMDPC on series production of SS–1c and now sole source of supply, if still in production.

Approved For Release 2008/09/08 : CIA-RDP08S01350R000100030002-2

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FIGURE 95. MISSILE ROCKET ENGINE PRODUCTION PLANTS

PLANT NAME	COORDINATES		PRODUCT USED IN:	REMARKS*
	° ′N.	° ′E.		
Liquid engine plants:				
Dnepropetrovsk Missile Development and Production Center (DMDPC).	48 26	34 59	SCUD A (SS-1b), SCUD B (SS-1c), SHYSTER (SS-3), SANDAL (SS-4), SKEAN (SS-5), SADDLER (SS-7), SS-9, possibly SS-11, and SS-12.	Only about 1,000,000 sq. ft. of the total floorspace is estimated to be used for rocket engine production.
Moscow Aircraft Engine Plant 45	55 46	37 43	KANGAROO (AS-3)	
Moscow Missile and Space Development Center Kaliningrad 88 (MMSDC).	55 55	37 48	SCUNNER (SS-1a), SCUD A (SS-1b), SIBLING (SS-2), GUILD (SA-1).	Limited production for models in Column 4. None known since mid-1950's.
Moscow Aircraft Engine Experimental Plant Luznetskaya 300.	55 42	37 34	SS-N-3/SHADDOCK, (SSC-1) and variants.	Floorspace for missile engine production is only a portion of total and cannot be determined.
Moscow Missile and Space Propulsion Development Center Khimki 456 (MMSPDC).	55 54	37 26	SCUD A (SS-1b), SCUD B (SS-1c), R&D on most newer systems.	Limited production for early models of Column 4 items. Current production believed to be all R&D.
Ufa Aircraft Engine Plant 26	54 47	56 04	KIPPER (AS-2)	Floorspace is for both Plants A and B; Plant B occupies approximately half the total area.
Solid propellant production plants:				
Biysk Solid Motor Production Plant.	53 31	85 04	Unknown	
Bryansk Ammunition and Agricultural Machinery Plant Seltso 121.	53 23	34 07	ATOLL (AA-2) motors	
Kamensk-Shakhtinskiy Solid Motor Production Plant.	48 18	40 12	Solid propellant motors/boosters for unspecified missile systems.	
Kemerovo Solid Motor Production Plant.	55 26	85 57	do	
Krasnoyarsk Solid Motor Production Plant.	56 03	93 03	do	
Perm Solid Motor Production Plant.	57 58	55 52	do	
Sterlitamak Solid Motor Production Plant.	53 42	55 57	do	
Unidentified propulsion facilities:				
Faustovo Rocket Engine Test Facility.	55 27	38 31		
Krasnoarmeysk Solid Motor Development Facility.	56 09	38 10		
Krasnoyarsk Rocket Engine Test Facility.	56 06	93 25		
Kurumoch Rocket Engine Test Facility.	53 32	49 51		
Leningrad Solid Motor Test Eacility.	60 12	30 42		
Nizhnyaya Salda Rocket Engine Test Facility.	58 09	60 56		
Omsk Rocket Engine Test Facility, Gornaya Bitiya.	55 25	73 16		
Perm Rocket Engine Test Facility	58 00	56 34		
Ufa Rocket Engine Test Facility	54 59	56 04		
Voronezh Rocket Engine Test Facility.	51 34	39 09		
Zagorsk Rocket Engine Test Facility, Krasnozavodsk.	56 25	38 10		

* All production plants have test facilities colocated with them. Those facilities appearing as unidentified facilities are different and not necessarily associated with entries in liquid engine plants or solid propellant plants.

Approved For Release 2008/09/08 : CIA-RDP08S01350R000100030002-2

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FIGURE 96. SOVIET EXPORTS OF MISSILES

COMMUNIST-ASSOCIATED COUNTRIES

Albania
  Guideline (SA–2)
Bulgaria
  Air-to-air*
  Guideline (SA–2)
  Antitank**
Communist China
  Guideline (SA–2)
  Shyster/Sandal (SS–3/4)
  Samlet (SSC–2b)
Cuba
  Atoll (AA–2)
  Guideline (SA–2)
  Salish (SSC–2a)
  Samlet (SSC–2b)
  Styx (SS–N–2)
  Snapper (AT–1)
Czechoslovakia
  Air-to-air*
  Guideline (SA–2)
  Scud (SS–1)
  Sagger (AT–3)
  Other antitank**
East Germany
  Air-to-air*
  Guideline (SA–2)
  Salish (SSC–2a)
  Samlet (SSC–2b)
  Scud (SS–1)
  Styx (SS–N–2)
  Antitank**
Hungary
  Air-to-air*
  Guideline (SA–2)
  Scud (SS–1)
  Antitank**
Mongolia
  Guideline (SA–2)
North Korea
  Guideline (SA–2)
  Samlet (SSC–2b)
Poland
  Air-to-air*
  Guideline (SA–2)
  Scud (SS–1)
  Styx (SS–N–2)
  Antitank**
Rumania
  Air-to-air*
  Guideline (SA–2)
  Antitank**
North Vietnam
  Guideline (SA–2)
  Samlet (SSC–2b)
Yugoslavia
  Guideline (SA–2)
  Snapper (AT–1)

NON-COMMUNIST COUNTRIES

Afghanistan
  Guideline (SA–2)
  Snapper (AT–1)
Algeria
  Guideline (SA–2)
  Styx (SS–N–2)
Finland
  Atoll (AA–2)
India
  Atoll (AA–2)
  Guideline (SA–2)
Syria
  Guideline (SA–2) (possible)
  Styx (SS–N–2)
Indonesia
  Atoll (AA–2)
  Guideline (SA–2)
  Kennel (AS–1)
  Styx (SS–N–2)
Iraq
  Atoll (AA–2)
  Snapper (AT–1)
United Arab Republic
  Atoll (AA–2)
  Kennel (AS–1)
  Guideline (SA–2)
  Samlet (SSC–2b)
  Styx (SS–N–2)
  Snapper (AT–1)

* The eastern European Communist countries (including East Germany) have all probably received the Atoll (AA–2); earlier deliveries of air-to-air missiles were probably Alkali (AA–1).

** The Snapper (AT–1) was the antitank missile probably delivered by the U.S.S.R., but possibly the Swatter (AT–2) could also have been sent.

Approved For Release 2008/09/08 : CIA-RDP08S01350R000100030002-2

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FIGURE 97. PRODUCERS OF INFRARED, TOPOGRAPHIC, AND MILITARY PRECISION OPTICAL AND PHOTOGRAPHIC EQUIPMENT, 1965

LOCATION	PLANT NAME	PRODUCTS	REMARKS
Derbyshki.......... 55°51'N.; 49°12'E.	Derbyshki Optical Plant No. 237. Also known as Kazan Optical Plant No. 237.	Prism binoculars, rangefinders, tank periscopes, battery commander telescopes, and aerial gun cameras.	Has produced optical glass, lenses, and prisms. Also produces microscopes, motion picture equipment and color film.
Kiev............... 50°26'N.; 30°31'E.	Lenin Arsenal Optical Machinery Plant No. 784. Formerly known as Kiev Arsenal No. 1. (*Opticheskiy Zavod imeni I. Lenin No. 784*).	Prism binoculars, gunsights, cameras; surveying instruments including theodolites.	May support Soviet missile program. Probably makes cinetheodolites and infrared devices. Products include nonmilitary equipment.
Krasnogorsk........ 55°50'N.; 37°20'E.	Krasnogorsk Optical Equipment Plant No. 393. Also called Lenin Optical Works. Formerly known as "Bolshevik" optical Instrument Factory.	Field glasses, telescopes, rangefinders, and periscopes; theodolites; photogrammetric equipment; photographic equipment; night-driving devices, metascopes, alarm devices, sniperscopes, and infrared missile and fire control systems.	One of the largest optical equipment producers; an important research, development, and production center for infrared equipment. Employment about 13,700 in 1960, including about 4,000 in research and development. Probably produces cinetheodolites.
Leningrad........... 59°55'N.; 30°15'E.	State Optical Machinery Plant, No. 349, GOMZ. Also called OGPU Plant. (*Gosudarstvennyy Optichesko-Mekhanicheskiy Zavod 349*).	Periscopes, telescopes, bombsights, gunsights, and rangefinders; cameras for ground and aerial use; transits, stereographs, and aerial mapping equipment. Infrared devices.	Associated with the State Optical Institute (GOI). One of the largest Soviet optical equipment works. May be partially housed in Leningrad Progress Optical Instrument Plant No. 357. Labor force about 12,000. Plant supports space program. Also makes civilian scientific and industrial items.
Minsk.............. 53°54'N.; 27°34'E.	Vavilov Optical-Mechanical Plant.	Field glasses, gunsights, and telescopes.	Plant constructed during 1956–57. Also makes civilian cameras.
Moscow............ 55°45'N.; 37°35'E.	Geophysical Optical Instruments Plant No. 589. Also called Prisma Optical Instrument Plant. (*Zavod "Geofizika"*).	Telescopes, field glasses, rifle and bomb sights; theodolites, transits, automatic altimeters, aerial cameras, vehicle- and head-mounted infrared night-driving devices.	Also makes precision lenses, microscopes and motion picture projectors. Estimated labor force 3,000 to 4,000.
Novosibirsk......... 55°02'N.; 82°55'E.	Lenin Optical Instrument Plant No. 69.	Artillery rangefinders, artillery sights, telescopic gunsights, and field glasses; lens systems; phototheodolites.	Production probably includes cinetheodolites. Labor force about 3,000.
Zagorsk............. 56°18'N.; 38°08'E.	Optical and Mechanical Plant, ZOMZ, No. 355 (*Optichesko Mehanicheskiy Zavod 355*).	Field glasses, panoramic telescopes, artillery rangefinders and gun sights, periscopes including submarine devices. Infrared night-driving and airborne detecting equipment.	Probably supports the missile and space program. Estimated labor force 6,000.

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FIGURE 98. MAJOR PRODUCERS OF INSTRUMENTS, GAGES, AND SERVOMOTORS OF SPECIAL MILITARY INTEREST, 1965

LOCATION	PLANT NAME	PRODUCTS	REMARKS
Chelyabinsk......... 55°10′N.; 61°24′E.	Electrical Equipment Plant No. 255.	Produces generators, starters, and other electrical components for tanks and aircraft.	Possibly produces servomotors.
Kemerovo.......... 55°20′N.; 86°05′E.	Electric Machinery Plant No. 652. Also called Kuzbas Electro-Motor Plant.	Produces electric motors for the mining industry, motors for tank turret traverse, traverse of heavy coastal fortifications, and submarine use.	*Do.*
Kiev............... 50°26′N.; 30°31′E.	Electrical Precision Instrument Plant.	Complex electrical measuring and high precision instruments.	
Leningrad........... 59°55′N.; 30°15′E.	Measuring Equipment Manufacturing Plant.	Measuring instruments and gages...	Makes about 400 different items. Labor force about 2,000 (1963).
Do...........	Optical Instrument Plant No. 218. Also called Pyrometer Plant (*Zavod "Pirometr"*).	Electro-optical pyrometers, potentiometers, periscopes, and aircraft instruments.	
Do...........	Vibrator Plant (*Zavod "Vibrator"*).	Electric meters, gages, measuring instruments, fire-control equipment, electrical steering devices, and testing equipment.	Probably most important meter plant in the U.S.S.R. Estimated factory area about 35,000 square meters; labor force about 4,000 (1963).
Do...........	Hydro-Meteorological Instrument Plant (*Gidrometpribor*).	Meteorological instruments, aircraft compasses, altimeters, horizon indicators, ship compasses, gyrocompasses, and depth-sounding devices.	Reported to be a modern and well-equipped plant.
Do...........	Kirov "Electric Power" Machine Building Plant No. 38.	Synchronous motors, transformers, switches, measuring instruments, regulators, rheostats, and relay boxes. Produces turbogenerators, nautical electric motors, and high-speed synchronous and asynchronous motors.	Foremost producer of generators in the U.S.S.R. Labor force 13,000.
Moscow............ 55°45′N.; 37°35′E.	Caliber Precision Equipment Plant.	Automatic control equipment, aiming devices, micrometers, gages, calipers, beam compasses, and other precision instruments.	One of the largest precision equipment plants in the U.S.S.R. Also makes surveying instruments including theodolites. Labor force, about 8,000.

Approved For Release 2008/09/08 : CIA-RDP08S01350R000100030002-2

Approved For Release 2008/09/08 : CIA-RDP08S01350R000100030002-2

FIGURE 99. PRINCIPAL TELECOM EQUIPMENT PLANTS, 1965

LOCATION	PLANT NAME	CHIEF PRODUCTS	REMARKS
Aleksandrov 56°24'N.; 38°43'E.	Aleksandrov Radio Plant (ARZ).	Radiocommunication equipment, radiobroadcast and television receivers.	Major producer of television receivers. Produces civilian and some military radio equipment.
Fryazino 55°58'N.; 38°04'E.	Scientific Research Institute No. 160.	Electron tubes, special-purpose tubes and semiconductor devices.	A major electron tube plant development center, producing standard, miniature and subminiature tubes. Also produces electronic devices used in missile guidance systems.
Gor'kiy 56°20'N.; 44°00'E.	Gor'kiy Communication Equipment Plant Lenin 197-Frunze 326.	Radar, including vehicular units: early warning, target acquisition, and undetermined types.	One of the most important military plants. Has produced various electronic devices, but believed now to be specializing in manufacture of radar. Labor force about 14,000 in 1960.
Krasnoyarsk 56°01'N.; 92°50'E.	Krasnoyarsk Television Plant	Military radiocommunication equipment, radio and television receivers.	Modern plant with conveyor-line production. Has military section. Labor force, 1,800.
Kuchino 55°45'N.; 37°58'E.	Kuchino Electronic Research Laboratory.	Radio relay equipment, missile guidance radar, direction finders, infrared communication devices (ortiphones).	Military production and research and development. Developed and carried out initial production of *Krug* radio direction-finding equipment, and probably YO-YO radar.
Kuntsevo 55°44'N.; 37°26'E.	Moscow Radar Plant No. 304	Fire-control radar and components for ground guidance systems.	Closely associated with Research Institute NII-20. Produced FIRE CAN fire-control radar and YO-YO radar for tracking and control of surface-to-air missiles.
Leningrad 59°55'N.; 30°15'E.	Electric Instrument Plant No. 212.	Radiocommunication equipment for ground, shipborne and airborne use.	Important producer of military equipment. Is one of the largest Soviet precision instrument plants. Has produced navigational and fire-control radar and electronic devices for guided missiles.
Do	Leningrad Plant *imeni* Kozitskiy No. 616.	Radiocommunication equipment, radiobroadcast and television receivers, radar and navigational equipment.	Has produced military equipment for ground, shipborne and airborne use.
Do	Leningrad Aircraft Radio and Instrument Plant No. 287.	Television, military radio transmitters and receivers, airborne intercept equipment, radiobroadcast receivers and radar navigational equipment.	
Do	Radio Plant No. 619	Radio receivers and transmitters for ground and airborne use; radiobroadcast and television receivers; radar and navigational equipment for ships, aircraft for ships, aircraft and space vehicles; electronic countermeasure equipment.	Produces mainly for the military. Probably produces *Krug* DF equipment.
Do	"Red Dawn" Plant	Telephone and telegraph equipment, switchboards, carrier equipment, teleprinters, and telephone handsets.	Produced both military and civilian telephone equipment. Has automatic production lines. Labor force of approximately 10,000 persons in 1965.
Do	Svetlana Tube and Lamp Plant No. 211.	Electron tubes, special-purpose tubes, and semiconductor devices.	Leading developer and producer of tubes and semiconductor devices, both military and civilian. Labor force exceeded 10,000 in 1963.
Do	"Komintern" Radio Plant	Radiocommunication equipment, radio transmitters, and radar and navigational equipment, including radio direction-finders.	Primarily military producer of radar and radiocommunication equipment including R-series.

Approved For Release 2008/09/08 : CIA-RDP08S01350R000100030002-2

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FIGURE 99. PRINCIPAL TELECOM EQUIPMENT PLANTS (*Continued*)

LOCATION	PLANT NAME	CHIEF PRODUCTS	REMARKS
Leningrad (*Con.*) 59°55N.; 30°15′E.	Kulakov Electrical Equipment Plant No. 209.	Telephone equipment, radiotelephone equipment, navigational equipment, radar, and sonar.	Large plant, with about one-half of output consisting of telecom and related electronic items.
Lianozovo 55°54′N.; 37°35′E.	Lianozovo Electronic Equipment Plant.	Microwave radio relay equipment and ground radar for military use.	Produces vehicular types including radar for early warning, surveillance, height finding and missile tracking.
L'vov 49°50′N.; 24°00′E.	Military Plant No. 125	Radio equipment for aircraft	Produces instruments for guided missiles and probably some radar equipment; also produces electric items.
Minsk 53°54′N.; 27°34′E.	Minsk Radio Plant	Radiocommunication equipment (fixed and mobile); radiobroadcast and television receivers.	Produces both military and civilian items.
Do	Plant Post Box No. 32	Marine radio equipment, navigational radar, sonar.	Production includes shipboard emergency communication devices.
Moscow 55°45′N.; 37°35′E.	Moscow Order of Lenin Radio Plant No. 528.	Radiocommunication equipment, both fixed and mobile, and radiobroadcast and television receivers.	Military radio equipment includes shipborne, airborne, army signal, and tank equipment.
Do	Moscow Order of Lenin Electric Lamp Plant No. 632.	Electron tubes (standard, miniature and subminiature), wide-angle television tubes, special-purpose tubes, and wire (tungsten, molybdenum, and platinite).	A principal tube and electric bulb plant. Produces wide range of tubes for military use. Labor force over 10,000.
Do	Moscow Television Equipment Plant.	Television receivers and transmitters.	Equipped with machinery from Czechoslovakia. Mass-produces television receivers.
Do	Radar Plant No. 703. Also known as Electrical Institute and Special Design Bureau (OKB) 703.	Radar equipment (search and fire-control) for ground, shipborne, and airborne use.	Has modern equipment and may be engaged in missile guidance work.
Novosibirsk 55°02′N.; 82°55′E.	Novosibirsk Radio Plant No. 590. Also known as "Elecktrosignal" Plant.	Radiocommunication equipment (vehicular stations, light weight tube-transistor sets); radiobroadcast receivers.	Produces military electronic equipment mainly for aircraft. Estimated labor force, 5,000 in 1961.
Do	Svetlana Tube and Lamp Plant No. 617.	Electron tubes, including metal-ceramic types, special-purpose miniature and subminiature tubes, semiconductor devices.	One of the largest tube producers in the U.S.S.R. Production is primarily for military use.
Do	Radio Plant No. 208	Radiocommunication equipment, radiobroadcast receivers, and radar (IFF).	Has produced naval transmitter-receivers, and radio transmitter and receiver units for signal trucks, military aircraft, and tanks.
Omsk 55°00′N.; 73°24′E.	Kozitsky Radio and Instrument Plant No. 210.	Radiocommunication equipment for railroads, agricultural tractor stations and military vehicles; public address systems.	Plant produces transceivers for tanks and also produces components.
Riga 56°57′N.; 24°06′E.	Electrical Equipment Plant (VEF).	Telephone and telegraph equipment, radio-communication equipment, radiobroadcast and television receivers.	One of the largest electronics equipment plants; has a military section and has local branch plants. Is equipped with modern machinery and has been scheduled for automation. Labor force of 10,000 in 1965.
Do	Radio Equipment Plant *imeni* A. S. Popov.	Radiobroadcast and television receivers.	Plant mass-produces transistorized radio receivers and pocket-type receivers. About 8,000 workers in 1965.
Rostov 47°14′N.; 39°42′E.	Radar Instrument Plant. Also known as Plant "LA."	Shipborne navigational radar; radar mapreading devices.	Important producer of shipborne radar for merchant marine.
Sarapul 56°28′N.; 53°48′E.	Ordzhonikidze Electrical Plant No. 203.	Radio signal equipment, radiobroadcast receivers (transistorized), and radio direction-finding equipment.	Produces both military and civilian equipment. Produces radios for tanks and aircraft.

Approved For Release 2008/09/08 : CIA-RDP08S01350R000100030002-2

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FIGURE 99. PRINCIPAL TELECOM EQUIPMENT PLANTS (*Continued*)

LOCATION	PLANT NAME	CHIEF PRODUCTS	REMARKS
Saratov............. 51°34′N.; 46°02′E.	Electro-Vacuum Tube Plant..	Electron and special-purpose tubes (standard miniature and subminiature).	Plant has highly mechanized production lines. Produces tubes for military and civilian use. Labor force about 10,000 in the early 1960's.
Sverdlovsk.......... 56°51′N.; 60°36′E.	Ural Radio Plant No. 626.....	Radiocommunication equipment, radiobroadcast and television in the early 1960's.	Labor force approximately 5,000 receivers.
Tallinn............. 59°25′N.; 24°45′E.	Semiconductor Plant *imeni* Kh. Pegelman.	Semiconductor devices (transistors, resistors).	Began production in 1959. Estimated labor force, 1,500 in early 1960's.
Vilnius............. 54°41′N.; 25°19′E.	Electrical Instrument Plant, No. 555.	Radiocommunication equipment for ground, shipborne, and airborne use; radar for aircraft and radar parts for anticollision units.	Also makes test and measuring equipment including oscillographs. Employs several thousand workers.
Vladivostok......... 43°08′N.; 131°54′E.	Electrical Equipment Plant....	Telegraph equipment and radiocommunication equipment.	Produces radio equipment for the navy.
Voronezh........... 51°46′N.; 33°28′E.	Voronezh Electro-Signal Plant No. 728.	Radiocommunication equipment, radiobroadcast and television receivers.	Produces military and civilian equipment. Produces units of R-100 series for portable and vehicular use.
Zelenodol'sk......... 55°51′N.; 48°33′E.	Radar Plant No. 708. Also known as Kazan Radar Plant 708.	Radio relay equipment, marine radar equipment, sonar, and components and accessory parts including loudspeakers.	Plant also is engaged in development of electronic equipment for guided missiles. Labor force 3,000.

FIGURE 100. VALUE OF FOREIGN TRADE IN CHEMICALS AND ALLIED PRODUCTS
(*Millions of foreign exchange rubles*)

COMMODITY	EXPORTS				IMPORTS			
	1958	1960	1964	1965	1958	1960	1964	1965
Basic and coke chemicals, plastics and intermediates...............................	45.1	60.5	77.9	87.9	47.4	79.4	148.9	173.1
Dyes, paints, varnishes, and tanning materials.	6.3	5.9	10.6	11.0	18.0	21.9	36.5	44.7
Photographic chemicals....................	1.9	1.4	2.3	2.5	12.7	16.1	13.9	14.1
Fertilizers and pesticides...................	45.8	57.2	76.5	93.9	9.4	9.1	52.8	38.6
Rubber and rubber products...............	32.4	41.8	48.3	51.1	163.9	176.3	130.5	179.0
Essential oils, etc.........................	2.1	4.0	4.7	5.7	6.3	5.9	7.2	6.8
Manmade staple fiber.....................	*Insig*	*Insig*	*Insig*	*Insig*	25.8	24.8	27.1	29.2
Rayon and synthetic yarn.................	*Insig*	*Insig*	*Insig*	*Insig*	13.1	13.4	5.6	9.5
Medicines, soap, perfumes, etc.............	10.7	12.1	18.1	17.7	22.5	27.5	99.3	111.0
Total.................................	144.3	183.0	238.4	269.8	319:1	374.4	521.8	606.0

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FIGURE 101. SELECTED PRODUCERS OF SULFURIC ACID

LOCATION	PLANT NAME
Alaverdi 41°08′N.; 44°39′E.	Alaverdi Copper and Chemical Plant.
Chardzhou 39°06′N.; 63°34′E.	Chardzhou Superphosphate Plant
Chimkent 42°18′N.; 69°36′E.	Chimkent Lead Plant
Dzhambul 42°52′N.; 71°23′E.	Dzhambul Superphosphate Plant
Gomel 52°25′N.; 31°00′E.	Gomel Superphosphate Plant
Kedainiai 55°17′N.; 23°58′E.	Kedainiai Chemical Combine
Kokand 40°30′N.; 70°57′E.	Kokand Superphosphate Plant
Konstantinovka 48°32′N.; 37°43′E.	Konstantinovka Chemical Plant
Lipetsk 52°35′N.; 39°37′E.	Novolipetsk Metallurgical Works
Salavat 53°21′N.; 55°55′E.	Salavat Petrochemical Combine
Samarkand 39°40′N.; 66°58′E.	Samarkand Superphosphate Plant
Sumy 50°54′N.; 34°48′E.	Sumy Superphosphate Plant
Ufa 54°44′N.; 55°56′E.	Ufa Oil Refinery
Volkhov 59°55′N.; 32°20′E.	Volkhov Aluminum Plant
Voskresensk 55°19′N.; 38°42′E.	Voskresensk Chemical Combine *imeni* Kuybyshev.

FIGURE 102. MAJOR PRODUCERS OF AMMONIA AND NITRIC ACID, 1965

LOCATION	PLANT NAME
Berezniki 59°24′N.; 56°46′E.	Berezniki Chemical Combine
Chirchik 41°29′N.; 69°35′E.	Chirchik Electrochemical Combine
Dneprodzerzhinsk 48°30′N.; 34°37′E.	Dneprodzerzhinsk Nitrogen Fertilizer Plant.
Fergana 40°23′N.; 71°46′E.	Fergana Nitrogen Fertilizer Plant
Grodno 53°41′N.; 23°50′E.	Grodno Nitrogen Fertilizer Plant
Kemerovo 55°20′N.; 86°05′E.	Kemerovo Nitrogen Fertilizer Plant
Do	Novokemerovo Chemical Combine
Kirovakan 40°48′N.; 44°30′E.	Kirovakan Chemical Combine *imeni* Myasnikyan.
Nevinnomyssk 44°38′N.; 41°57′E.	Nevinnomyssk Chemical Combine
Novomoskovsk 54°05′N.; 38°13′E.	Novomoskovsk Chemical Combine
Rustavi 42°17′N.; 43°51′E.	Rustavi Nitrogen Fertilizer Plant
Salavat 53°21′N.; 55°55′E.	Salavat Petrochemical Combine
Severodonetsk 48°55′N.; 38°26′E.	Lisichansk Chemical Combine
Shchekino 54°00′N.; 37°31′E.	Shchekino Chemical Combine
Tol'yatti 53°31′N.; 49°20′E.	Tol'yatti Nitrogen Fertilizer Plant

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FIGURE 103. SELECTED PRODUCERS OF CHLORINE, CAUSTIC SODA, AND SODA ASH

CITY	NAME AND LOCATION	PRODUCTS
Beketovka 48°35′N.; 44°25′E.	Beketovka Chemical Plant No. 91	Chlorine, caustic soda.
Berezniki 59°24′N.; 56°46′E.	Berezniki Chemical Combine	Chlorine, caustic soda, soda ash.
Chapayevsk 52°58′N.; 49°41′E.	Chapayevsk Chemical Plant No. 102	Chlorine, caustic soda.
Chirchik 41°29′N.; 69°35′E.	Chirchik Electrochemical Combine	*Do.*
Dzerzhinsk 56°15′N.; 43°24′E.	Chernorech'ye Chemical Plant *imeni* Kalinin.	*Do.*
Do	Chemical Plant No. 96	*Do.*
Kemerovo 55°20′N.; 86°05′E.	Kemerovo Chemical Plant No. 510	*Do.*
Mikhaylovka 51°49′N.; 79°45′E.	Mikhaylovka Soda Combine	Soda ash.
Novomoskovsk 54°05′N.; 38°13′E.	Novomoskovsk Chemical Combine	Chlorine, caustic soda.
Shchelkovo 55°55′N.; 38°00′E.	Shchelkovo Chemical Plant	*Do.*
Slavyansk 48°52′N.; 37°37′E.	Slavyansk Soda Plant	Chlorine, caustic soda, soda ash.
Sterlitamak 53°37′N.; 55°58′E.	Sterlitamak Soda Combine	*Do.*
Sumgait 40°37′N.; 49°37′E.	Sumgait Chemical Plant No. 142	Chlorine, caustic soda.
Ufa 54°44′N.; 55°56′E.	Ufa Chemical Works	Chlorine.
Usol'ye 52°45′N.; 82°40′E.	Chemical Plant No. 97	Chlorine, caustic soda.
Ust Kamenogorsk 49°58′N.; 82°40′E.	Titanium Magnesium Combines	Chlorine.
Verkhneye 48°53′N.; 38°28′E.	Donets Soda Plant	Chlorine, caustic soda, soda ash.
Yerevan 40°11′N.; 44°30′E.	Yerevan Synthetic Rubber Plant	Chlorine, caustic soda.

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FIGURE 104. SELECTED FERTILIZER PLANTS

LOCATION	PLANT	PRODUCT
Angarsk 52°34′N.; 103°54′E.	Angarsk Mineral Fertilizer Plant	Nitrogen fertilizer.
Berezniki 59°24′N.; 56°46′E.	Berezniki Chemical Combine	*Do.*
	Berezniki Potassium Combine.	Potassium fertilizer.
Chirchik 41°29′N.; 69°35′E.	Chirchik Electrochemical Combine	Nitrogen fertilizer.
Dorogobuzh 54°55′N.; 33°18′E.	Dorogobuzh Nitrogen Fertilizer Plant	*Do.*
Dneprodzerzhinsk 48°30′N.; 34°37′E.	Dneprodzerzhinsk Nitrogen Fertilizer Plant	*Do.*
Dzhambul 42°52′N.; 71°23′E.	Dzhambul Superphosphate Plant	Superphosphate and ammoniated superphosphate.
Gorlovka 48°18′N.; 38°03′E.	Gorlovka Nitrogen Fertilizer Plant *imeni* Sergo	Nitrogen fertilizer.
Ionava 55°05′N.; 24°17′E.	Ionava Nitrogen Fertilizer Plant	*Do.*
Kalush 49°01′N.; 24°22′E.	Kalush Chemicometallurgical Combine	Potassium fertilizer.
Kirovakan 40°48′N.; 44°30′E.	Kirovakan Chemical Combine *imeni* Myasnikyan.	Nitrogen fertilizer.
Kokand 40°30′N.; 70°57′E.	Kokand Superphosphate Plant	Superphosphate and ammoniated superphosphate.
Konstantinovka 48°32′N.; 37°43′E.	Konstantinovka Chemical Plant	*Do.*
Maardu 59°25′N.; 25°01′E.	Maardu Chemical Combine	Phosphate fertilizer.
Navoi 40°09′N.; 65°22′E.	Navoi Chemical Combine	Nitrogen fertilizer.
Nevinnomyssk 44°38′N.; 41°57′E.	Nevinnomyssk Chemical Combine	*Do.*
Novokemerovo 55°20′N.; 86°05′E.	Novokemerovo Chemical Combine	*Do.*
Novomoskovsk 54°05′N.; 38°13′E.	Novomoskovsk Chemical Combine	Nitrogen and mixed fertilizers.
Salavat 53°21′N.; 55°55′E.	Salavat Petrochemical Combine	Nitrogen fertilizer.
Sverodonetsk 48°55′N.; 38°26′E.	Sverodonetsk Chemical Combine (Lisichansk)	Nitrogen, phosphate, complex.
Shchekino 54°00′N.; 37°31′E.	Shchekino Chemical Combine	Nitrogen fertilizer.
Soligorsk 52°44′N.; 27°28′E.	Soligorsk Potassium Combines 1 and 2	Potassium fertilizer.
Solikamsk 59°39′N.; 56°49′E.	Solikamsk Potassium Plant	*Do.*
Stebnik 49°18′N.; 23°34′E.	Stebnik Potassium Combine	*Do.*
Sumgait 40°36′N.; 49°38′E.	Sumgait Superphosphate Plant	Superphosphate.
Sumy 50°54′N.; 34°48′E.	Sumy Superphosphate Plant	Phosphate fertilizer.
Tol'yatti 53°31′N.; 49°20′E.	Tol'yatti Nitrogen Fertilizer Plant	Nitrogen fertilizer.
Vinnitsa 49°14′N.; 28°29′E.	Vinnitsa Chemical Combine	Superphosphate and triple superphosphate.
Voskresensk 55°19′N.; 38°42′E.	Voskresensk Chemical Combine	Phosphates, Complex fertilizer.

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FIGURE 105. SOVIET SYNTHETIC RUBBER PLANTS

LOCATION	PRODUCT	REMARKS
Chaykovskiy 56°47′N.; 54°09′E.	*na*	Initial production scheduled by 1970.
Gudermes 43°21′N.; 46°06′E.	*na*	Construction started late in 1965. Initial production planned before end of Five Year Plan (1966–70).
Irkutsk area	Possibly chloroprene	Production of synthetic rubber planned in the Angaro-Usole' petrochemical complex.
Kazan' 55°45′N.; 49°08′E.	Sodium polymerized butadiene rubber (SKB).	Production of polybutadiene planned.
Krasnoyarsk 56°01′N.; 92°50′E.	SKB, nitrile (SKN), oil-extended butadiene-styrene rubber.	
Nizhne Kamsk 55°40′N.; 51°52′E.	Polyisoprene	Plant under construction. First stage was scheduled to start up in 1966 but may have been delayed.
Omsk 55°00′N.; 73°24′E.	Butadiene, methylstyrene, styrene-butadiene latex, methyl pyridine latexes and rubber.	Initial output reported in 1962.
Sterlitamak 53°37′N.; 55°58′E.	Oil-extended copolymer rubber based on butane, polyisoprene, latex.	Initial operation 1960. Experimental output of polyisoprene started in 1964.
Sumgait 40°37′N.; 49°37′E.	Oil-extended copolymer rubber, butyl rubber, styrene-butadiene.	Production scheduled to increase by 64% during 1966–70. Production of styrene-butadiene was expanded in 1965. Nitrile rubbers are planned for production.
Temir Tau 50°05′N.; 72°56′E.	Butadiene rubber, new type of frost-resistant rubber.	Future production may include chloroprene rubber.
Tol'yatti 53°31′N.; 49°20′E.	Styrene-butadiene, polyisoprene	Initial operation began in 1961. Production of polyisoprene began in late 1964. Output of polybutadiene and chloroprene rubber is planned.
Volzhskiy 48°49′N.; 44°44′E.	Polyisoprene	Production of polyisoprene began in late 1964. Plant is being expanded.
Voronezh 51°38′N.; 39°12′E.	SKB, oil-extended copolymer latex, experimental output of polyisoprene rubber.	Capacity was planned to almost double in 1964–66. Commercial-scale output of polybutadiene and polyisoprene is planned.
Yaroslavl' 57°37′N.; 39°52′E.	SKB, nitrile rubber, butyl rubber, oil-extended, frost-resistant rubber, polybutadiene (experimental).	Production of synthetic rubber was planned to double during 1959–65.
Yavan 38°19′N.; 69°02′E.	Chloroprene and other types of rubber (planned).	This synthetic rubber plant will be built as part of a major chemical combine on which construction began in 1965.
Yefremov 53°09′N.; 38°07′E.	SKB, polyisobutylene, butyl rubber, polybutadiene.	Production of polybutadiene began in 1965. Polyisoprene planned.
Yerevan 40°11′N.; 44°30′E.	Chloroprene rubber and latex	Production was scheduled to double in 1959–65. Actual increase was 73%.

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FIGURE 106. SELECTED PRODUCERS OF PLASTICS, 1966

LOCATION	PLANT NAME	TYPE
Dankov 53°15'N.; 39°08'E.	Dankov Chemical Plant	Silicones.
Dzerzhinsk 56°15'N.; 43°24'E.	Chemical Plant Zavodstroy	Polyvinyl chloride.
Do	Chemical Plant Zarya	Polycarbonate (experimental).
Fergana 40°23'N.; 17°46'E.	Fergana Hydrolytic Plant	Furan resins.
Gorlovka 48°18'N.; 38°03'E.	Gorlovka Nitrogen Fertilizer Plant	Polystyrene.
Gur'yev 47°07'N.; 51°53'E.	Gur'yev Polyethylene Plant	Low-pressure polyethylene.
Kazan' 55°45'N.; 49°08'E.	Organic Synthesis Plant	Polyethylene.
Kemerovo 55°20'N.; 86°05'E.	Plant "Karbolit"	Phenolics, ion-exchange, polyurethane.
Kuskovo 55°44'N.; 37°49'E.	Kuskovo Chemical Plant	Polystyrene, polyvinyl butyral, amino, silicone, polyvinyl, acetate.
Leningrad 59°55'N.; 30°15'E.	Okhta Chemical Combine	Epoxy, polyethylene, polystyrene, polyvinyl butyral, ethyl cellulose, cellulose acetate.
Moscow 55°45'N.; 37°35'E.	Moscow Oil Refinery	Polypropylene.
Nizhniy-Tagil 57°55'N.; 59°57'E.	Nizhniy-Tagil Plastics Plant	Fluoroplastics, phenolic, ion-exchange resins.
Novokuybyshevsk 53°07'N.; 48°58'E.	Novokuybyshevsk Chemical Plant	Low-pressure polyethylene.
Novomoskovsk 54°05'N.; 38°13'E.	Novomoskovsk Chemical Combine	Polyvinyl chloride.
Orekhovo-Zuyevo 55°49'N.; 38°59'E.	Orekhovo-Zuyevo Plant "Karbolit"	Phenolic, amino.
Salavat 53°21'N.; 55°55'E.	Salavat Petrochemical Combine	High-pressure polyethylene.
Sverdlovsk 56°51'N.; 60°36'E.	Sverdlovsk Plastic Plant	Polyamide, polyethylene, cellulose acetate.
Ufa 54°44'N.; 55°56'E.	Ufa Synthetic Alcohol Plant	Polyethylene.
Yerevan 40°11'N.; 44°30'E.	Yerevan Polyvinyl Acetate Plant	Cellulose acetate, polyvinyl acetate, polyvinyl butyral.

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FIGURE 107. SOVIET PRODUCERS OF MANMADE FIBERS

LOCATION	PRODUCTS
Balakovo 52°02′N.; 47°47′E.	Viscose cord, staple, cellophane.
Barnaul 53°22′N.; 83°45′E.	Viscose cord, staple, cellophane, nylon 6.
Cherkassy 49°26′N.; 32°04′E.	Viscose staple and filament.
Chernigov 51°30′N.; 31°18′E.	Nylon 6, nylon 66.
Daugavpils 55°53′N.; 26°32′E.	Nylon 6.
Engel's 51°30′N.; 46°07′E.	Nylon 6, cellulose acetate.
Kalinin 56°52′N.; 35°55′E.	Viscose staple, filament, cord; polyacrylonitrile fiber; nylon 6 cord.
Kaunus 54°54′N.; 23°54′E.	Cellulose triacetate.
Kemerovo 55°20′N.; 86°05′E.	Caprolactam.
Kiev 50°26′N.; 30°31′E.	Viscose rayon.
Kirovakan 40°48′N.; 44°30′E.	Cellulose acetate.
Klin 56°20′N.; 36°44′E.	Viscose rayon, nylon 6, nylon 66.
Krasnoyarsk 56°01′N.; 92°50′E.	Viscose rayon.
Kursk 51°42′N.; 36°12′E.	Polyester fiber, polypropylene, nylon 6.
Kustanay 53°10′N.; 63°35′E.	Viscose and cuprammonium rayon, polyvinyl chloride fiber (planned).
Leningrad 59°55′N.; 30°15′E.	Viscose rayon, polyvinyl alcohol fiber.
Lisichansk 48°55′N.; 38°26′E.	Vinyl acetate, caprolactam.
Mogilev 53°54′N.; 30°21′E.	Viscose rayon. A second plant is under construction and will produce polyester fiber.
Polotsk 55°29′N.; 28°47′E.	Under construction. Large-scale production of polyacrylonitrile fiber planned.
Rustavi 41°33′N.; 45°03′E.	Nylon 6.
Ryazan' 54°38′N.; 39°44′E.	Viscose rayon.
Saratov 51°34′N.; 46°02′E.	Polyacrylonitrile fiber.
Svetlogorsk 54°37′N.; 20°10′E.	Viscose rayon.
Volzhskiy 48°49′N.; 44°44′E.	Nylon 6.

Approved For Release 2008/09/08 : CIA-RDP08S01350R000100030002-2

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FIGURE 108. PRODUCTION OF IMPORTANT TYPES OF PROCESSED FOODS
(*Thousand metric tons, unless otherwise specified*)

COMMODITY	1958	1961	1962	1963	1964	1965	1966
Meat	3,372	4,251	4,808	5,440	4,148	5,245	5,724
Sausage products	1,049	1,321	1,369	1,492	1,490	1,600	1,760
Milk products	22,095	27,541	29,215	28,541	31,397	38,692	40,100
Butter	659	781	830	777	846	1,073	1,042
Cheese	150	185	208	222	256	288	324
Sugar*	5,433	8,376	7,800	6,219	8,209	11,037	9,740
Confections	1,676	1,806	1,950	2,061	2,306	2,314	2,242
Vegetable oil	1,465	1,815	2,114	2,195	2,249.	2,770	2,730
Margarine and margarine compounds	395	474	515	566	606	670	595
Canned foods (million 400 g cans)	4,073	5,550	5,914	6,470	7,452	7,078	7,410
Flour (million metric tons)	35	36	36	36	34	37	*na*
Bread and bakery products (million metric tons)	15	*na*	*na*	*na*	*na*	20	*na*
Macaroni products (1,000 metric tons)	950	999	1,054	1,134	1,264	1,251	*na*
Vodka (million dkl.)	145	146	162	169	177	*na*	*na*
Beer (million dkl.)	199	267	282	281	283	317	*na*
Grape wine (million dkl.)	62	85	98	119	127	134	162
Cigarettes (billion cigarettes)	232	248	230	258	280	*na*	*na*
Fish (100 metric tons)	2,936	3,724	4,167	4,681	5,171	5,770	6,049

NOTE—The sugar and margarine series cover total production. The milk products series is equivalent to state procurements of milk. The butter, vegetable oil, and grape wine series exclude household production. The meat and cheese series exclude household and collective farm production. The bread and bakery products series exclude household, collective farm, and industrial cooperative production (cooperatives became part of state industry in 1959). Fish production is given by landed weight.

* Sugar from sugar beets only.

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FIGURE 109. FOREIGN TRADE IN SELECTED CONSUMER GOODS

COMMODITY	UNIT	1959		1961		1963		1964		1965	
		Imports	Exports	Imports	Exports	Imports	Exports	Imports	Exports	Imports	Exports
Durable consumer goods:											
Bicycles	Thousand units	*Insig*	227	*Insig*	199	*Insig*	115	*Insig*	120	*Insig*	155
Cameras	*do*	*Insig*	47	*Insig*	113	*Insig*	256	*Insig*	290	*Insig*	305
Clocks and watches	*do*	*Insig*	3,291	*Insig*	4,704	*Insig*	5,753	*Insig*	5,215	*Insig*	5,115
Radios	*do*	*Insig*	30	*Insig*	28	*Insig*	72	*Insig*	111	*Insig*	375
Refrigerators	*do*	*Insig*	24	*Insig*	23	*Insig*	25	*Insig*	35	*Insig*	29
Sewing machinery, domestic	*do*	256	24	393	24	214	26	128	59	64	52
Television sets	*do*	*Insig*	75	*Insig*	78	*Insig*	153	*Insig*	57	....	86
Leather footwear	Thousand pairs	26,100	350	25,100	392	25,600	348	25,100	406	27,900	1,165
Paper	Thousand metric tons	66	103	112	139	107	143	112	163	145	203
Textiles:											
Cloth of manmade fiber and natural silk.	Million linear meters	65	19	78	26	64	33	39	46	30	36
Cotton cloth	*do*	190	169	61	195	83	227	69	252	95	272
Linen cloth	*do*	16	*Insig*	7	2	5	*Insig*	6	*Insig*	4	6
Wool cloth	*do*	19	*Insig*	24	*Insig*	21	*Insig*	14	*Insig*	9	*Insig*

Approved For Release 2008/09/08 : CIA-RDP08S01350R000100030002-2

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FIGURE 110. MAJOR COMBINES OF THE COTTON TEXTILE INDUSTRY, 1966

LOCATION	PLANT	REMARKS
Barnaul 53°22′N.; 83°45′E.	Barnaul Cotton Textile Combine	One of the largest cotton textile combines in Siberia. Estimated annual production of 100 million linear meters.
Dushanbe 38°33′N.; 68°48′E.	Dushanbe Cotton Textile Combine	Began production during World War II. Has undergone expansion which has raised annual output to 120 million linear meters.
Gori 41°58′N.; 44°07′E.	Gori Cotton Textile Combine	Employs over 7,000 workers to produce an estimated 100 million linear meters yearly.
Kamyshin 50°06′N.; 45°24′E.	Kamyshin Cotton Textile Combine	Began production in 1955. Reportedly the largest cotton combine in the U.S.S.R.
Kherson 46°38′N.; 32°36′E.	Kherson Cotton Textile Combine	Undergoing expansion. Estimated annual production of 150 million linear meters.
Tashkent 41°20′N.; 69°18′E.	Tashkent Cotton Textile Combine	One of the largest cotton textile mills in Central Asia producing more than 200 million linear meters annually.

FIGURE 111. MAJOR COMBINES OF THE WOOL TEXTILE INDUSTRY, 1966

LOCATION	PLANT	REMARKS
Bryansk 40°23′N.; 49°51′E.	Bryansk Worsted Fabrics Combine	Began production in 1956.
Chernigov 51°30′N.; 31°18′E.	Chernigov Worsted Fabrics Combine	Second stage has been commissioned and produces wool yarn for the knitwear industry. With full capacity it will produce 14 million linear meters of worsted and thin fabric cloth.
Frunze 42°54′N.; 74°36′E.	Frunze Worsted and Woolen Cloth Combine.	Production began in 1962. Full production capacity of 9 million linear meters a year will make it the largest woolen mill in Central Asia.
Kansk 56°13′N.; 95°41′E.	Kansk Textile Combine	Built during World War II and modernized in 1962. Produces heavy woolens.
Krasnodar 45°02′N.: 39°00′E.	Krasnodar Worsted Fabrics Combine	Production of more than 12 million linear meters yearly is used mainly for suits and coats. To be reconstructed during 1966–68.
Ivanovo 57°14′N.; 30°20′E.	Ivanovo Worsted Combine	Built during the Seven Year Plan. When in full production, will be one of the country's major worsted combines, with a yearly output of 17.5 million linear meters.
Minsk 53°54′N.; 27°34′E.	Minsk Worsted Fabrics Combine	Built during the Seven Year Plan. To be reconstructed during 1966–68.
Sverdlovsk 56°51′N.; 60°36′E.	Sverdlovsk Worsted Fabrics Combine	Built during the Seven Year Plan. Is the largest textile undertaking in the eastern part of the U.S.S.R. Construction is continuing through 1966–68.
Tbilisi 41°42′N.; 44°45′E.	Tbilisi Worsted Spinning and Weaving Mill.	Put into operation in 1963. Has a planned capacity of 11 million linear meters of worsted fabric yearly.

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FIGURE 112. MAJOR PRODUCERS OF TEXTILES OF MANMADE FIBERS AND NATURAL SILK, U.S.S.R., 1966

LOCATION	PLANT	REMARKS
Bendery 46°49′N.; 29°29′E.	Bendery Silk Combine	Chief products are silk and rayon. Completed during the Seven Year Plan.
Chaykovskiy 56°47′N.; 54°09′E.	Chaykovskiy Combine For Silk Fabrics	Put into operation in 1965. Expected to produce 90 million linear meters of material from articial fiber by the end of 1970.
Kalinin 56°52′N.; 35°55′E.	Kalinin Synthetic Fiber	Chief products are textiles of rayon and synthetic fiber. Began production in 1954 as part of the Kalinin Textile Combine, which is principally a cotton combine.
Kaunas 54°54′N.; 23°54′E.	Kaunas Artificial Fiber Plant	Put into operation in the Seven Year Plan. To be one of the largest acetate silk mills in the world. Equipment supplied by the British firm, Courtaulds.
Kiev 50°26′N.; 30°31′E.	Darnitsa Silk Combine	Chief products are rayon and synthetic fiber. Began production in 1940 and was expanded during the Seven Year Plan.
Klin 56°20′N.; 36°44′E.	Klin Synthetic Fiber Plant	Chief products are textiles of rayon and synthetic fiber. Began production in 1920 and has an estimated labor force of 10,000 persons.
Korablino 53°55′N.; 40°01′E.	Korablino Cloth and Fiber Combine	Built during Seven Year Plan. To be the largest of its kind in the R.S.F.S.R.
Leninabad 40°17′N.; 69°37′E.	Leninabad Silk Combine	Has been undergoing expansion since 1962. Is a large processor of silk cocoons, in addition to producing more than 20 million linear meters of artificial silk fabric yearly.
Orenburg 51°45′N.; 55°06′E.	Orenburg Silk Combine	Began production in 1964 and is to be the largest producer of silk fabrics in the U.S.S.R.

FIGURE 113. MAJOR PRODUCERS OF LINEN TEXTILES, 1966

LOCATION	PLANT	REMARKS
Grodno 53°41′N.; 23°50′E.	Grodno Linen Combine	Built in Seven Year Plan. Estimated capacity of 15 million linear meters a year.
Kostroma 57°46′N.; 40°55′E.	Linen Combine *imeni* V.I. Lenin	Produces 50 million linear meters of linen, linen-lavsan, and line-nylon blends yearly.
Orsha 54°31′N.; 30°26′E.	Orsha Linen Combine	Built in Seven Year Plan. Planned yearly production of over 7.5 million linear meters of fine linen fabric.
Panevezhis 55°44′N.; 24°21′E.	Panevezhis Linen Combine	Completed in 1961. The largest undertaking of its kind in the Baltic region.
Rovno 50°37′N.; 26°15′E.	Rovno Linen Combine	Began to produce consumer fabrics in 1965 in addition to its previous production of industrial linens. Reached a capacity of 8 million linear meters in 1966.
Zhitomir 50°15′N.; 28°40′E.	Zhitomir Linen Combine	Estimated production of 23 million linear meters.

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Approved For Release 2008/09/08 : CIA-RDP08S01350R000100030002-2

FIGURE 114. MAJOR PRODUCERS OF LEATHER FOOTWEAR, 1966

LOCATION	PLANT	REMARKS
Alma Ata. 43°15'N.; 76°57'E.	"Dzhetysu" Firm	Estimated annual production of 6.5 million pairs of footwear.
Dzhambul. 42°54'N.; 71°22'E.	Dzambul Leather Footwear Combine.	Completed in 1965. Has annual capacity of 5.5 million pairs of footwear.
Kiev. 50°26'N.; 30°31'E.	Podolska Footwear Factory Number 4.	The largest footwear factory in the Ukraine, with an annual production of over 8 million pairs.
Kishinev. 47°00'N.; 28°50'E.	Kishinev Model Footwear Factory	One of the largest enterprises in Moldavia. Recently combined with several other factories to form the firm "Avangard."
Lugansk. 47°22'N.; 37°06'E.	Lugansk Footwear Factory	Is to have an eventual annual capacity of 12 million pairs of footwear.
L'vov. 49°50'N.; 24°00'E.	L'vov Footwear Firm "Progress"	Was the first of the footwear firms. Comprises the L'vov Footwear Factory Number 3 and four other factories in the area. Will have an eventual capacity of 8 million pairs annually.
Tbilisi. 41°42'N.; 44°45'E.	"Isani" Firm	Part of the Tbilisi Footwear Production Association. Specializes in footwear made from synthetic leather. Estimated production of more than 5 million pairs yearly.
Ussuriysk. 43°48'N.; 131°59'E.	Ussuriysk Leather and Footwear Combine.	Largest industrial combine of its kind in the Far East and Siberia. Will be the first fully automated footwear enterprise in the U.S.S.R. and should deliver 3 million pairs of footwear annually.
Yerevan. 40°11'N.; 44°30'E.	The "Masis" Firm	Annual production of about 8 million pairs of footwear.

FIGURE 115. MAJOR PLANTS OF THE PAPER INDUSTRY, 1965

LOCATION	PLANT	CHIEF PRODUCTS	REMARKS
Archangel. 64°34'N.; 40°32'E.	Archangel Celulose and Paper Combine.	Pulp, paper, viscose, alcohol, wood fiber panels.	Will eventually have a capacity in excess of 800,000 metric tons of pulp and paper per year.
Balakhna. 53°47'N.; 38°14'E.	Balakhna Paper Combine	Paper	One of the three largest producers of newsprint.
Bratsk. 56°05'N.; 101°48'E.	Bratsk Wood Processing Complex.	Kraft pulp, paperboard, turpentine, and oil products.	Only partially completed. Will eventually produce a million metric tons of various products a year.
Kondopoga. 62°12'N.; 34°17'E.	Kondopoga Paper Combine.	Sulfite pulp, newsprint, and composition board.	One of the three largest producers of newsprint. Contains a paper mill which is reportedly the largest plant of its kind in the world.
Koryazhma. 61°18'N.; 47°11'E.	Kotlas Cellulose and Paper Combine.	Sulfate cellulose, packaging board, paper bags, cardboard.	Annual production of 400,000 metric tons of bleached sulfite pulp, kraft bag papers and liner, and corrugating medium.
Segezha. 63°44'N.; 34°19'E.	Segezha Cellulose and Paper Combine.	Kraft pulp and wrapping and bag paper.	Capacity reported at 40,000 metric tons in 1962 but has since undergone modernization.
Solikamsk. 59°39'N.; 56°47'E.	Solikamsk Paper Plant	Sulfite and newsprint	The country's largest supplier of newsprint.
Syas. 60°09'N.; 32°30'E.	Syas Cellulose and Paper Combine.	Paper, cardboard, alcohol	Is one of the largest producers of cellulose, paper, alcohol, and insulation board in the U.S.S.R.

Approved For Release 2008/09/08 : CIA-RDP08S01350R000100030002-2

Approved For Release 2008/09/08 : CIA-RDP08S01350R000100030002-2

FIGURE 116. MAJOR PRODUCERS OF HOUSEHOLD REFRIGERATORS, 1965

LOCATION	PLANT	ESTIMATED ANNUAL OUTPUT	REMARKS
Alma Ata 43°15′N.; 76°57′E.	Alma Ata Low Voltage Equipment Plant.	75,000	Eventual capacity of 100,000. Also produces washing machines.
Dnepropetrovsk 48°27′N.; 34°59′E.	Machine Building Plant Number 192	120,000	Also engaged in production of missiles.
Donetsk 48°00′N.; 37°48′E.	Refrigerator plant	80,000	Scheduled to be the largest single producer.
Leninakan 40°48′N.; 43°50′E.	Domestic refrigerator plant	150,000	Also produces bicycles, air-conditioners, and electric fans.
Moscow 55°45′N.; 37°35′E.	Moscow Motor Vehicle Plant *imeni* Likhachev (ZIL).	150,000	Primarily a motor vehicle plant. Also produces bicycles and washing machines.
Murom 55°34′N.; 42°02′E.	Refrigeration Plant *imeni* Ordzhonikidze.	100,000	
Orenburg 51°45′N.; 55°06′E.	Refrigerator Equipment Plant	88,000	
Rostov 47°14′N.; 39°42′E.	*Proletarskiy Molot* Plant	85,000	Basic products are refrigerators and washing machines but also produces various other consumer goods.
Sarotov 51°34′N.; 46°02′E.	Machine Building Plant Number 105	100,000	Also produces aircraft accessories.
Vasilkov 50°11′N.; 30°19′E.	Vasilkovskiy Works Refrigeration Plant.	120,000	

FIGURE 117. MAJOR PRODUCERS OF HOUSEHOLD WASHING MACHINES, 1965

LOCATION	PLANT	ESTIMATED ANNUAL OUTPUT	REMARKS
Alma Ata 43°15′N.; 76°57′E.	Alma Ata Low Voltage Equipment Plant	175,000	Also produces refrigerators.
Batumi 41°38′N.; 41°38′E.	Electrical Engineering Plant	75,000	Also produces refrigerators and vacuum cleaners.
Frunze 42°54′N.; 74°36′E.	*Krasnyy Mettalist*	150,000	
Kharkov 50°00′N.; 36°15′E.	Kharkov Galvanized Ware Plant	250,000	
Kishinev 47°00′N.; 28°50′E.	Electrical machinery plant *imeni* Kotovskiy	150,000	
Moscow 55°45′N.; 37°35′E.	Electromechanical plant *imeni* Vladimir Il'ich	60,000	
Do	Motor Vehicle Plant *imeni* Likhachev (ZIL)	70,000	Primarily a motor vehicle plant; also produces bicycles.
Omsk 55°00′N.; 73°24′E.	Omsk Washing Machine Plant	75,000	
Riga 56°57′N.; 24°06′E.	Electrical Machine Building Plant	400,000	
Sverdlovsk 56°51′N.; 60°36′E.	Ural Electric Appliance Plant	60,000	
Tula 54°12′N.; 37°37′E.	Shtamp Plant	300,000	Also produces sewing machines.

Approved For Release 2008/09/08 : CIA-RDP08S01350R000100030002-2

Approved For Release 2008/09/08 : CIA-RDP08S01350R000100030002-2

FIGURE 118. CONSTRUCTION OF HOUSING
(*Millions of square meters total space*)

YEAR	TOTAL	URBAN		RURAL		
		Constructed by state and cooperative organizations	Constructed by workers and employees*	Constructed by state organi-zations	Constructed by workers and employees*	Constructed by collective farmers and rural intelligentsia**
1959......	107.4	44.0	15.4	9.5	11.8	26.7
1960......	103.4	44.6	14.4	11.2	12.6	20.6
1961......	96.9	43.7	12.4	12.9	11.2	16.7
1962......	94.9	47.5	11.4	12.3	9.3	14.4
1963......	92.8	48.6	9.8	13.3	7.6	13.5
1964......	87.9	48.3	9.2	10.6	7.0	12.8
1965......	91.6	52.6	8.0	10.5	8.1	12.4

* At their own expense or with the help of state credit.

** Based on number of houses, converted to total area (average size house is 33.3 square meters).

FIGURE 119. MECHANIZATION OF CONSTRUCTION WORK, BY TYPE*
(*Volume of mechanized work in percent of total volume of work*)

	1959	1960	1961	1962	1963	1964	1965
Earthwork........................	*95.2*	*95.7*	*95.9*	*96.4*	*96.4*	*97.3*	*97.7*
Loading and unloading rock products..........................	*86.9*	*89.5*	*90.2*	*92.2*	*92.5*	*94.1*	*92.8*
Loading and unloading metals, lumber, metallic, concrete, and reinforced concrete structurals.......	*85.3*	*89.4*	*90.6*	*92.3*	*93.1*	*94.3*	*94.0*
Loading and unloading cement.....	*45.9*	*52.4*	*59.4*	*61.0*	*65.4*	*70.1*	*64.6*
Plastering........................	*53.6*	*57.6*	*58.2*	*58.7*	*58.1*	*59.2*	*59.5*
Painting..........................	*63.3*	*61.5*	*64.1*	*64.2*	*64.7*	*67.4*	*67.0*

* For 1959–64, the data cover contract organizations with an annual volume of work of 0.5 million or more rubles and projects built by the economic method at an estimate cost of 2.5 million or more rubles. For 1965, the data cover all contract construction organizations.

Approved For Release 2008/09/08 : CIA-RDP08S01350R000100030002-2

Approved For Release 2008/09/08 : CIA-RDP08S01350R000100030002-2

FIGURE 120. COMPLEX MECHANIZATION OF CONSTRUCTION WORK, BY TYPE*
(*Volume of complex mechanized work in percent of total volume of work*)

	1959	1960	1961	1962	1963	1964	1965
Earthwork	*88.0*	*90.3*	*91.0*	*91.8*	*92.8*	*94.0*	*94.2*
Installation of concrete and reinforced concrete structurals	*85.3*	*86.6*	*91.0*	*92.5*	*92.5*	*95.3*	*94.6*
Preparation of concrete	*78.1*	*79.0*	*81.8*	*84.0*	*86.4*	*88.2*	*79.7*
Preparation of mortar	*59.9*	*61.5*	*62.2*	*66.5*	*68.0*	*72.0*	*62.8*
Concrete work	*70.0*	*72.1*	*74.1*	*75.4*	*77.6*	*81.3*	*82.1*

* For 1959–64, the data cover contract organizations with an annual volume of work of 0.5 million or more rubles and projects built by the economic method at an estimated cost of 2.5 million or more rubles. For 1965, the data cover all contract construction organizations.

FIGURE 121. AVERAGE NUMBER OF WORKERS AND EMPLOYEES IN CONSTRUCTION*
(*Thousand persons*)

	1950	1958	1959	1960	1961	1962	1963	1964	1965
Persons engaged in construction (total)	4,087	5,933	6,208	6,555	6,642	6,596	6,723	6,896	7,217
Persons engaged in construction-installation work	2,603	4,442	4,800	5,143	5,270	5,172	5,237	5,370	5,617
Workers (including apprentices)	2,297	3,921	4,238	4,544	4,638	4,502	4,544	4,640	4,813
Engineer-technical workers	156	311	355	385	416	443	461	492	549
Employees	150	210	207	204	216	227	232	238	255
Persons engaged in support industries and services	1,484	1,491	1,408	1,412	1,372	1,424	1,486	1,526	1,600

* The data include personnel engaged in repair-construction offices, machine rental bases, intercollective farm construction organizations, and industries servicing construction.

FIGURE 122. PRODUCTION OF WALL MATERIALS
(*Millions of standard bricks*)

	1958	1959	1960	1961	1962	1963	1964	1965
Construction bricks	28,689	33,143	35,500	36,694	35,979	35,183	35,939	36,923
Natural stone	3,804	4,275	4,666	4,744	4,135	3,911	4,195	4,495
Large blocks	984	1,145	1,327	1,508	1,614	1,602	1,521	1,632
Other blocks	3,610	3,448	3,014	2,480	2,326	2,162	1,984	1,949
Wall materials, excluding precast reinforced wall panels	37,087	42,011	44,507	45,426	44,054	42,858	43,639	44,999
Precast reinforced concrete wall panels	72	182	477	941	1,478	1,935	2,580	3,162
Total all types of wall materials	37,159	42,193	44,984	46,367	45,532	44,793	46,219	48,161

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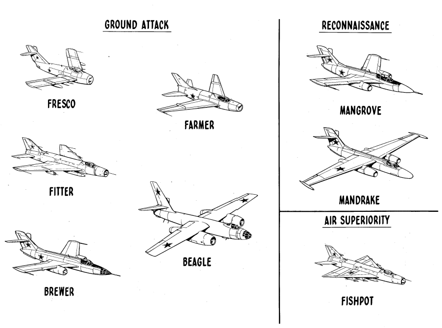
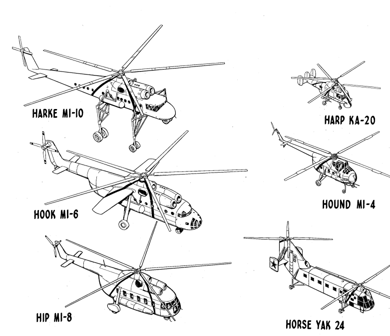
Approved For Release 2008/09/08 : CIA-RDP08S01350R000100030002-2

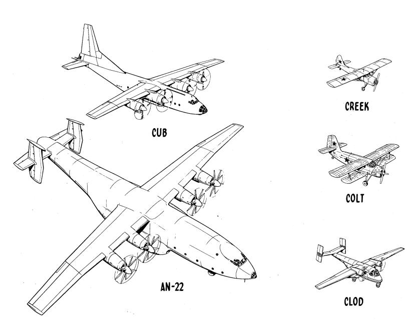
Approved For Release 2008/09/08 : CIA-RDP08S01350R000100030002-2



Typical ground attack, air superiority (fighter/interceptor), and reconnaissance aircraft



Helicopters



Transport/utility aircraft

Approved For Release 2008/09/08 : CIA-RDP08S01350R000100030002-2

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