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Economic Intelligence Report

THE INSTRUMENT INDUSTRY OF THE USSR

CIA/RR ER 61-51

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CENTRAL INTELLIGENCE AGENCY

Office of Research and Reports

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FOREWORD

This report analyzes information on production and distribution of precision instruments in the USSR, including the history of production before 1959, current and projected production and requirements, major facilities for research and production, characteristics and problems of production, trends in technology, and patterns of distribution.

This report also attempts to define the categories of production that are included in the Soviet instrument industry, a task made difficult by the ambiguous and conflicting nature of Soviet statements on the subject. The report further attempts to determine the categories of instruments that are included in Soviet statistical reporting on the value of output of instruments.

For the most part, this report treats the instruments industry as a whole, analysis in depth of the various branches of the industry being left for future research.

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THE INSTRUMENT INDUSTRY OF THE USSR*

Summary

The USSR has a large and expanding instrument industry that has grown rapidly in the last decade and is scheduled for continued rapid growth during the period of the Seven Year Plan (1959-65). In connection with the ambitious goals for mechanization and automation of industry, production of process control instruments is receiving particular emphasis and is expected to increase at a considerably faster rate than is production of other types of instruments. Current production of instruments is insufficient in terms of both quantity and product mix to meet the requirements of the Soviet economy. Although the gap between production and requirements will be narrowed in the course of the Seven Year Plan, production of instruments in 1965 will still lag behind requirements.

Although the Russians produced some types of instruments before the Bolshevik Revolution, output of a comprehensive range of items did not begin in the USSR until after World War II, and not until the middle of the decade of the 1950's did Soviet industry produce the more sophisticated types of instruments in large quantities. Production of instruments during 1956-59 is estimated to have increased at an average annual rate of 25 to 30 percent. In 1960, production increased only 18 percent to a total value of output of 1.1 billion rubles.** The 1961 plan calls for an output of 1.3 billion rubles, and output in 1965 is expected to reach 2.4 billion to 2.5 billion rubles. The industry therefore is expected to exceed its original Seven Year Plan goals of 1.85 billion to 1.92 billion rubles as early as 1963 or 1964. Thus, instead of an average annual rate of growth of 14.3 percent as apparently programed under the original terms of the Seven Year Plan, it is estimated that the rate of growth will be about 18.7 percent per year. During 1959-60 the rate of growth averaged slightly more than 22.5 percent per year. The estimated annual rate of growth of 18.7 percent for the Seven Year Plan is believed to be within the capability of the industry, which is expected to have considerable additional capacity available for production of instruments in the remaining years of the plan. The marked attention given by Soviet officials

* The estimates and conclusions in this report represent the best judgment of this Office as of 1 November 1961.

** Except for data on foreign trade, ruble values in this report are given in new rubles (based on the Soviet currency reform of 1961) and may be converted to US dollars at the rate of exchange of 0.4 ruble to US $1, which is believed to reflect relative costs of similar instruments in the US and the USSR.

to mechanization and automation in 1959 and 1960 and to the industries that provide equipment for this program suggest that a high priority will be accorded the instrument industry in its efforts to achieve a high level of production by 1965.

During the period of the Seven Year Plan the structure of the industry will change appreciably. Production of process control instruments, which constituted only 12 percent of the total production of instruments in 1958, is expected to comprise 28 percent of the total production in 1965. The share of timepieces in the total production is scheduled to decrease from 23 percent in 1958 to 18 percent in 1965. These changes are reflected in the following tabulation:

Category	Percent of Total Production	
	1958	1965
Electrical measuring instruments	13.0	14.8
Process control instruments	11.7	27.8
Calculators and computers	7.0	9.4
Instruments for measuring mechanical quantities	9.3	7.7
Timekeeping devices	23.0	18.3
Other instruments	36.0	22.0
Total	100.0	100.0

In spite of rapid growth, the Soviet instrument industry lags well behind its US counterpart. Soviet production of instruments in 1958 probably was about two-fifths of that of the US. The US instrument industry also has been growing rapidly, at an average annual rate of 11 percent since World War II, and is expected to increase even faster in the next 15 years. Even if the USSR achieves a production of 2.5 billion rubles of instruments in 1965, Soviet output of instruments in that year probably will be no more than two-thirds that of the US.

Approximately 263 industrial plants in the USSR are principally engaged in production of instruments, and a number of research institutes also produce small quantities. Of these 263 plants, 71 plants (the largest category) have been identified as producers of process control instruments, and 28 produce optical instruments; 23, electrical measuring instruments; 20, timekeeping devices; and 19, weighing devices. The urban areas of Moscow, Leningrad, and Kiev have the heaviest concentrations of plants, although instrument plants are located in all industrial regions of the USSR. In spite of the large number of plants

now in existence, the industry is receiving substantial investment allocations for the construction of new plants and the expansion of a large number of those now in existence. This investment is estimated to range between approximately 700 million and 1 billion rubles during the Seven Year Plan, or 6 to 8 percent of the 11.8 billion rubles originally planned for investment in the machine building and metalworking sector during 1959-65.

Employment in the instrument industry in 1959 is estimated to have been 280,000 to 290,000, which is about 5 percent of employment in the machine building and metalworking sector in 1959.

The USSR is in a far better position now than it has been in the past insofar as an adequate supply of a comprehensive range of modern instruments is concerned, but the requirements of industrial users are growing so rapidly that the instrument industry has not been able to keep pace with the demand. A recent Soviet study indicates that production of instruments and automation equipment* in 1958 satisfied only 60 percent of domestic requirements and that the requirements for some types of instruments were satisfied only to the extent of 20 to 40 percent. Moreover, it is unlikely that the requirements of the using industries will be satisfied as to either quantity or quality of instruments by the end of 1965.

The technology of Soviet instruments has improved greatly in the last decade. At present the general range of Soviet technology and its degree of sophistication are still lagging behind the US, although the gap is closing in many areas, the most significant of which is in the field of automation equipment. The USSR is currently believed to be about on a par with the US in theory of automation but well behind the US in application of automation. A vast network of research organizations has been brought into being to devise new equipment, raise the efficiency and quality of production, direct the implementation of the automation program, and overcome the general lag in automation application. As a result of the concentration of effort, the Soviet lag in this area should steadily decrease. Instrumentation in such fields as guidance, upper atmosphere research, and telemetry is believed to be of a high order of technology. Soviet optics are considered to be very good. Instruments used in electron microscopy, ultra-high-energy physics, and gas chromatography lag behind the US in quality of workmanship and in sophistication.

* The term automation equipment is defined in the USSR as including sensors, amplifiers, electronic data-processing equipment, and servomechanisms.

The USSR has emphasized the development of radioactive isotopic devices and may be using them to a much greater extent than is the practice in the US.

Soviet analog computers, although not comparable with the better US models, are adequate for a wide variety of important applications. In contrast, Soviet digital computers are markedly inferior to those of the US.

Although all sectors of the Soviet economy will have a share of output of the instrument industry, the greater part is channeled into domestic industrial use or goes to the armed forces. Such key areas as the chemical, petroleum-processing, and metallurgical industries receive large quantities of this equipment. Currently the USSR supplements its output of instruments through selective imports of small quantities of high-priority items, such as process control instruments, from the Free World and the three major Satellite producers (East Germany, Czechoslovakia, and Hungary). Soviet exports of instruments to either the remainder of the Bloc or the Free World are small in quantity and are about evenly divided between scientific and industrial types on the one hand and consumer goods types -- timekeeping devices and photographic and cinematographic equipment -- on the other.

I. Introduction

An instrument is any device used in observing, measuring, controlling, recording, computing, or communicating. Instruments and instrument systems refine, extend, or supplement human faculties and abilities to sense, perceive, communicate, remember, calculate, or reason. The human senses are refined or extended by such devices as surface-roughness and contour gauges, micrometers, chemical analyzers, pH meters, microscopes, telescopes, gyrostabilized platforms, range finders, and many others. Other instruments, such as magnetometers and cosmic-ray counters, sense or measure physical quantities for which there is no physiological sense developed in human beings. Still other instruments (such as cameras, correlators, simulators, and computers) perform functions of storing, transmitting, or processing information signals in ways analogous to, or going beyond, human abilities to record, remember, communicate, compare, count, and apply logical operations systematically.

The following list includes some of the more important functions of instruments or components of instrumentation systems in creating or handling signals (or information or data): excitation, generation, modulation, detection, comparison, amplification, differentiation, integration, attenuation, conversion, switching, counting, coding, timing, programing, correlating, linearizing, correcting, displaying, recording, reducing, analyzing, computing, and controlling. Because all branches of experimental science and technology depend on instrumentation, specialized instruments (with a corresponding body of knowledge and practice) have been developed separately in many fields. Thus chemical, aeronautical, medical, and optical instrumentation among other types of instrumentation indicate areas of specialization in various industries or professions. Most types of instrumentation, however, have so-called "universal" usage -- that is, they can be used by a large number of diverse consumers without major modifications.

Instruments are sometimes classified according to their field of purpose or application, such as navigation instruments, surveying instruments, or oceanographic instruments; according to their functions in instrument systems, such as detection, measurement, recording, computing, controlling, signal modification, or display; or according to the physical quantity or property that is to be measured or controlled by the instrument, such as flow, temperature, pressure, force, displacement, level, viscosity, acceleration, electrical quantities (voltage, current, resistance, and capacitance), and optical qualities (transmission, gloss, color, and brightness). Another method of designating or classifying instruments, particularly those of wide applicability, is according to

operating principles, examples being X-ray instruments (microscopes and diffractometers); spectrometric instruments of various types for various portions of the frequency spectrum or various particles (including infrared, ultraviolet, visible, microwave, X-ray, gamma-ray, neutron, electron, and alpha particles); and pneumatic, mechanical, electronic, electrical, magnetic, hydraulic, nuclear, acoustic, optical, and photographic instruments. Each of the methods of classifying instruments is useful only in specific instances. A single instrument or instrument system may utilize many combinations of different principles. A given instrument often has many applications. Any physical quantity may be measured by a number of different principles. Each of the many operations performed in handling the flow of information in instrumentation systems may be accomplished by various techniques and devices. Thus no single method of classifying instruments is possible, and the several methods are used where they apply.

In the USSR the instrument industry is referred to as priborostroyeniye (instrument manufacturing) and the products of the industry as pribory i sredstva avtomatizatsii (instruments and automation equipment). This industry is a branch of machine building, and its enterprises produce most types of precision instruments (including some devices not usually regarded as precision instruments, such as photographic and motion picture apparatus, watches and clocks, and calculating machines for office use). Soviet accounting procedures for reporting physical production of instruments narrow this list by omitting, apparently, value figures for production of cameras and clocks and watches, output of which is reported separately by units. Also, the Soviet instrument industry apparently does not include among its list of products such categories as medical and dental instruments, machinists' precision tools, or X-ray equipment (either medical or industrial). 1/*

II. Production Facilities and Output of Precision Instruments

A. Before 1959

Production of instruments dates back to the Tsarist period in what is now the USSR, but significant production of such equipment did not begin until early in the 1920's with the establishment of plants for large-scale production of clocks and watches, weighing devices, and temperature-measuring devices. 2/ Simple devices for instrumentation and testing, such as theodolites, microscopes, metal-analyzing devices, and rudimentary electrical and thermal control instruments, began to be produced in volume during the First Five Year Plan (1928-32). 3/ In compari-

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son with similar products of Western Europe and the US, these instruments were crude and inferior, and the USSR depended on imports for most of the more complex precision instruments.

Before World War II, production facilities were concentrated largely around Moscow, Leningrad, and Kiev. These plants were relocated to the east when the German Army overran the western USSR. When the German Army was thrown back, many of the individual plants were reestablished in their former locations, leaving all or most of their production machinery and a good portion of their labor force at their relocated facility, which thenceforth was to have a separate identity. This arrangement did not work a hardship, however, as Soviet instrument plants at about the same time received a massive growth stimulant in the form of dismantled German instrument plants and machinery and conscripted German scientists and technicians. For example, shortly after the Soviet forces took over Dresden in 1945, they drew up elaborate floor plans of the Zeiss Ikon Plant, then dismantled the plant and moved everything, including light fixtures and key workman, to the USSR. This technique was employed in Jena, Berlin, Rathenow, and other centers of the German optical and precision instrument industry. 4/ More than 90 percent of the Carl Zeiss Plant in Jena, which before World War II was preeminent in the field of optical equipment, was dismantled and sent to reestablished plants in Krasnogorsk, Kiev, and Leningrad. In addition, the Saxonian watch industry in Glashuette was completely dismantled. 5/ With the possible exception of the machine tool industry, the USSR placed greater emphasis on the systematic and thorough dismantling of optical plants than it did on any other branch of German industry. 6/ Apparently the Red Army also dismantled some of the optical plants of other occupied countries, such as, for example, the Magyar Optikai Muvek (Hungarian Optical Plant) in Budapest. 7/

These gains were reflected in the industrial record of the first two postwar 5-year plans. The USSR made considerable progress in production of simple quality control instruments and optical instruments. Great stress also was placed on achieving large-volume production of process control instruments, 8/ but the complexity in designing and producing such equipment apparently caused the program to fall behind schedule in the Fourth Five Year Plan (1946-50).

Production of watches and clocks, however, jumped from about 0.3 million units in 1945 to almost 7.6 million units in 1950 and 19.7 million units in 1955 (the probable prewar high-water mark was 4.5 million units in 1935). Production of cameras also made a strong postwar recovery from virtually none in 1945 to 0.3 million units in 1950 and 1.0 million units in 1955 (the probable prewar high-water mark was 0.4 million units in 1940). 9/

By 1951, Moscow and Leningrad were still the most important centers of production of instruments, with 16 plants in the former and 14 in the latter city accounting for about 20 and 15 percent, respectively, of the total production of instruments. 10/ By the end of the Fifth Five Year Plan (1951-55), production of computers and process control instruments moved into high gear.

All types of instruments continued to be produced at an expanding rate. During the Fifth Five Year Plan, production tripled.* In 1955, output of process control instruments was 2.8 times that of 1950; of calculators and computers, 7.4 times; and of instruments for gas analysis, 3 times. 12/ Production of timekeeping devices and cameras more then doubled, 13/ as indicated below:

	Thousand Units				
	1951	1952	1953	1954	1955
Timekeeping devices	9,645	10,486	12,838	16,397	19,705
Cameras	357.2	459.1	499.1	767.9	1,022.5

In spite of its impressive rate of growth in production of instruments, the USSR found itself hampered by several nagging problems. As the country moved into the abortive Sixth Five Year Plan (1956-60), instruments were being produced in large numbers by more than a dozen different ministries,** [redacted] 50X1
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Each ministry often manufactured instruments solely for its own use. 16/ Also, output of instruments fell far short of satisfying the needs of the national economy. 17/ Not enough instruments were being produced, and, in comparison with the West, the level of technology was lower. Production often included obsolete items, 18/ and shortages of raw materials and components were frequent problems. 19/ As if these problems themselves were not enough, the Sixth Five Year Plan called for production of instruments worth 700 million rubles in 1960.*** 21/

* [redacted] production of instruments in 1955 was 50X1
2.7 times that of 1950 rather than 3 times. 11/

** For example, most of the optical instruments were produced by the Ministry of Defense Industries; electrical measuring instruments were produced principally by both the Ministry of Electric Power Stations and the Ministry of Electrical Engineering Industry; and process control instruments were produced by more than half a dozen ministries. 14/

*** The goals under the Sixth Five Year Plan varied for different categories of instruments, as follows: process [footnote continued on p. 9]

Early in 1956 the Council of Ministers of the USSR divided the Ministry of Machine and Instrument Building into two separate ministries, one of which was the Ministry of Instrument Building and Automation. The new ministry inherited those instrument plants under the jurisdiction of its predecessor and was to coordinate production of measuring instruments and automation equipment and speed up production. 22/ The new ministry apparently was simply another of the many ministries producing instruments, and there is no indication that it solved or alleviated any of the nagging problems. 23/ This ministry and all other instrument-producing ministries were swept away in the general administrative reorganization of industry in the summer of 1957. Over-all planning functions for the instrument industry were shifted to Gosplan and perhaps other state committees as well. Instrument plants fell under the jurisdiction of the various sovnarkhozes (Councils of the National Economy).

During the first 3 years of the Sixth Five Year Plan, output of instruments continued to rise sharply at an average annual rate of 25 to 30 percent. The value of instruments produced in 1958 24/ (excluding watches, clocks, and cameras) is estimated to have been slightly less than 740 million rubles. Growth of production of consumer goods (watches, clocks, and cameras) was sluggish, as indicated by the following official figures 25/:

	Million Units		
	1956	1957	1958
Timekeeping devices	22.6	23.5	24.8
Cameras	1.2	1.3	1.5

At a time when most branches of the machine building sector were failing to achieve the levels of production called for by annual plan goals during the Sixth Five Year Plan, the instrument industry in 1958 had already exceeded the 1960 goals established by the Sixth Five Year Plan, thanks to the construction of new plants, the expansion of existing ones, and the conversion of certain plants to production of instruments. In spite of the rapid growth of the industry, production of instruments in 1958 was still insufficient in terms of both quantity and product mix.

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control instruments, 4 times that of 1955; electrical measuring instruments, 3.6 times; calculators and computers, 4.5 times; and optical-mechanical instruments, 3 times. 20/

B. Seven Year Plan (1959-65)

1. Organization and Administrative Structure

The sovnarkhoz system of administration was in full operation by the beginning of the Seven Year Plan. The large number of monolithic, Moscow-centered ministries had been replaced by the sovnarkhozes as supervisors of individual plants, although ultimate authority and policymaking powers had been retained by functional state committees under the Council of Ministers, USSR. The day-to-day responsibility for distribution of raw materials, the appointment of principal officials of the plants, and other forms of direct control, however, were now vested in functional administrations subordinate to sovnarkhozes.

The designation of these administrations varies from one sovnarkhoz to another, depending on the volume and character of the industrial production of the sovnarkhoz. Ordinarily, if there is a significant volume of production of instruments, there is an Administration of Electrical Engineering Industry and Instrument Making, as in the Belorussian Sovnarkhoz, or an Administration of Radio Engineering and Instrument Making, as in the Moscow city Sovnarkhoz, or simply an Administration of Instrument Making, as in the Lithuanian and L'vovskiy Sovnarkhozes. 26/ If production of instruments is of minor importance, responsibility for instrument plants may be lodged in an Administration of Machine Building, as in the Estonian and Kirgiz Sovnarkhozes. 27/

The sovnarkhoz directs and monitors production activity. It also is believed to have an important voice in appointing or removing major officials at instrument plants, in establishing what a plant should produce, and in instituting corrective action for any plant failing to meet its plan goals or being remiss in controlling the quality of its production.

Gosplan, USSR, through its Division of Electrical Engineering and Instrument Making Industry, together with its counterpart at the republic level,* gives final approval to the plan for production of instruments after consideration of the recommendations of sovnarkhozes and other interested governmental organs. In some instances, Gosplan, USSR, or its counterpart in one of the larger republics will even designate the plant that is to produce or cease to produce a specific item. 29/ In addition, the gosplan of a major republic apparently assigns to individual plants

* As in the sovnarkhozes, the designations are believed to differ slightly in the various republics, depending on the importance of the industry. In the smaller republics, the areas of which coincide with the areas of individual sovnarkhozes, there may not be a separate Gosplan division for instruments. 28/

the specific development responsibilities for a new instrument. Gosplan, USSR, also establishes wholesale and retail prices for instruments. 30/

The new system of administration has provided the instrument industry with a greater degree of both centralization and decentralization. The assumption by Gosplan, USSR, of certain control functions previously dispersed among the many ministries responsible for production of instruments has provided the opportunity for treating the country's instrument industry as an integrated unit. This increased centralization makes possible the elimination of unnecessary duplication in both research and development and production. The benefits of centralization, however, presuppose effective coordination among various centralized bodies, some of them new, which have responsibilities in the field of instrumentation. In addition to Gosplan, USSR, these bodies include the State Committee on Automation and Machine Building; the State Committee on Standards, Measures, and Measuring Instruments; and the recently formed Committee for Coordination of Scientific Research Work. Statements in the Soviet press indicate that the degree of coordination necessary for these organizations to furnish unified policy guidance and over-all control has not yet been achieved.

The increased degree of decentralization has been provided by sovnarkhoz administration of local plants, which has made possible better coordination of production of instruments at the regional level. This system also seems to have enabled the older, smaller, and more backward plants to improve their production capacity by relieving them of the responsibility for manufacturing extraneous products and enabling them to specialize in the output of fewer items. Sovnarkhoz operational control at the local level, however, is not complete. There is evidence that the Division of the Electrical Engineering and Instrument Industry of Gosplan, USSR, and the Division of Electrical Engineering and Electronics of the State Committee for Automation and Machine Building not only exercise over-all policy guidance and control but also can interfere in operations at the plant level. 31/

Certain problems that were supposed to have been solved by the reorganization of industry -- such as continued production of obsolete instruments, insufficient cooperation between plants, and poor allocation of materials -- have not been eliminated under the new administrative system, although they have been alleviated.

Long-range policy guidance for the instrument industry comes from the Communist Party itself. A recent example is the Plenary Session of the Central Committee of the Communist Party of the USSR, held on 24-29 June 1959. At this meeting, certain specific tasks were pinpointed for the industry. These tasks included a requirement for improving the present product list of instruments and instructions for the principal

administrative organizations to cooperate in drawing together within a 6-month period a list of proposals for review by the Council of Ministers, USSR, to improve the organization, coordination, and control of the most important research, experimental, and planning operations of instrument development. 32/ Other actions included an order to emphasize the standardization of certain categories of instruments and a reiteration that the development of specialization and cooperation of industrial installations of the industry are important programs of the Seven Year Plan. 33/ The Party devoted another plenary session to this subject in July 1960.

2. Production and Research Facilities

a. Major Plants

It is estimated that there are 263 plants in the USSR that are principally engaged in production of instruments.* The number of plants under the industry is growing each year as new ones are built or converted to production of instruments. Since the beginning of the Seven Year Plan, between 30 and 40 new plants have been identified.** It is quite likely that perhaps an equal number may be added to the list during the remainder of the plan period, although few of these will reach significant levels of production by 1965.

In addition to the new plants being added to the industry, there is an impressive expansion program for many of the existing plants. For example, the Leninakan Instrument Plant during 1960 was to have increased its facilities by the construction of new shops worth 1.8 million rubles, 34/ and the Baku Machinery and Instrument Plant imeni Kalinin began a reconstruction program in the middle of 1959 which, when completed, reportedly will enable the plant to increase its output 20 times by the end of the Seven Year Plan. 35/ Similarly the Leningrad Vibrator Plant, one of the oldest and largest manufacturers of electrical instruments, is adding an additional one-third to its present 400,000 square feet of floorspace. 36/

The question of how much it is costing the USSR to build 30 to 40 new plants and to expand a large number of existing plants is intriguing. No official figures have been released, and the few references to capital investment in the industry have been disappointingly brief and vague. On the basis of available data, however, it is believed that during

* For a list of plants known or suspected to be producing significant quantities of instruments in the USSR, see Appendix A. For a list of major plants producing instruments in the USSR, see Appendix B.

** Not all of these plants have actually gone into production. Construction has just begun on some, and still others have not yet progressed beyond the planning stage.

the Seven Year Plan period the USSR may invest between approximately 700 million and 1 billion rubles for new and expanded plant facilities,* which is 6 to 8 percent of the 11.8 billion rubles originally planned for investment in the machine building and metalworking sector during the Seven Year Plan.

Not all output of the industry comes from the regular producing plants. Some of the research institutes, which do design and development work (generally of a theoretical nature), also often produce prototypes or have a limited output of highly technical or complex instruments. For example, the Institute of Optics (GOI) imeni S.I. Vavilov in Leningrad, which is primarily a research facility, is believed to manufacture limited quantities of the Linnik microscope, profile interferometers, portable polarizing microscopes, fluorescent microscopes, high-temperature microscopes, and diffraction gratings. 37/ The Central Laboratory of Automatics of the Ministry of Construction, RSFSR, in 1960 produced its first consignment of high-speed automatic photoelectric pyrometers. 38/ Still other institutes have "experimental works" where large-volume production is carried out, as at the Experimental Works of the Ural Scientific Research Institute of Chemistry, which is producing electrical instruments and exporting them to Communist China, Burma, India, Rumania, Poland, and other countries. 39/ Or, again, there is the Experimental Production Division of the Institute of Physics, Academy of Sciences, Ukrainian SSR, which recently began the series production of bolometers, high-precision instruments designed to detect very slight temperature changes. 40/

The western part of the USSR contains most of the plants of the instrument industry, although instrument plants are located in all of the industrialized regions of the country. The largest localized concentration of plants is around Moscow (34 plants), Leningrad (31 plants), Kiev (17 plants), Khar'kov (7 plants), and Minsk (7 plants). These five urban areas contain more than one-third of the 263 plants of the industry.

The size of the labor force at the plants of the industry varies widely.** Of a group of 30 plants for which recent employment figures are available, the range is from 200 employees in the Tashkent Gidrometpribor Plant to 12,000 at the Leningrad State Optical Machinery Plant imeni OGPU. 41/ On the basis of derivative data, it is estimated that there were 280,000 to 290,000 employees in the instrument industry in 1959, or about 5 percent of the 6.2 million employees that are estimated

* For an analysis of factors used in reaching this conclusion, see Appendix C.

** For the methodology used in computing the labor force of the instrument industry of the USSR, see Appendix D.

to have been in the machine building and metalworking sector of industry in 1959. The number of women employed by the industry is high, possibly constituting more than half of the labor force. Illustrative of the large number of women employed are the Moscow Timepiece Plant [redacted] where 80 percent of the 7,500 workers are women 42/; the Leningrad Vibrator Plant, where 64 percent of the 3,500 employees are women 43/; and the Leningrad Electrical Machinery Plant, where 80 percent of the 1,500 employees are women, many of whom are girls just out of high school. 44/ The ratio of women employed in comparable industries in the US is believed to be far below these levels. 50X1

Apparently the Soviet instrument industry is not dependent on any one plant for the entire output of any one category of instruments. In 1958, however, two plants, the Moscow and the Penza Analytical and Calculating Machine (SAM) Plants, are believed to have produced, by value, approximately 83 percent of production of electronic computers in the USSR. This concentration of production of computers is expected to lessen in the Seven Year Plan as new plants go into production. Five computer plants are presently in various states of construction, and 22 plants are to be producing computers by the end of 1965. 45/

Of the 263 plants believed to be serving the instrument industry, those plants principally engaged in output of process control instruments comprise the largest single category, with optical instrument facilities the next largest. The following is a rough estimate of plants engaged in the output of various categories of instruments:

Category	Number of Plants
Process control instruments*	71
Unknown and other instruments (including, among other categories, testing machinery, industrial jewels, and certain scientific instruments)*	61
Optical instruments (including photographic, cinematographic, and film-processing equipment)	28
Electrical measuring instruments*	23
Timekeeping devices	20
Weighing devices	19
Calculators and computers	12
Aircraft instruments	9
Geodetic and geophysical instruments	7
Hydrographic and meteorological instruments	7
Watt-hour meters	6

* Because of the problem of classifying some types of instruments, it is possible that several plants should be listed under another category of instruments.

b. Research Facilities

An impressive research effort supports the production program for instruments. Research and design organizations exist at many governmental levels in the USSR and for all the scientific disciplines of interest to the industry. There has been a general proliferation in both type and number of such organizations in recent years and an increase in their importance. This rank growth apparently has not been accompanied by stringent control or delineation of programs in spite of the fact that in theory, at least, there is a high degree of centralization. The field is a jungle of confusing administrative subordination and overlapping functions and responsibilities. 46/

In the spring of 1961 a shakeup evidently took place in the administration of all scientific research, including that pertaining to instruments. A new agency, the State Committee for Coordination of Scientific Research Work, was created with broad administrative powers. Specific functions of this new committee are somewhat vague but seem to be primarily concerned with a reduction in the span of time between product development and production, a general tightening up of coordination and direction of collection and dissemination of scientific information, and (probably the most significant of all) a major voice in the preparation of annual plans for financing Soviet scientific research and capital investment in research facilities. 47/

Most of the major plants have their own research and development personnel and facilities, which generally are supposed to limit their efforts to engineering modifications and improvements and to expansion of product application. Some of the plants occasionally engage in more or less basic design work on their own, but such research is supposed to require the agreement of superior scientific bodies. 48/ The latter are made up of research institutes (NII's and VNII's) and design bureaus (KB's and SKB's). 49/

It is these organizations that do the major design and development work. At their head is a group of administrative bodies that collectively exercise either direct or indirect supervision over all design and development work pertaining to instruments and also are vested occasionally with broad powers over the entire machine building and metalworking sector. These administrative bodies include the following: (1) State Committee for Coordination of Scientific Research Work of the Council of Ministers, USSR; (2) Committee on Standards, Measures, and Measuring Instruments (which is attached to the Council of Ministers, USSR, and to some extent is comparable to the US National Bureau of Standards, although more powerful); (3) Main Administration of Scientific Research Institutes and Planning Organizations (under Gosplan, USSR); (4) State Committee on Automation and Machine Building of the Council of

Ministers, USSR; and (5) Academy of Sciences, USSR. 50/ Among these scientific organizations the State Committee on Automation and Machine Building plays an important role in the formulation and supervision of plans for the introduction of automation and production processes into all the branches of national industry and the development of new (and the improvement of existing) instruments and automation equipment. 51/

Each of the research institutes and design bureaus solves the basic research and development problems associated with its own specialized field of application.* Major institutes have branches located in some of the principal cities, and each of these branches serves a sovnarkhoz in the same area of specialization as its parent organization. An example is Kirovakan NIIAvtomatika in the Armenian SSR, which is subordinate to the State Committee on Automation and Machine Building of the Council of Ministers, USSR. 52/ The responsibility of the institute and its branches is to work in the realm of theory, and when the capability of a device to function has been satisfactorily demonstrated, the project is passed on to a design bureau. The latter bureau works on precisely defined individual projects for the creation of specific types of items and performs all development work to the point of readiness for production. At this point a designated plant is given the necessary technical documentation relating to the developed item and, on approval of the sovnarkhoz, will produce the new item. 53/

Although theoretically none of the research facilities is to engage in production of equipment, it is evident that they often engage in custom production or small series production, particularly at so-called experimental plants. 54/ In addition, the degree of teamwork and support rendered by the various research facilities appears to be uneven. An example is evident in a recent complaint by the Mytishchi Electric Meter Plant. In attempting to gather data on the effects of mechanical wear in bearings of electric meters, it asked for help from the Leningrad branch of VNIIEP, the All-Union Scientific Research Institute of Electrical Measuring Instruments.** In response, VNIIEP apparently sent a survey team which gathered some statistics. Neither VNIIEP nor its survey team furnished the plant with any data or recommendations. A survey team from VNITIPribor, the All-Union Scientific Research Technological Institute of Instrument Making,*** was in the plant at the same time, and, instead of pooling resources and cooperating, the two teams went through the plant duplicating each other's questions. 55/

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* For a list of the research organizations of special importance to the precision mechanism and automation equipment industry, see Appendix E.

** Vsesoyuznyy Nauchno-Issledovatel'skiy Institut Elektroizmeritel'nykh Priborov.

*** Vsesoyuznyy Nauchno-Issledovatel'skiy Tekhnologicheskiy Institut Priborostroyeniya.

The problem of duplication of effort has been of real concern to the government. Late in 1957 it was reported that more than 40 organizations were engaged in the development or application of ultrasonic instruments and that 18 worked on computers, and in 1960 more than 20 organizations were involved in the designing of flow meters and level meters. 56/ In addition, it appears that tight control of research, through various high-level institutes such as clearinghouses, is not always effective. Visitors to the Institute of Automatics and Telemechanics of Gosplan, Ukrainian SSR, in mid-1960 concluded from discussions with officials of the institute that there was a strong trend toward decentralization of research and development. Thus each republic and even each plant would work out its own methods of automation. 57/ Unless some new form of stringent control is exercised, it appears that this trend could effectively vitiate the coordination of research and development.

A close tie among industrial plants, scientific organizations, and administrative organs is obtained through the trade journals, which are published by the scientific bodies and which furnish policy guidance and specific details on theory or recent developments in instrumentation for the benefit of research and design facilities and manufacturing establishments. Among the most important are Mekhanizatsiya i avtomatizatsiya proizvodstva (Mechanization and Automation of Production) and Priborostroyeniye (Instrument Manufacture), published jointly by the State Committee on Automation and Machine Building of the Council of Ministers, USSR, and the Central Administration of the Scientific and Technical Society of the Instrument Industry, and Izmeritel'naya tekhnika (Measurement Techniques), Avtomatika i telemekhanika (Automation and Remote Control), and Pribory i tekhnika eksperimenta (Instruments and Equipment for Experiments), all published under the auspices of the Academy of Sciences, USSR.

In spite of the multiplication of scientific organizations in recent years, it is likely that there will be even more in the future. At the beginning of 1960 it was announced that the number and scope of projects connected with instrument design and development work were beyond the capabilities of existing NII's and KB's and that new NII's and KB's would be created (some of which will be attached to the larger manufacturing establishments) and existing ones expanded. 58/ Process control instrumentation was singled out for increased developmental emphasis in the future. 59/

3. Production and Goals

a. Levels of Production

Production of instruments during the first 2 years of the Seven Year Plan increased 27.5 percent in 1959 and 17.9 percent in

1960 compared with an average annual rate of growth of 14.3 percent required to meet the Seven Year Plan goal for 1965.

It is probable that the Soviet instrument industry has set its sights considerably higher than the Seven Year Plan goal for 1965 of 1.8 billion to 1.9 billion rubles. Shortly after the publication in November 1958 of Khrushchev's theses for the Seven Year Plan, a leading official in the instrument industry asserted that these goals were insufficient, and he submitted some rough calculations to prove that an output of 2.4 billion to 2.5 billion rubles would be required in 1965 to meet the requirements of the economy for instruments. 60/ A goal of this magnitude would require an average annual rate of growth of 18.7 percent for 1959-65. The increases in production that were achieved during 1959-60, coupled with the planned increase of 21 percent for 1961, suggest that the USSR will reach a level of production of 2.4 billion to 2.5 billion rubles in 1965. To accomplish this goal would require absolute annual increments to production during 1961-65 of 258 million to 278 million rubles, which are considerably greater than the increments of 203 million and 169 million rubles achieved, respectively, in 1959 and 1960. The priority attention devoted to the instrument industry in recent years, however, and the program for mechanization and automation of Soviet industry, the growing number of new instrument plants, and the widespread program for expansion of existing instrument plants all indicate an effort that makes feasible the achievement of the level of 2.4 billion to 2.5 billion rubles.

The planned, actual, and estimated value of production of instruments* for selected years, 1958-65, is as follows 61/:

Million Rubles

1958	1959	1960	1961 Plan	Original 1965 Plan	Probable Level of Production in 1965
739	942	1,111	1,344	1,850 to 1,920	2,400 to 2,500

* These statistics include production of optical-mechanical instruments and apparatus, electrical and electronic measuring instruments, calculators and computers, instruments for the control and regulation of thermal-energy processes, instruments for measuring mechanical magnitudes, instruments for navigation and piloting, and instruments of time but do not include cameras, [footnote continued on p. 19]

For a graphic presentation of production of instruments during this period, see the chart.*

Information on production by individual category of equipment is extremely meager. Classification of instruments tends to be arbitrary and occasionally misleading, as even the leading Soviet professional journal in the field of instrument manufacture admits, as follows:

> When examining [the planned change in production of instruments in 1965 compared with 1958] it is necessary to keep in mind that we have treated in a somewhat arbitrary manner the distribution of instrument production by groups. It is clear, for example, that some electrical measuring instruments (laboratory and others) are incorrectly referred to as automation equipment, while many instruments included in the group entitled "other instruments," such as time relays, etc., must necessarily be considered automation equipment. Instruments used in determination of mechanical quantities, when installed in automatic production lines of machine building enterprises, undoubtedly should also be considered as automation equipment. Opticomechanical instruments and radio measuring and dosimetric instruments, etc., are considered special-purpose instruments. 62/

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watches and clocks, X-ray equipment, or medical instruments. These figures probably include some, but not all, of the instruments destined for military use, but there is little evidence on this point. The figures, with the exception of the probable level of 1965, are either those reported by the USSR or those derived from Soviet published figures. The figures are believed to represent the quantity of instruments produced multiplied by 1955 prices and adjusted to new rubles.

* Following p. 20.

The change in composition in the Soviet instrument industry between the beginning and end of the Seven Year Plan has been estimated by the official Soviet journal Priborostroyeniye (in percentages*), as follows 63/:

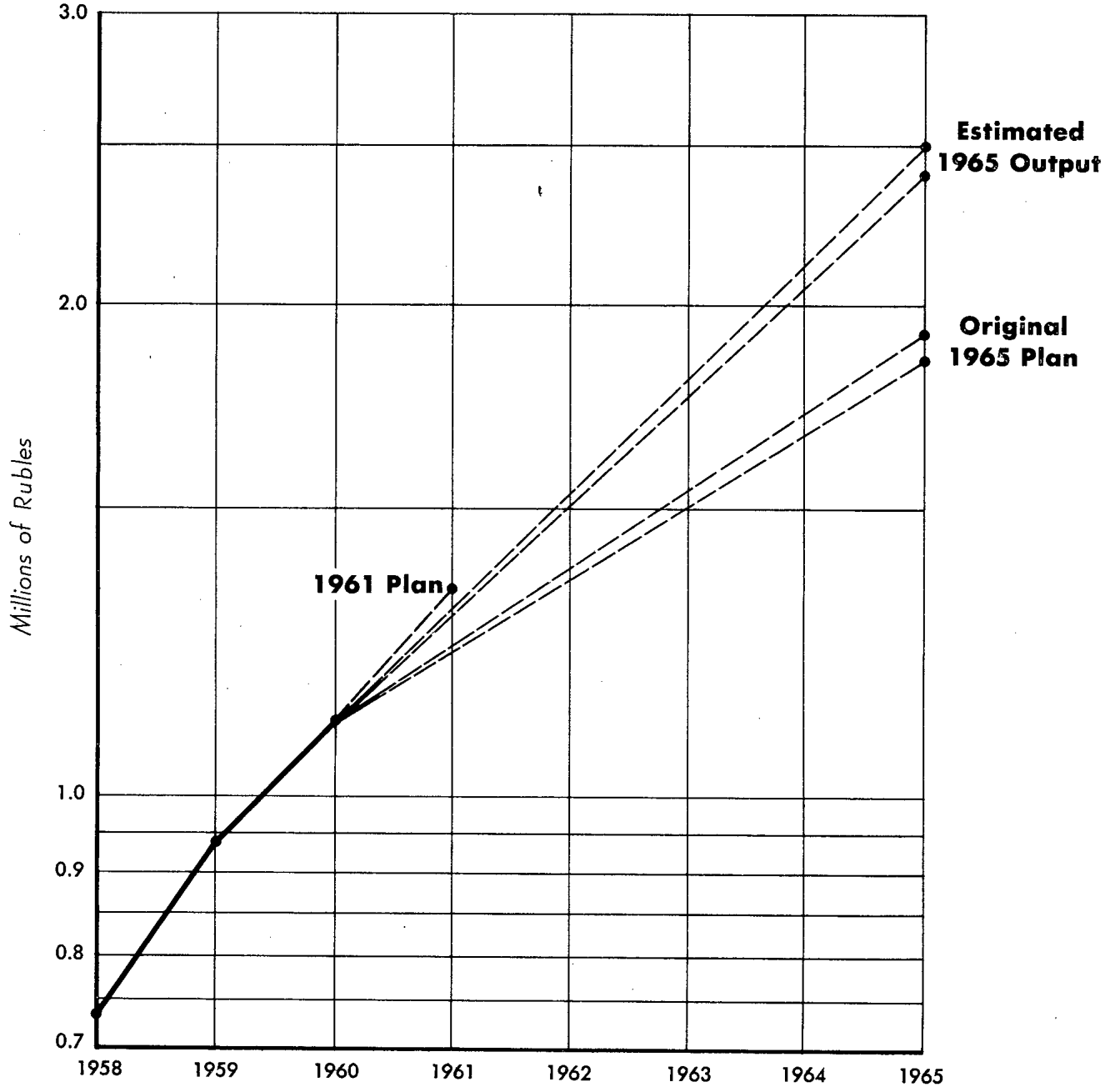
Category	Percent of Total Production 1958	1965
Electrical measuring instruments	13.0	14.8
Process control instruments	11.7	27.8
Calculators and computers	7.0	9.4
Instruments for measuring mechanical quantities	9.3	7.7
Timekeeping devices	23.0	18.3
Other instruments (probably including optical instruments and special-purpose scientific instruments)	36.0	22.0
Total	100.0	100.0

The most important aspect of the character of output of instruments during the Seven Year Plan is the increase in volume of process control instruments. The share of these instruments is to increase from 12 percent of the total production of instruments in 1958 to 28 percent of the total production of instruments in 1965. This trend is accompanied by a decrease in the relative shares of timekeeping devices and "other" instruments. 64/

A physical unit indicator of production of instruments is possible in only two categories of consumer goods, timekeeping devices and cameras. Output, which is believed to be running behind schedule, is as follows 65/:

* These percentages represent output of the entire instrument industry, including clocks, watches, and cameras, which are not included in Soviet statistics on the value of output of instruments. The value of output of the individual categories listed above, therefore, cannot be determined.

USSR: Production of Instruments, 1958-65*



*Exclusive of Cameras, Timekeeping Devices, and Watt-hour Meters

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	Million Units			
	1958	1959	1960	1965 Plan
Timekeeping devices	24.8	26.2	26.0	35.5
Cameras	1.5	1.6	1.8	3.48

The RSFSR is the largest producer of instruments among the republics, producing 75 percent of the total Soviet output in 1960. Instrument plants are located in most of the other republics, including the Ukrainian SSR, which is the second most important producer.

Although the USSR is demonstrating a remarkable growth in output of instruments, it appears unlikely that the country will equal US output of instruments for at least another decade. Since World War II, for example, US output has increased at an average annual rate of growth of 11 percent and is expected to increase faster than 11 percent in the next 15 years. In 1958, US output probably was over twice that of the USSR. 66/ Even at the probable upper limit of 2.5 billion rubles, the Soviet output of instruments in 1965 will be no more than two-thirds of that of the US in that year if US output continues to grow as it has since World War II.*

The USSR, like the US, is engaged in large-volume production of instruments for its armed forces. So little is known, however, concerning the relative volume of production of this equipment in the USSR that it is impossible to estimate its magnitude.

b. Production Process

In spite of the extreme diversity in products and the wide range in volume of output among the various categories of equipment, the instrument industry for the most part pursues the same programs as the other sectors of machine building. Currently, the most important of these programs include (1) an emphasis on a high degree of mechanization in the production process and (2) increased standardization and interchangeability of components.

In emphasizing a high degree of mechanization in the production process, the objective of the industry is to achieve increased production at reduced labor costs. In some cases, such as conveyor assembly line techniques,** the USSR apparently has overworked

* For a computation of output of instruments in the US, see Appendix F.
** Including testing and calibration work in addition to assembly operations. 67/

the concept. In those instrument plants visited by Western observers it has been noted that conveyor assembly line techniques are used to a much greater extent than in the US. Such techniques often are employed in the case of production runs as small as several dozen units and are considered by the USSR to be preferable to individual assembly methods for runs as short as 2 days' duration or as low as 100 units a month. Qualified Western observers have noted the irrationality of using conveyor line techniques in small-unit runs, particularly in the case of complex instruments where as many as 5,000 different parts are involved and where small dimensions and high precision are significant factors in the production process. 68/

A second important program is aimed at increasing standardization and interchangeability of components. Some standardization of parts, components, and products has been going on for many years in the instrument industry, but the program apparently is being rapidly accelerated during the period of the Seven Year Plan. TsNIIKA, the Central Scientific Research Institute for Complex Automation* (which is subordinate to the State Committee on Automation and Machine Building), and no less than eight other research institutes and design bureaus are primarily concerned with the application of standardization in the instrument field. Work is in progress on the development of norms for both instruments and their components, including materials and methods of manufacture. 69/ One Soviet journal recently reported that even high-precision instruments of diverse types can be built through the use of 40 to 60 percent of the standardized parts. 70/ In addition to the savings accrued through the use of standard interchangeable parts, the industry hopes to reap an additional benefit by reducing the number of parallel models. Soviet engineers believe, for example, that the number of tachometer designs can be reduced from 32 to 7, yet these 7 will have a broader range of high-precision measurement than the original 32. Other benefits expected from the standardization program are savings in materials, labor, and money.

In spite of the increased emphasis on standardization in the Seven Year Plan and the particular attention devoted to the subject at the 1959 Plenum of the Central Committee of the Communist Party of the USSR, it appears that progress during 1959-60 has been slow. Also notable is the fact that TsNIIKA has been pilloried by the press for ineffectual leadership and failure to fulfill its assigned work projects. 71/

One of the more serious problems of production facing the Soviet instrument industry is that of excessive lead time in the development of an item of equipment. Four or more years frequently

* Tsentral'nyy Nauchno-Issledovatel'skiy Institut Kompleksnoy Avtomatizatsii.

elapse between the date on which the development of an item begins and the date on which it goes into industrial production, compared with from 1 to 2 years in the US. A new Soviet instrument occasionally becomes obsolete in some of its aspects by the time it is readied for large-scale production. 72/ In the area of instrumentation for complex weapons systems, however, excessive lead time does not appear to be a problem.

An even more serious problem facing the industry is the continued production of obsolete or poor-quality equipment. The Kazan' Teplokontrol' Plant, the Krasnodar ZIP Plant, and the Tomsk Manometer Plant, for example (producers of process control instruments), have been excoriated in the press for several years for failing to observe production standards and for producing obsolete or poor-quality items. 73/ Supposedly, there is a safeguard against such a condition -- each plant has a quality control organization, the OTK, which is supposed to insure good quality of output. In addition, the State Committee on Measures and Measuring Instruments, which is attached to the Council of Ministers, USSR, is required to make a spot check of output of a plant for adherence to production standards. Although this committee has the power to forbid production of obsolete equipment, apparently it can and does permit production of acknowledged obsolete items. 74/

4. Trends in Technology

In addition to attempting to triple its production of instruments during the Seven Year Plan, the USSR is making an extraordinary effort to raise the level of equipment technology. The supreme authority of the Central Committee of the Communist Party of the USSR in June 1959 and again in July 1960 emphasized the importance of this effort. 75/ A maze of scientific organizations is implementing this policy by developing equipment characterized by simplicity of design and advanced technical attributes. The utilization of common parts and components is being stressed to effect savings in labor, materials, space, and time. An attempt also is being made to develop all types of instrumentation needed by the entire spectrum of the Soviet economy.

The USSR is already a long way along the road to these goals. 76/ In its space program the country has clearly demonstrated a high order of technology in such fields of instrumentation as guidance, research on the upper atmosphere, and telemetry. 77/ Research institutes have custom-produced scientific apparatus of superior technical attributes in such fields as high-speed photography, high-temperature measurement, and the physics of high pressure. 78/ There are other areas, however, where the USSR is clearly lagging in tech-

nology behind the US and other leading Western industrial countries, as in process control instrumentation. The industry is well aware of its weaknesses in this regard because the popular press and scientific journals give this subject a great deal of attention. 79/

The Soviet instrument industry, like all branches of the machine building and metalworking sector, has long been an unabashed imitator of the best in equipment technology developed abroad. Occasionally, an item of equipment produced in the USSR is such a close reproduction of an existing foreign-produced item as to be practically indistinguishable from it.

50X1
50X1

In some cases a replica has modifications of the original which indicate a considerable degree of sophistication, as in the IKS-14 double-beam spectrophotometer, which is an improved version of the Perkin Elmer Model 21 produced in the US. 81/

Technical and scientific publications from all over the world are systematically exploited for the latest developments in practice and theory of design and application, which are then utilized in new and improved types of equipment. The designers of instruments, however, are by no means incapable of producing new departures in instrumentation.

50X1
50X1

both the equipment of domestic design and the improved facsimiles of foreign instruments reflect a high degree of Soviet technical competence in all or nearly all fields of instrumentation. 82/

Instrumentation appears to vary widely in level of technology from one category of equipment to another as well as within each category. The disparity in levels of technology among the various types of equipment precludes the possibility of making over-all generalizations that will hold true for all the major categories. The present "state of the art" for several of the more important categories of instruments is as follows:

a. Scientific and Analytical Instruments

Apparently a full range of spectroscopic equipment is produced in the USSR. The quality of such equipment is believed to be good, although not on a par with the best of comparable products of the West. The USSR is capable of producing optical gratings in the quality and in the quantities that it requires. 83/ In equipment used for electron microscopy, in ultra-high-energy physics,

and in gas chromatography, there apparently is a substantial timelag behind the US, particularly in such areas as quality of workmanship, lack of refinements, and sophistication. 84/ Equipment produced in the USSR for use in interferometry and metrology apparently differs from similar equipment produced in Western Europe and the US, principally because the Soviet equipment is much more optical in character, whereas equipment produced in the West would be primarily electronic. Soviet optics are regarded as being very good. 85/

b. Process Control Instruments

In the area of process control instrumentation the USSR is believed to be well behind the US and other Western industrial countries in technology. The USSR is deficient in instruments for the measurement of high vacuums and for the measurement of corrosive media or viscous fuels of a combustible and aggressive nature; in long-submersion thermocouples for measuring the temperature of molten steel; in continuous fluid-stream analyzers; and in automatic devices for controlling concentrations of multicomponent solutions of salts, acids, and alkalis. 86/ In the practical application of automatic control to industrial processes the USSR clearly lags behind the US. In theory of automatic control, however, the Soviet effort is considered to be excellent and at least equal to comparable effort in the US and the UK. 87/ The USSR also is believed to be strong in the theory of self-optimizing and data-sampling systems, in application of computer-actuated pneumatic controls, and in pneumatic computer components. 88/

In electronic computer development the current Soviet position reflects the emphasis accorded to analog types since the end of World War II. A wide range of types of analog computers for routine use in schools, scientific laboratories, and industry and in military applications has been produced. Although the majority of Soviet analog computers do not meet the levels of performance of the better analog computers produced in the US, they are clearly adequate for a wide variety of important applications. In contrast, Soviet production of digital computers until recently has exhibited a much slower rate of growth, and production technology in the digital computer field has been markedly inferior to US practice. Beginning about 1956, however, the economic effort devoted to production of digital electronic computers was intensified, and at the present time production of digital computers is showing signs of vigorous growth. 89/

Although the current level of technology of process control instrumentation does not seem impressive at first glance, there are factors at work that probably will raise this level considerably.

It should be borne in mind that the success of the program for integrated mechanization and automation of industry is of utmost importance to the Soviet government. Because automatic control is the heart of precision guidance systems, continuous advancement in automatic control theory and in complex automatic control systems is necessary in order to keep the rocket and space programs of the USSR moving ahead. Automation also is considered to be the best means of increasing industrial production and of lowering manufacturing costs. The USSR correlates the success and progress of its social system, at least in part, with the country's economic status (including its position in world markets), and, therefore, the cost of automation is regarded as a cost to the government rather than a cost applicable to industry. The importance that the government attaches to the development of automatic control can be seen in the caliber of the personnel assigned to work in this field. About 7 percent of the 167 Soviet academicians are working directly on automatic control. Many of the best mathematicians in the USSR also are working on control theory in close collaboration with engineers. This support has taken the form of several new institutes to implement the translation of theory into practical application, and the institutes are expected to double or triple in size in the next few years. The result of this tremendous concentration of effort should be a considerable strengthening of the research and development base in the field of automatic control and, eventually, production of a more comprehensive range of better quality instruments than are currently produced. 90/

One other category of Soviet process control instrumentation, radioactive isotopic devices, is of considerable significance from the point of view of its level of technology. The USSR became actively interested in this field during the Fourth Five Year Plan (1946-50) and since then has been according it preferential treatment because it is considered to be of great importance in achieving automation in industry. 91/ Currently the USSR may be using radioactive isotopic devices to a much greater extent than is the practice in the US.* In 1959 the USSR produced 800,000 curies of cobalt 60 (the isotopic element used in industrial gauges utilizing radioactive isotopes), and 1.5 million curies were to be produced in 1960, or about twice the amount being produced in the US.** At least eight plants in the USSR are engaged in production of radioactive isotopic instruments. 92/

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* In the US, current interest is largely centered on instruments of the beta ray type because they can be so constructed as to protect workers from exposure to radiation. The USSR apparently is utilizing the instruments of both the beta ray and the gamma ray types.

** Industries in the US, however, also use other radioactive materials such as strontium-90, cesium-137, krypton-85, and ruthenium-106.

c. Other Categories of Instruments

In the category of general instrumentation, there is apparently little superior technology. Equipment of domestic Soviet design is sturdily built but often is large and bulky and is slightly inferior in quality to comparable items manufactured in the US and other leading industrial countries of the West. Also, there is no apparent desire to strive for miniaturization, as in the US. 93/ Consumer goods such as watches and clocks and cameras are produced in a limited number of types and sizes and generally, from the point of view of technology, are satisfactory but not exceptional. 94/ Components, especially electronic components, also are slightly inferior to those produced in the US. Tubes, for example, have a shorter service life, and other components are more susceptible to malfunctioning. Poor quality and inadequate quantities of components have severely handicapped Soviet production of computers. 95/

III. Patterns of Distribution

A. General

Although the USSR has a healthy and growing instrument industry, output of several categories of instruments is seriously inadequate. A recent Soviet study indicates that production of instruments and automation equipment in 1958 satisfied only 60 percent of domestic requirements and that the requirements for some types of instruments were satisfied only to the extent of 20 to 40 percent. 96/ To compensate for the inadequacy of output in certain categories of instruments, the USSR has stepped up its own production program during the Seven Year Plan and also imports a selective list of equipment to fill specific high-priority needs. East Germany and Czechoslovakia have been and probably will continue to be important Bloc sources of instruments, and West Germany and Switzerland are major Free World suppliers. East Germany, however, is encountering serious problems in its development and production program and is expected to be unable to meet an important segment of its export commitments to the USSR. 97/ Soviet purchases of instruments from the West are hampered by trade controls and by reluctance on the part of some firms to do business with Communist countries. The USSR in the past has managed to import a large volume of instruments in spite of these handicaps and is expected to continue to make vigorous efforts to get those high-priority instruments which are needed by its economy but are not available within the Bloc. On the other hand, exports are not significant and are not expected to become so in the remaining years of the Seven Year Plan.

B. Domestic

The constantly growing requirements for more and better instruments have led to several problems of a cyclic nature involving the industry and the domestic consumer. There is the problem of achieving standardization of a new instrument yet at the same time making certain that all of the principal industries using this instrument will find it acceptable. Often it is necessary to convince an industry that this instrument should be used rather than another specialized type that the industry wants to see developed or produced. The timelag between development and production frequently drags out over several years, and an instrument that may have been modern while under development is occasionally obsolete when produced, resulting in consumer dissatisfaction and a new cycle of development. 98/

Minor problems also confront the users of instruments. Few catalogs are available, for example, making it difficult to prepare purchase orders. Also, repair shops apparently are not available in sufficient numbers. As a result, users discard equipment prematurely (thus placing an additional load on the already overburdened industry) or are forced to set up their own repair shops. Finally, a plant using a foreign-made item of equipment has a difficult time obtaining replacement parts, because the plants of the instrument industry refuse to produce spare parts for equipment that they do not make. 99/

C. International

The USSR is engaged in a small but growing volume of foreign trade in instruments. Between 1955 and 1960, Soviet exports of instruments increased from 11.0 million to 40.0 million rubles.* (In addition, an unknown quantity of instruments was exported as parts of complete industrial plants.) Imports of instruments during the same period grew at a slightly slower rate, from 12.8 million to 43.3 million rubles. The Sino-Soviet Bloc is the principal trading partner of the USSR in instruments, absorbing about 95 percent of the total Soviet exports of instruments and furnishing about 75 percent of the total Soviet imports of instruments (see Tables 1 and 2**). The major importers of Soviet instruments are Poland, Czechoslovakia, and Communist China, and the principal suppliers are East Germany (which in recent years has furnished between one-half and two-thirds, by value, of all Soviet imports of instruments), Czechoslovakia, and Hungary.

* All trade figures used in this report have been drawn from official Soviet trade statistics, 100/ are given in new foreign trade rubles, and may be converted to US dollars at the rate of exchange of 0.90 ruble to US $1.

** Tables 1 and 2 follow on pp. 30 and 31, respectively, below.

The current trends in Soviet foreign trade in instruments are expected to continue throughout the remainder of the Seven Year Plan. Recent agreements between the USSR and Hungary and Czechoslovakia have committed those two Satellites to export a very large amount of instruments to the USSR throughout the period. 101/ Trade with the UK, West Germany, and other Western countries in instruments is expected to remain active, especially in instruments not produced in the USSR such as those for measuring high vacuums, viscous fuels, and corrosive media; balanced instruments for measuring pressure and pressure differences; and continuous fluid stream analyzers. 102/ The USSR also has announced that it will import six times as many instruments in 1965 as in 1960. 103/

There is a good possibility in the next few years that the USSR will resort to dumping tactics to market some of its time-keeping devices in the West. Output is extremely large at present and is scheduled to increase substantially by 1965. This outlook has been of concern to some Western producers. 104/ The USSR has announced its intention to export a much larger quantity of measuring and control instruments in 1965 than at present. It is believed, however, that the critical requirements of the domestic economy will cause this announcement to be soon forgotten. 105/

Virtually all foreign trade in instruments has to be conducted through one of the state monopolies established for this purpose. Until recently, several monopolies had responsibility for different types of equipment in this category. It now appears that V/O Mashpriborintorg, the All-Union Association for Foreign Trade in Instruments,* is the successor to several or all of the organizations that coordinated the trade in instruments in the past. 106/

* Vsesoyuznoye Ob"yedineniye Mashinostroyeniye Pribori Inostrannaya Torgovlya.

Table 1

Soviet Exports of Instruments a/
1955-60

Category	1955		1956		1957		1958		1959		1960	
	Value b/ (Thousand Rubles)	Percent to the Bloc	Value b/ (Thousand Rubles)	Percent to the Bloc	Value b/ (Thousand Rubles)	Percent to the Bloc	Value b/ (Thousand Rubles)	Percent to the Bloc	Value b/ (Thousand Rubles)	Percent to the Bloc	Value b/ (Thousand Rubles)	Percent to the Bloc
Seismic stations	933.8	95.8	1,329.1	100.0	477.5	78.6	760.4	92.8	980	61.7	1,026	63.5
Movie cameras and apparatus	690.8	97.4	983.6	88.3	1,163.1	70.1	945.9	74.2	1,194	71.8	1,103	71.2
Calculating machines and spare parts	290.5	100.0	924.1	99.6	758.3	71.4	593.5	84.3	1,823	66.3	1,356	54.6 c/
Precision instruments	6,023.0	99.4	7,699.1	99.0	11,454.7	90.7	15,592.3	98.2	15,355	98.5	16,602	94.7
Timekeeping devices	2,189.4	99.7	5,582.4	98.9	6,908.6	97.9	10,996.2	99.3	15,469	97.4	18,966	96.7
Cameras (still)	903.5 d/	94.1	1,655.4 d/	96.0	2,143.9	93.6	2,371.8	95.5	908	85.8	936	76.1
Accessories for cameras	e/		e/		8.8	94.9	79.5	94.9	63	76.2	60	68.3
Total	11,030.9	98.6	18,173.7	98.2	22,914.9	91.2	31,339.6	97.3	35,792	94.1	40,049	92.2

a. Instruments exported as a part of equipment and materials for complete plants are not included in these figures.
b. In new foreign trade rubles, which may be converted to US dollars at the rate of exchange of 0.90 ruble to US $1.
c. This figure is misleading because official Soviet trade statistics show no exports of this commodity to the Free World.
d. Including accessories for cameras.
e. Data for this category are included with data for cameras.

Table 2

Soviet Imports of Instruments
1955-60

Category	1955		1956		1957		1958		1959		1960	
	Value a/ (Thousand Rubles)	Percent from the Bloc	Value a/ (Thousand Rubles)	Percent from the Bloc	Value a/ (Thousand Rubles)	Percent from the Bloc	Value a/ (Thousand Rubles)	Percent from the Bloc	Value a/ (Thousand Rubles)	Percent from the Bloc	Value a/ (Thousand Rubles)	Percent from the Bloc
Movie cameras and apparatus	525.4	0	385.6	0	879.7	0	1,718.9	0	2,219	0	3,042	40.7
Calculating machines and spare parts	2,228.8	98.1	2,993.9	99.6	3,199.1	99.4	8,375.2	81.6	7,227	92.9	8,198	91.8
Precision instruments	9,994.1	82.8	10,750.9	79.6	18,098.4	73.8	20,231.3	77.5	26,856	77.4	32,060	73.9
Total	12,784.3	82.1	14,130.4	81.7	22,177.2	74.6	30,325.4	74.2	36,302	75.8	43,300 b/	74.9

a. In new foreign trade rubles, which may be converted to US dollars at the rate of exchange of 0.90 ruble to US $1.
b. This total does not include still cameras and photographic equipment worth 526,000 rubles that were imported from Czechoslovakia.

APPENDIX A

PLANTS KNOWN OR SUSPECTED TO BE PRODUCING SIGNIFICANT QUANTITIES OF INSTRUMENTS IN THE USSR IN 1961

Probable Current Official Designation	Variants and Former Names
1. Alma-Ata Scales Plant	
2. Angarsk Electrical Machinery Plant	
3. Angarsk Precision Instrument Plant	
4. Armavir Armalit Scales Plant	
5. Armavir Testing Machine Plant	
6. Arzni Precision Industrial Jewels Plant	
7. Baku Elektro-Avtomat Works	
8. Baku Geophysical Instrument Plant	Baku Geophysical Instrument and Equipment Plant
9. Baku Instrument Making Plant	
10. Baku Machinery and Instrument Making Plant imeni Kalinin	Baku Machinery Plant imeni Kalinin
11. Barnaul Geophysical Apparatus Plant	
12. Bobruysk Scales Plant	
13. Cheboksary Electrical Instrument Plant	Cheboksary Electrical Measuring Instrument Plant
14. Cheboksary Electrical Performing Mechanisms Plant	
15. Chelyabinsk Electrical Repair Plant	
16. Chelyabinsk Teplopribor Plant	Chelyabinsk Teploelektropribor Plant
17. Chelyabinsk Timepiece Plant	
18. Cherkessk Plant	
19. Chistopol' Timepiece Plant	
20. Chumlyak Plant	
21. Dnepropetrovsk Mine Automation Plant	Dnepropetrovsk Selenium Rectifier Plant
22. Engel's Aviation Instrument Plant	
23. Frunze Physical Instrument Plant	
24. Gomel' Instrument Making Plant	Gomel' Measuring Instrument Plant

Probable Current Official Designation	Variants and Former Names	
25. Gori Instrument Making Plant	Gori Precision Instrument Plant	
26. Grodno Electrical Measuring Instrument Plant		
27. Groznyy Electrical Machinery Plant		
28. Irkutsk Plant of the former Ministry of Electrical Engineering Industry, USSR		
29. Ivanovo Ivmashpribor Plant		
30. Ivanovo Measuring Instrument Plant		
31. Ivanovo Performing Mechanisms Plant		
32. Ivanovo Testing Machine Plant		
33. Izyum Optical Plant [redacted] imeni Dzerzhinskiy		50X1
34. Kalinin Engineering and Instrument Building Plant		
35. Kalinin Radio and Electrical Machinery Plant		
36. Kaluga Pyrometric Instrument Plant	Kaluga Instrument Making Plant Kalugapribor	
37. Kaunas Automation Equipment Plant	Kaunas Automatic Instrument Plant	
38. Kazan' Aircraft Instrument Plant [redacted]		50X1
39. Kazan' Optical Plant, Derbyshki	Derbyshki Optical Plant [redacted]	50X1
40. Kazan' Pneumatic Computer Plant		
41. Kazan' Teplokontrol' Plant		
42. Kazanbulak Electrical Instrument Plant	Kazanbulak Electrical Equipment Plant	
43. Khar'kov Control and Measuring Instrument Plant (KIP)		
44. Khar'kov Khimavtomat Plant		
45. Khar'kov Nonstandard Equipment Plant	Khar'kov Assembly Parts, Nonstandard Equipment, and Instrument Plant (trade name: FED)	
46. Khar'kov Plant imeni Dzerzhinskiy		
47. Khar'kov Scales Plant		
48. Khar'kov Teploavtomat Plant		
49. Khar'kov Transsvyaz' Plant		
50. Khimki Yunyy Tekhnik Plant		
51. Kiev Arsenal Optical Machinery Plant imeni V.I. Lenin	Kiev Machinery Plant Kiev Arsenal [redacted] Plant [redacted]	50X1 50X1

Probable Current Official Designation	Variants and Former Names
52. Kiev Aviation Instrument Plant	
53. Kiev Control and Measuring Instrument Plant	Kiev Plant KIP
54. Kiev Electrical Instrument Plant	Kiev Elektropribor Plant
55. Kiev Electrical Machinery Plant	
56. Kiev Electrical Measuring Equipment Plant	Kiev Plant of the Armset' Trust
57. Kiev Gazpribor Plant	
58. Kiev Geophysical Instrument Making Plant	
59. Kiev Instrument Plant	
60. Kiev Kinap Plant	
61. Kiev Kinodetal' Plant	
62. Kiev Nefteizmeritel' Plant	
63. Kiev Oktyabr' Plant	
64. Kiev Radiopribor Plant	
65. Kiev Relay and Automatics Plant	
66. Kiev Automatic Apportioning Machine Plant imeni Dzerzhinskiy	Kiev Scales Plant imeni Dzerzhinskiy
67. Kiev Tochelektropribor Plant	
68. Kirov Fizpribor Plant [redacted]	50X1
69. Kirovabad Instrument Making Plant	Kirovabad Machinery Plant
70. Kirovakan Avtomatika Plant	Kirovakan Avtomatika Instrument Making Plant
71. Kishinev Elektrotochpribor Plant	
72. Kishinev Electrical Measuring Instrument and Oscillograph Plant	Kishinev Electrical Measuring Instrument Plant
73. Klintsy Machinery Plant	
74. Kokchetav Machinery Plant	
75. Konstantinovka Vtorchermet Plant	
76. Krasnodar Electrical Measuring Instrument Plant	Krasnodar Measuring Instrument Plant Krasnodar ZIP Plant Krasnodar ZIP Electrical Engineering Plant
77. Krasnodar Krasnolit Plant	
78. Krasnogorsk Optical Machinery Plant	Krasnogorsk Machinery Plant Krasnogorsk Mechanical Plant Krasnogorsk Plant [redacted] 50X1
79. Kursk Computing Machine Plant	
80. Kusa Precision Industrial Jewels Plant	

Probable Current Official Designation	Variants and Former Names
81. Kuybyshev Kinap Plant	
82. Kuzbass Elektroapparat Plant	
83. Leninakan Electric Meter Plant	
84. Leninakan Instrument Making Plant	
85. Leningrad Aircraft Parts Plant [redacted]	Leningrad Precision and Optical Instrument Plant imeni Pirometr, [redacted] 50X1 50X1
86. Leningrad Analytical Instrument Plant	
87. Leningrad Electric Timepiece Plant	
88. Leningrad Electrical Machinery Plant (LEMZ)	Petrodvorets Electrical Machinery Plant
89. Leningrad Elektrodelo Plant	
90. Leningrad Elektropribor Plant	
91. Leningrad Elektropul't Plant	
92. Leningrad Etalon Experimental Plant	
93. Leningrad Experimental Computer Plant	Leningrad Computing and Analyzing Machine Plant
94. Leningrad Experimental Semiconductor and Ultrasonic Instrument Plant	
95. Leningrad Geofizika Plant	
96. Leningrad Geologorazvedka Plant	
97. Leningrad Gidrometpribor Plant	Leningrad Hydrometeorological Instrument Plant
98. Leningrad Gosmetr Scales Plant	
99. Leningrad Kinap Plant	Leningrad Cinema Apparatus Plant
100. Leningrad Krasnyy Izobretatel' Plant	
101. Leningrad Lengazapparat Plant [redacted]	50X1
102. Leningrad Lengazapparat Plant [redacted]	50X1
103. Leningrad Lenneftekip Plant	
104. Leningrad Lenpribor Plant	
105. Leningrad Lenteplopribor Plant	
106. Leningrad Optical Machinery Plant	Leningrad Experimental Optical Machinery Plant
107. Leningrad Optical Machinery Plant of the Main Administration of Local Industry	
108. Leningrad Progress Plant	
109. Leningrad Reduktor Plant	
110. Leningrad Scales Repair Plant	

	Probable Current Official Designation	Variants and Former Names	
111.	Leningrad Sevzapteplokontrol' Plant		
112.	Leningrad State Optical Machinery Plant imeni OGPU (GOMZ)	Leningrad GOMZ Machinery Plant	
113.	Leningrad State Computer Plant		
114.	Leningrad Svoboda Plant		
115.	Leningrad Vibrator Plant [redacted]	Leningrad Electrical Measuring Instrument Plant Leningrad Electrical Instrument Plant Leningrad Elektropribor Plant [redacted]	50X1 50X1
116.	Lokhvitsa Instrument Making Plant		
117.	Lytkorino Optical Plant [redacted]	Lyubertsy Plant [redacted]	50X1
118.	L'vov Aircraft Instrument Plant		
119.	L'vov Instrument Plant	L'vov Pribor Plant	50X1
120.	L'vov Kontakt Plant	L'vov Kontakt Electrical Machinery Plant	
121.	L'vov Teplokontrol' Plant	L'vov Thermal Control Instrument Plant	
122.	Lyubertsy Mosneftekip Plant	Lyubertsy Control and Measuring Instrument Plant	
123.	Minsk Instrument Repair Plant		
124.	Minsk Kinap Plant		
125.	Minsk Kinodetal' Plant		
126.	Minsk Mathematical Machine Plant		
127.	Minsk Optical Machinery Plant imeni S.I. Vavilov		
128.	Minsk Timepiece Plant		
129.	Minsk Udarnik Scales Plant		
130.	Moscow Computer and Analytical Machine Plant		
131.	Moscow Control and Measuring Instrument Plant of the former Ministry of Light and Food Industry, USSR	Moscow Moskip Experimental Control and Measuring Instrument Plant	
132.	Moscow Control and Measuring Instrument Plant of the former Ministry of the Petroleum Industry, USSR	Moscow Experimental Control and Measuring Instrument Plant	
133.	Moscow Electrical Machinery Plant (MEZ) of the former Ministry of Machine and Instrument Building		

Probable Current Official Designation	Variants and Former Names
134. Moscow Electrical Machinery Plant (Sokolnicheskiy Rayon) of the former Ministry of the Electrical Engineering Industry	
135. Moscow Elektroapparat Plant	
136. Moscow Elektroshchetchik Plant	
137. Moscow Energodetal' Plant	
138. Moscow Energopribor Plant	
139. Moscow Experimental Testing Machine and Scales Plant	
140. Moscow Experimental Factory for Timepiece Production	
141. Moscow Fizpribor Plant	
142. Moscow Geofizika Plant	
143. Moscow Geopribortsvetmet Experimental Plant	
144. Moscow Hydrometeorological Instrument Plant	Moscow Gidrometeopribor Plant Moscow Gidrometpribor Plant
145. Moscow Instrument Plant	50X1
146. Moscow KEMZ Cinema Electrical Machinery Plant	
147. Moscow Komega Plant	
148. Moscow Kontrol'pribor Plant (KIP)	Moscow Experimental Control and Measuring Instrument Plant
149. Moscow Manometer Plant	Moscow Experimental Instrument Plant
150. Moscow Medical and Sanitation Equipment Plant	
151. Moscow Moskinap Plant	Moscow Kinap Experimental Cinema Apparatus Plant
152. Moscow Neftepribor Plant	
153. Moscow Phonograph Plant	
154. Moscow Photographic Accessories Plant	
155. Moscow Platinopribor Plant	
156. Moscow State Measuring Instrument Plant (GZIP)	
157. Moscow Tekhnolog Experimental Plant	Moscow Tekhnolog Machinery Plant Moscow Tekhnolog Plant
158. Moscow Tekstil'mashpribor Control and Measuring Instrument Plant	

	Probable Current Official Designation	Variants and Former Names	
159.	Moscow Timepiece Plant [redacted] imeni Kirov		50X1
160.	Moscow Timepiece Plant [redacted]		50X1
161.	Moscow Timepiece Plant		
162.	Moscow Thermal Measuring Instrument Plant	Moscow Plant Tizpribor	
163.	Moscow Tochizmeritel' Plant		
164.	Mytishchi Electric Meter Plant	Mytishchi Elektroschetchik Plant	
165.	Mytishchi Instrument Making Plant		
166.	Nal'chik Tsvetmetpribor Plant		
167.	Nazran' Instrument Making Works		
168.	Nikolayev Instrument Plant		
169.	Nor Khayn Precision Gems Plant		
170.	Novosibirsk Aviation Instrument Plant		
171.	Novosibirsk Plant imeni Lenin	Novosibirsk Optical Instrument Plant [redacted]	50X1
172.	Odessa Kinap Plant imeni Dzerzhinskiy	Odessa Cinema Equipment Plant imeni Dzerzhinskiy	
173.	Odessa Krasnyy Oktyabr' Plant	Odessa Krasnyy Oktyabr' Physical Instrument Plant	
174.	Odessa Scales Plant imeni Starostin	Odessa Heavy Scales Building Plant imeni Starostin	
175.	Omsk Omelektrotochpribor Plant	Omsk Electrical Measuring Instrument Plant	
176.	Ordzhonikidze Gazapparat Plant		
177.	Ordzhonikidze Precision Industrial Jewels Plant		
178.	Ordzhonikidze Signal and Electric Clock Plant		
179.	Orekhovo-Zuyevo Priborodetal' Plant	Orekhovo-Zuyevo Scales Plant	
180.	Orel Instrument Making Plant		
181.	Orel Timepiece Plant		
182.	Penza Aviation Instrument Plant		
183.	Penza Computer and Analytical Machine Plant		
184.	Penza Timepiece Plant	Penza State Timepiece Plant	
185.	Petrodvorets Electrical Machinery Plant		
186.	Petrodvorets Timepiece Plant		
187.	Petropavlovsk Pneumatic Performing Mechanisms Plant		

Probable Current Official Designation	Variants and Former Names
188. Pokrovka Automation Equipment Plant	
189. Pskov Instrument Plant	
190. Pushkino Electrical Machinery Plant	
191. Pushkino Elektrokonstruktsiya Electrical Machinery Plant	
192. Rakvere Ultrasonic Equipment Plant	Rakvere Oscillograph Plant
193. Riga Avtoelektropribor Plant	
194. Riga Etalon Plant	Riga Etalon Experimental Plant
195. Riga Gidrometpribor Plant	Riga Hydrometeorological Instrument Plant
196. Riga Scales Plant	
197. Rostov Cinema Apparatus Plant	Rostov Cinema Machinery Plant
198. Rostov Electric Instrument Plant	
199. Rostov-na-Donu Timepiece Plant	
200. Rostov Yumetalluravtomatika Plant	
201. Ryazan' Analytical and Calculating Machine Plant	
202. Ryazan' Aviation Instrument Plant	
203. Ryazan' Thermal Instrument Plant	
204. Rybinsk Aviation Instrument Plant	
205. Safonovo Gidrometeopribor Plant	
206. Safonovo Teplokontrol'pribor Plant	
207. Samarkand Kinap Plant	Samarkand Cinema Apparatus Plant Cinema Mechanical Plant
208. Saransk Instrument Plant	
209. Saratov Motion Picture Machinery Plant	
210. Saratov Scales Plant	
211. Serdobsk Timepiece Plant	
212. Sevan Performing Mechanisms Plant	
213. Simferopol' Krymmetroves Plant	
214. Smolensk Automation Equipment Plant	
215. Smolensk Instrument Plant	
216. Stalino Electrical Machinery Plant	
217. Stalino Experimental Works for Controlling and Measuring Instruments	
218. Stalino Power Engineering Plant	

Probable Current Official Designation	Variants and Former Names
219. Stanislav Machine Building Plant	
220. Stanislav Weighing Instrument and Engineering Plant	
221. Stavropol' Electrical Automation Equipment Plant	
222. Stepnyak Instrument Plant	
223. Sukhumi Instrument and Automation Equipment Plant	
224. Suksun Optical Machinery Plant	
225. Sumy Electronic Microscope and Electroautomatics Plant	Sumy Instrument Making Plant
226. Sverdlovsk Hydrometeorological Instrument, Plant	Sverdlovsk Gidrometpribor Plant
227. Tallinn Control and Measuring Instrument Plant (KIP)	Tallinn Experimental Control and Measuring Instrument Plant
228. Tallinn Measuring Instrument Plant	
229. Tallinn Punane RET Plant	
230. Tartu Instrument Making Plant	Tartu Thermal Automatic Apparatus Plant Tartu AGE Plant
231. Tashkent Automation Equipment Plant	
232. Tashkent Gidrometeopribor Plant	
233. Tashkent Machinery and Repair Plant	
234. Tbilisi Agat Plant	
235. Tbilisi Gidrometpribor Plant	Tbilisi Hydrometeorological Instrument Plant
236. Tbilisi Precision Instrument Plant	
237. Tbilisi Tbilpribor Plant	
238. Ternopol' Electric Fixtures Plant	
239. Tiraspol' Electric Instrument Plant	
240. Tomsk Manometer Plant	
241. Ufa Aircraft Instrument Plant	
242. Uglich Industrial Jewels Plant	
243. Uglich Timepiece Plant	
244. Uman' Megommetr Electrical Measuring Instrument Plant	

Probable Current Official Designation	Variants and Former Names
245. Ust'-Kamenogorsk Gas Analysis Instrument Plant	
246. Ust'-Kamenogorsk Instrument Making Plant	
247. Vil'nyus Computing Machine Plant	
248. Vil'nyus Electric Meter Plant (VZES)	
249. Vil'nyus Electrical Instrument Plant, [redacted]	Vil'nyus Electronic Instrument Factory [redacted] 50X1
250. Vitebsk Electrical Measuring Instrument Plant	
251. Vitebsk Timepiece Parts Plant	
252. Vladimir Avtopribor Plant	
253. Voru Gas Analyzer Plant	
254. Yerevan Elektrotochpribor Plant	Yerevan Precision Instrument Plant Yerevan Electrical Precision Instrument Plant Yerevan Measuring Instrument Plant
255. Yerevan Instrument Making Plant	
256. Yerevan Timepiece Plant	
257. Yerevan Wristwatch Plant	Yerevan Artistic Timepiece Plant
258. Yoshkar-Ola Electroautomatics Plant	
259. Zagorsk Optical Plant [redacted]	50X1
260. Zhdanov Vesotochmash Plant	
261. Zhitomir Electrical Measuring Instrument Plant	
262. Zhitomir Electric Panel Instrument Plant	
263. Zlatoust Timepiece Plant	

APPENDIX B

MAJOR PLANTS PRODUCING INSTRUMENTS IN THE USSR IN 1961

Location	Plant	Chief Products	Remarks
Baku	Baku Instrument Making Plant	Instruments and automatic devices for the petroleum industry	This plant is believed to be a major producer of instruments and automation equipment for the extraction and refining of petroleum. 107/
Dnepropetrovsk	Dnepropetrovsk Mine Automation Plant	Various instruments and equipment, particularly for coal mines	Among the instruments produced in this plant are detonating instruments VMK-3/50, BKUM-1/30, BKVM-1/59, and AVVIM-1/20 (prototype); detonating tester IVTs-1; 108/ relays based on radioactive isotopes; and instruments for automating the control of the level of coal and ore in hoppers and the locating of railroad cars. In 1960 the plant was to produce its first 100 radioactive control instruments for the coal industry. 109/
Frunze	Frunze Physical Instrument Plant	Electrical and electronic instruments for automatic control of production processes in various branches of industry and for use in research in medicine, biology, and physiology	Although this plant went into production early in 1958, its construction was not to have been completed until 1960. Supposedly it is or will be one of the biggest instrument-making plants in the USSR. Its first products were centrifuges for medical laboratories. Other output includes a complex electrophoresis apparatus for analyzing complex albumin compounds and an electronic level indicator. During the Seven Year Plan, output of the plant will be quintupled. 110/
Gori	Gori Instrument Making Plant	Industrial instruments	Construction of this plant reportedly began in 1959 and was to have been completed in October of that year. It was later reported that a second building would be added to the plant in 1960. Gross output was to have reached 0.6 million rubles by the end of 1959 and 8.5 million rubles annually by 1965. In August 1959 the plant was producing differential relays and also in 1959 was to produce 2,000 instruments for determining the fat content of milk. It also was scheduled to begin production of instruments to determine the ion concentration in hydrogen. 111/
Kaluga	Kaluga Pyrometric Instrument Plant	Process control instruments	This plant is believed to be a key producer of such items as instruments for automating complex processes in chemical and metallurgical enterprises. It also produces gauges, densitometers, and indicators using isotopic materials. These instruments are used in petroleum refineries, food-processing industries, and chemical plants. 112/

50X1

Location	Plant	Chief Products	Remarks
Kazan'	Kazan' Teplokontrol' Plant	Process control instruments	This plant is believed to be an important producer of industrial instrumentation. Late in 1959 the plant was severely criticized in the press for production of obsolete instruments, for inadequate quality control, and for failure to inaugurate production of new and improved types of instruments. 113/
Kiev	Kiev Arsenal Optical Machinery Plant imeni V.I. Lenin	Theodolites, leveling instruments, alidades, compasses, fire control equipment, and cameras	This plant was formerly known as Arsenal and Optical Plant Very little up-to-date information is available on this plant, but it is believed to be a major producer of optical instruments. Although the plant existed before World War II, it was evacuated to Novosibirsk in 1941 as the German Army approached Kiev. Late in 1946 it was reactivated and reequipped with machinery from the Carl Zeiss Plant in Jena, now East Germany, which the USSR had dismantled and shipped to Kiev together with a large number of German specialists. 114/
Kiev	Kiev Tochelektropribor Plant	Electrical measuring instruments	This plant is one of the chief producers of laboratory-type electrical measuring instruments in the USSR. These instruments measure current, frequency, voltage, and inductance capacitance and are produced with an accuracy of 0.1, 0.2, or 0.5 percent. About 120 different types of instruments are produced in a production process that is completely integrated -- that is, all parts are made at the plant. The plant employs about 4,000 workers, is being expanded, and in 1965 is to be producing a volume of instruments 2-1/2 times that of 1958. Although the primary interest is in electrical measuring instruments, the plant does produce several types of electric razors. 115/
Kishinev	Kishinev Elektrotochpribor Plant	Ultrasonic instruments and electromagnetic flaw detectors for nondestructive testing of metals	This plant is new and was to have begun series production of nine designs of flaw detectors at the beginning of 1960. Evidently the first Moldavian-made ultrasonic flaw detector was shipped from the plant at the end of November 1959. The plant was organized on the base of an automotive and tire repair workshop. 116/

50X1

50X1

50X1

Location	Plant	Chief Products	Remarks
Krasnodar [redacted]	Krasnodar Electrical Measuring Instrument Plant	Ammeters, voltmeters, wattmeters, frequency meters, phasometers, synchronoscopes, and many other types of electrical measuring instruments	This plant, which also is known as the Krasnodar ZIP Plant, the Krasnodar Measuring Instrument Plant, and the Krasnodar ZIP Electrical Engineering Plant, is believed to be one of the most important plants of its type in the USSR. In 1959 it was producing more than 100 types of products. 117/ 50X1
Krasnogorsk [redacted]	Krasnogorsk Optical Machinery Plant	Lead sulfide photocells and other infrared components and possibly military infrared systems for guidance, fire control, and night viewing; also cameras, 15 categories of microscopes, surveying instruments, and theodolites, binoculars, gauges, and micometers of several types; and numerous laboratory, industrial, and scientific optical instruments	This plant was formerly known as Optical Plant [redacted] It was engaged in production of optical equipment before World War II but was dismantled and moved to Novosibirsk during the war. After the war it was rebuilt largely from machinery and equipment from the Carl Zeiss Plant in Jena, now East Germany, under the guise of reparations, and staffed in part by key specialist personnel from the German firm. The plant is believed to be one of the two largest optical plants in the USSR. It employs 11,850 persons and probably is a key research, development, and production facility for infrared detectors and infrared optical materials and components. The plant is suspected of being similarly engaged in the field of military infrared systems for guidance, fire control, and night viewing both for ground and air (especially guided missiles) application and is believed to be producing a number of types of cameras. The plant is believed to have produced in 1958 more than 30,000 microscopes; more than 60,000 binoculars; 17,000 industrial gauges, micrometers, calipers, and other related test devices; 3,000 theodolites and leveling instruments; about 6,000 refractometers and polarimeters; and several thousand units of miscellaneous optical instruments. In 1958 the plant also was producing more than 1,000 cameras per day. 118/ 50X1 50X1
Leninakan [redacted]	Leninakan Instrument Making Plant	Viscosimeters and other general-purpose industrial instruments	This plant is believed to be typical of the newer fast-growing instrument producers. It was created in 1957 from the former Pokhpat Metalworking Artel. In December 1958 a new building was put into operation, and in 1960 more than 1.8 million rubles was to be spent for the construction of new shops and for new equipment. By the end of the Seven Year Plan the number of employees at the plant would be 15 times the number employed in 1959. 119/ 50X1

Location	Plant	Chief Products	Remarks
Leningrad	Leningrad Electrical Machinery Plant (LEMZ)	Electric meters	This plant, a few miles southwest of Leningrad, produces watt-hour meters. Before World War II it made typewriting machines. The plant suffered large-scale destruction during the War and was largely rebuilt afterward. After 1953 the plant began making electric single-phase watt-hour meters for home and industry. Its output in 1960 was approximately as follows: 1,200,000 meters for private dwellings, 175,000 meters for industry, and 1,500 meters for locomotives. About 2,000 workers are employed by the plant. New items produced by the plant are designed by it. Of the labor force of the plant, eighty percent are women, mostly girls just out of high school. Although the plant is considered a medium-size producer in comparison with the other two plants engaged in production of electric meters, the value of its output in 1960 was expected to be 10 million rubles. 120/
	Leningrad Gosmetr Scales Plant	Laboratory scales and electronic microscales	This plant is the only known producer of electronic microscales in the USSR. (These scales, which are used by the chemical industry, can measure the weight of chemical substances while reaction is taking place and are especially useful in measuring radioactive and explosive substances, density of gases, diffusion phenomena, and the like). The plant also produces analytic microscales for weighing precious metals. The plant reportedly has developed electronic remote-controlled scales that measure with an accuracy of within 1 millionth of a gram. In 1957 the plant was producing 30 different types of scales ranging from microscales up to large scales with a 1,000-kilogram capacity. In that year the plant employed 1,220 persons, and the value of its output amounted to 2.4 million rubles annually. 121/
	Leningrad Kinap Plant	Motion picture studio equipment, film-copying equipment, amplifiers for sound projectors, electrostatic microphones, loudspeakers, magnetic tape recorders, closed circuit television, optical sound recorders, film rejuvenator equipment, and motion picture camera lenses	This plant appears to be the largest producer of motion picture studio equipment in the USSR. A member of a US automatic control delegation, who visited this plant in the summer of 1958, considered the quality of its production equal to that of comparable US plants. The plant, established in 1932, has clean, well-equipped shops, employs about 3,000 people, and produces about 35 main items and about 65 accessory items. The plant uses mass production techniques to a much greater extent than would a plant of comparable size in the US. Output of the plant reportedly has increased 15 to 20 percent annually in recent years. 122/

Location	Plant	Chief Products	Remarks
Leningrad (Continued)	Leningrad Lenneftekip Plant	Instruments for regulating and controlling industrial processes	This plant is a major producer of instruments for automatic control of industrial processes of chemical, gas, and petroleum enterprises. 123/
	Leningrad Lenteplopribor Plant	Electronic potentiometers and automatic measuring bridges and other high-precision electronic instruments for measuring and regulating industrial processes	This plant is a leading producer of industrial instrumentation. It also is an important supplier of such equipment to the Bloc and underdeveloped countries of the Free World. It reportedly supplied the instruments for practically all of the metallurgical enterprises and electric power stations under construction in China in 1958. The plant apparently specialized in output of instruments for measuring industrial thermal processes in metallurgical, chemical, power-engineering, and other industries. The plant was awarded a prize in 1957 for production of an instrument that checks, automatically records, and regulates the ratios of acid and alkali solutions. 124/
	Leningrad State Optical Machinery Plant imeni OGPU (GOMZ)	Large astronomical equipment, spectroscopic equipment, surveying equipment, microscopes, and fire control equipment	Formerly known as the Leningrad State Optical and Mechanical Works [redacted] (GOMZ), this plant probably is one of the two largest optical plants in the USSR. It existed before World War II and like many other major plants was evacuated to the area east of the Urals early in the war. After the war it was reconstructed, largely from equipment of the dismantled Carl Zeiss Plant in Jena, now East Germany, and staffed in part by former Zeiss personnel. In 1959 it produced a reflector telescope with a 2.6-meter mirror. Its principal products include cameras, optical instruments for interplanetary flight, movie projectors, infrared spectroscopes, lead-screw standardizing equipment, optical micrometers, all-purpose measuring microscopes, grating spectrographs, quarts spectrographs, steelscopes, direct-reading spectrographs, transits, surveying instruments, and photoelectric Raman spectrophotometers. In 1960 the plant reportedly had approximately 12,000 employees. 125/

50X1

Location	Plant	Chief Products	Remarks
Leningrad (Continued)	Leningrad Vibrator Plant	Multichannel oscilloscopes, galvanometers, AC and DC amplifiers, switchboards, exposure meters, visual aids for schools, high-voltage and high-frequency AC laboratory equipment, and parts for other plants; and oscillographs, thermometers, and potentiometers	This facility is one of the oldest and most important instrument plants in the USSR. Although first established as a research laboratory, Vibrator became an instrument-manufacturing plant in 1928. The plant now makes about 500,000 electrical instruments annually, representing a value of about 20 million rubles. Production of the plant is believed to have doubled about every 3 years in recent years and to have increased 46 times in 1946-59. [redacted] in the future it might be able to compete seriously with the best West German firms. The plant is believed to be a producer of fire-control equipment and aiming devices for the armed forces and reportedly is specializing in production of the following items: DC laboratory instruments, high-voltage and high-frequency AC instruments, multichannel oscillographs, galvanometers, amplifiers, switchboard instruments (both AC and DC), photoelectric exposure meters, fluxmeters, and small parts. Visual aid instruments used in teaching also are made at the plant. Although the plant is not arranged for mass production and very little automatic equipment is used, there is some automatic production in assembly work with automatic control of the separate operations. In May 1960 the plant was being expanded and currently has 400,000 square feet of floorspace and 3,500 employees (64 percent of whom are women). The plant will have about 530,000 square feet of floorspace and 4,500 employees when expansion is completed. 126/ 50X1 50X1 50X1
L'vov [redacted]	L'vov Teplokontrol' Plant (Thermal Control Instrument Plant)	Industrial instruments, including potentiometers and portable instrument-testing apparatus	This plant was built in 1946. In the summer of 1957 the plant had about 700 employees and in that year produced potentiometer PP-56. During the Seven Year Plan it is scheduled to triple its output, which includes instruments for regulating manufacturing processes in chemical, metallurgical, and other industries and electrical measuring instruments. 127/ 50X1
Moscow [redacted]	Moscow Computer and Analytical Machine Plant	Digital and analog computers, computer components, oscillographs, and measuring and recording devices for use with electronic computers	This plant is the largest known production facility for electronic computers in the USSR. It is one of the older plants in the industry, having been built in 1918, 128/ and presently has a labor force of 6,000. 50X1

Location	Plant	Chief Products	Remarks
Moscow (Continued)	Moscow Energopribor Plant	Industrial instruments	This plant, which is about 15 years old, specializes in production of complex electronic instruments and apparatus, mainly for the automation and mechanization of electric power stations and systems. In 1959 it began producing the MARS-200 control computer, which simultaneously controls temperature, flow, vacuum, and other indexes of a production process at 200 points. In spite of its assigned specialization and the need for industrial instrumentation, there were complaints in 1959 that the sovnarkhoz had directed the plant to produce simple products such as vending machine coin boxes, strain gauges, and strain gauge diaphragms. 129/
	Moscow Fizpribor Plant	Scientific research instruments and industrial instrumentation	This plant produces beta spectrometers, Wilson cloud chambers, cosmic ray measuring equipment, and industrial instrumentation utilizing radioactive isotopes (a radioactive liquid densitometer designed for continuous remote measurement and registration of the density of various liquids, level gauges, and vacuum meters) and electropneumatic principles of operation. The plant has a design bureau where highly complex research and development of new instruments is carried out. Apparently the plant also produces still another category of instruments, as there have been several press announcements of preparations for output of electrical air fresheners of the ozone type. 130/
	Moscow Manometer Plant	Electronic regulating, measuring, and control instruments for industrial processes	Although this plant is considered to be only a medium-size plant, it is one of the most important producers of instruments for industry. The plant dates from 1883, but it produced steel castings until 1935, when it began to produce manometers (pressure gauges). In 1954 it began to produce electronic equipment, including electronic remote control devices, gauging equipment, remote gauging equipment, pickups, and converters. Basically this plant builds equipment for flow, level, and pressure sensing and, in addition, such secondary equipment as bridges and potentiometers. The high-pressure gauges are in the 10,000 to 15,000 atmosphere range and have an accuracy to 1 percent, which satisfies the demands of the Chemical Research Institute. The plant also produces electronic amplifiers for use in recording instruments and complete recorders. Vacuum tubes are used in the amplifiers, and 15 percent of output was to be transistorized beginning in 1959. The actual output of the plant in the

Location	Plant	Chief Products	Remarks
Moscow	Moscow Manometer Plant (Continued)		summer of 1958 was as follows: electronic measuring and control instruments, 2,500 per month; various mechanical pressure gauges and manometer indicators, 40,000 per month; and differential pressure transducers, 800 per month. In 1958 the plant had in operation an automatic production line for recorders and controllers. Three thousand people are employed by the plant, 40 percent of whom are women. The plant has its own development laboratories in which designs are made exclusively for its own production, and a large part of this development work is directed toward a gradual improvement of apparatus already in production. In 1959 the plant was making more than 4,000 type-sizes of instruments, including more than 570 manometric instruments and more than 2,000 electronic types. Unlike a plant of comparable size in the US, which uses bench-type production, this plant employs a continuous production line. 131/
	Moscow Timepiece Plant imeni Kirov	Timekeeping devices	Founded in 1930, this plant produces 10 different kinds of watches and specializes in men's wristwatches. Since 1956, output has been in excess of 2 million annually. In addition, the plant produces automobile clocks, marine watches, alarm clocks, and stopwatches. The plant employs 6,500 workers, of whom approximately 4,000 are women. 132/
	Moscow Timepiece Plant	Wristwatches and clocks	This plant employs 7,500 workers, 80 percent of whom are women. Annual production of the plant is 2.5 million men's and women's watches and 1 million clocks of various kinds. The Seven Year Plan calls for doubling the ruble value of output and specializing in women's watches, both by 1965. Built about 1932, the plant produces about 10 percent of the nation's output of men's and women's watches. During 1960 the plant was to begin mass production of electric watches running on batteries. It also is believed to be producing machine tools for instrument production and possibly to be engaged in production of guided missile components. In mid-1960 it was announced that the plant henceforth would specialize in production of high quality wristwatches for women. 133/

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Location	Plant	Chief Products	Remarks
Penza	Penza Computer and Analytical Machine Plant	Digital computers, analog computers, electronic test equipment, card punches, card reading devices, and office calculating equipment	This plant, with a labor force of approximately 4,000, is the second largest producer of computers after the Moscow plant of the same name. 134/
	Penza Timepiece Plant	Ladies' wristwatches	This facility reportedly is the largest of its type in the world and is being expanded for increased output. In 1959 it was producing 70,000 watches (with 16-jewel and 17-jewel lever movements) weekly and employed 7,800 workers. In 1960 its output was to have been 100,000 watches per week (5 million per year), and it was to employ 10,000 workers. 135/
Riga	Riga Gidrometpribor Plant	Hydrometeorological and aerological instruments	This plant is a major producer of scientific instruments. In 1959 it was producing more than 70 different types of instruments, and in 1957 it had the following monthly output: barographs, 200 to 220 units; thermographs, 200 to 220 units; rain gauges, 240 to 265 units; altimeters, 100 to 120 units; instruments for measuring the thickness of ice, about 100 units; instruments for measuring the water level of rivers, about 40 units; an instrument for measuring sea level, about 120 units; water meters, about 100 units; wind velocity meters, about 100 units; soil thermometers, about 1,000 units; radiosondes, about 10,000 units; and taximeters, 250 to 300 units. In addition, it was producing about 30 complete seismographs per year, and artillery correction tables and other miscellaneous instruments also were in production on an irregular basis. In 1957 the plant employed 1,000 workers. During the Seven Year Plan its output of instruments is scheduled to increase 2.4 times. Products of this plant are used in high-altitude research, in the program of the International Geophysical Year, and for general domestic service in warehouses, production shops, and elsewhere when humidity, temperature, and atmospheric pressure require control and regulation. 136/
Stalino	Stalino Experimental Works for Controlling and Measuring Instruments	Gauges	This plant is an important producer of radioactive isotopic gauges for use in determining the thickness of rolled metal. 137/

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Location	Plant	Chief Products	Remarks
Tallinn	Tallinn Control and Measuring Instrument Plant (KIP)	Isotopic instruments for regulation and control of industrial processes	Twelve instruments utilizing radioactive isotopes are produced by this plant for the automation of various processes in the metallurgical, chemical, mining, and food industries. The plant probably began production of instruments in 1951. In 1960 the plant employed approximately 350 personnel and was to have produced equipment worth 1.5 million rubles, with a planned output for 1961 of 1.9 million rubles. By 1965 the plant is to be producing annually instruments worth 2.5 million rubles. 138/
Vil'nyus	Vil'nyus Electrical Instrument Plant, Post Box 6	Oscillographs, nuclear instruments, and possibly other instruments	This plant was formerly known as the Electronic Instruments Factory In mid-1958 it employed approximately 3,500 workers and was producing about 300 oscillographs. 139/
	Vil'nyus Electric Meter Plant (VZES)	Electric meters	This facility is one of the most important electrical instrument plants in the USSR. In 1950 it produced 20,000 watt-hour meters and in 1959 was to have made more than 1.9 million. During the Seven Year Plan the plant is to be converted into an experimental pilot plant. In 1960 it was to have had automatic lines installed for machining, assembling, and adjusting the components of meters. During the Seven Year Plan, output of the plant will reach 5 million units annually, and the plant will become the only Soviet enterprise producing single-phase meters. 140/
Yerevan	Yerevan Elektrotochpribor Plant	Electrical measuring instruments	Built in 1943, this facility was the first instrument plant in Armenia. The plant reportedly is the basic supplier of current finders and high-voltage indicators. 141/
	Yerevan Instrument Making Plant	Millivoltmeters, ratiometers, and microamperemeters, marine instruments, and thermal instruments for use on diesel locomotives	This facility is the new Armenian plant built in 1957. 142/

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APPENDIX C

METHODOLOGY USED IN ESTIMATING THE VALUE OF CAPITAL INVESTMENT IN THE INSTRUMENT INDUSTRY OF THE USSR DURING THE SEVEN YEAR PLAN (1959-65)

Information on investment in the instrument industry of the USSR is sparse and inadequate. The USSR has not published a figure for investment in the industry during the Seven Year Plan (1959-65), and it has not indicated how many new plants are to be built or how many existing plants will be expanded.

Some information on this subject, however, is available for the abandoned Sixth Five Year Plan (1956-60). A Japanese publication indicates that 300 million rubles were to have been allocated during 1956-60 to construct 39 new plants and to expand 17 others, all of which apparently were to produce "measuring instruments for industrial use and automation tools." 143/

From analysis of plant information it is estimated that the USSR is building 30 to 40 new plants for production of instruments during the Seven Year Plan and is expanding a large number of existing plants as well as converting some plants to production of instruments.

A rough calculation of the cost of this program can be made by using the investment data for the Sixth Five Year Plan. Assuming that the cost of expanding an existing plant is one-half the cost of erecting a new plant, then the cost of one new plant would be 6.3 million rubles. (With x representing the cost of a new plant, $39x + 1/2(17x)$ equals 300 million rubles -- x therefore equals 6.3 million rubles.) The cost of building 30 new plants would therefore be 189 million rubles, and 40 new plants would cost 252 million rubles.

Determination of the investment allocation for expanding existing plants is more difficult. [redacted] more than 75 percent of all capital investment in the machine building sector during the Seven Year Plan is to be used for reconstruction, expansion, and replacement of equipment of existing enterprises. 144/ Applying this ratio to the instrument industry, the total investment in the industry would be four times the cost of 30 to 40 new plants, or from 756 million to 1 billion rubles. 50X1

A second method of estimating the probable level of Soviet capital investment in the instrument industry during the Seven Year Plan involves the use of a capital-output ratio. A ratio of 1 to 2 obtains for the

Soviet machine building industry. Thus 1 ruble of capital investment is required to produce 2 rubles of output. 145/ For the Soviet cutting and measuring tool industry a ratio of 1 to 1.67 obtains. This ratio is believed to be a better one for the instrument industry than the ratio for machine building as a whole because there is considerable similarity between tool and instrument plants. This same ratio apparently was used in the instrument industry in the Sixth Five Year Plan, for the Plan provided for an investment of 300 million rubles to produce an increment in production of 501 million rubles during 1956-60. The actual increment during this period was 912 million rubles, but this figure cannot be used, because actual investment in the industry during 1956-60 is not known.

The Seven Year Plan calls for production of instruments in 1965 valued at 1.85 billion to 1.92 billion rubles compared with production in 1958 valued at 740 million rubles, an absolute increment during 1959-65 of 1.11 billion to 1.18 billion rubles. Using the ratio of 1 to 1.67, an investment of 665 million to 707 million rubles would be required to reach the level of production scheduled for 1965. It has been estimated in this report, however, that the USSR will reach a level of production of 2.4 billion to 2.5 billion rubles in 1965. A level of production of 2.5 billion rubles would mean an absolute increment in production during 1959-65 of 1.76 billion rubles, which would require an investment of about 1.1 billion rubles.

The use of this method gives a range of investment in the instrument industry of from 665 million to 1.1 billion rubles. The higher figure implies that both the 1965 target and the 1965 investment allocations have been increased since the adoption of the Seven Year Plan early in 1959. This increase is believed to have occurred, although there is no evidence on this point. On the other hand, the capital-output ratio may be too low. There is evidence that in other sectors of industry there is a considerably better capital-output ratio for expansion of existing plants than for construction of new plants. Because 75 percent of the investment in the instrument industry has been estimated to be allocated to expansion of existing plants, a lower capital-output ratio would reduce considerably the figure for total investment.

Even if the correct capital-output ratio were known, the estimate of investment would be subject to some error because the ruble figure for production of instruments does not include the value of output of watches and clocks. An unknown amount should therefore be added to cover investment in the timepieces industry. The production figure for instruments presumably includes some instruments manufactured in plants that are not part of the instrument industry, and thus

an unknown amount should be subtracted because output of those instruments would be the result of investment allocations to other sectors of machine building.

There is sufficient congruence in the results obtained from both methods of estimating investment to suggest that investment in the Soviet instrument industry during the Seven Year Plan is in the range of approximately 700 million to 1 billion rubles.

APPENDIX D

METHODOLOGY USED IN COMPUTING THE LABOR FORCE IN THE INSTRUMENT INDUSTRY OF THE USSR

No information has been released by the USSR on the size of the labor force in the instrument industry. Of the 263 plants believed to be serving the industry, there are fairly reliable employment statistics available for 1956-61 for 30 of the plants, or slightly more than 11 percent of the total. The employment of these 30 plants varies as follows:

Number of Plants	Persons Employed per Plant
1	12,000
1	11,850
1	7,800
1	7,500
2	4,000
2	3,500
4	3,000
1	2,000
1	1,500
1	1,200
1	1,000
1	800
1	700
1	650
2	600
1	450
3	400
2	350
1	300
1	250
1	200
Total 30	78,300

The average (arithmetic mean) size of the labor force of these 30 plants is about 2,610 employees per plant, yielding an industry total of about 686,400 employees. Such an average, however, is not likely to be typical for the industry. In the first place, many of the

employment figures have come from the reports of the exchange delegations who have visited the plants. Because these delegations visited only the principal plants or the showplace plants, it is likely that these plants are far above the industry average in number of employees per plant. A second reason for regarding the average of the 30 plants as being far above the industry average is that about 40 of the plants which are counted in the industry total are newly in production or in some cases are not yet in production.

There is such a wide variation in employment in these 30 plants that no good distribution is apparent. Selection of the median employment of 1,100, however, yields a total employment for the industry of 289,300, which is believed to be a more reasonable figure than that obtained by averaging the employment of the 30 plants.

As a check on the above figure, another method has been utilized to estimate employment in the industry. The known labor force and the level of output of four representative plants* are used to compute the annual ruble-value output per worker. This figure is then divided into the estimated total ruble-value figure for annual production during the year concerned, as follows:

Leningrad Gosmetr Scales Plant

In 1957 this plant had 1,220 employees and produced analysis and commercial scales worth 2.4 million rubles for an average annual output per employee of 1,970 rubles.

Leningrad Electrical Machinery Plant (LEMZ)

In 1959 this plant employed about 2,000 people and produced watt-hour meters worth 10.0 million rubles for an average output per employee of 5,000 rubles.

Tallinn Control and Measuring Instrument Plant (KIP)

In 1960 this plant had approximately 350 employees and was to have produced radioactive isotopic instruments worth 1.5 million rubles for an average output per employee of 4,290 rubles.

Leningrad Vibrator Plant [redacted] 50X1

In 1960 this plant employed 3,500 workers and was to have produced electrical measuring instruments and gauges, photoelectric exposure

* The representative plants include one plant with a large volume of production, another with a small volume of production, and two plants in between.

meters, and electrical components worth a total of 20.0 million rubles for an average output per employee of 5,710 rubles.

The average annual output per employee at these four plants therefore is 4,240 rubles. Because it is believed that the output figures for these plants are gross output (valovaya produktsiya) or goods output (tovarnaya produktsiya), these figures are not strictly comparable with the total value of output of instruments for the USSR. The plant output figures would include some repair work and services performed for other plants. The national figures are believed to represent the quantity of instruments produced multiplied by price. An arbitrary reduction of 10 percent in the average output per employee has therefore been made in an attempt to achieve greater comparability, or an average annual output per employee of 3,820 rubles. If the value of Soviet output of instruments for 1959* (942 million rubles) is divided by 3,820 rubles, the result is an estimated labor force for the industry of 247,000. Because the value of output of cameras, clocks, and watches is not included in the value figure for output of instruments, it is necessary to add employment at the 20 to 30 plants producing these items, an employment estimated to be 35,000. This figure gives an estimate of employment for the entire instrument industry of 282,000 persons.

Using the above figure and the estimate derived from taking the median of the 30 plants, a range of 280,000 to 290,000 is used in this report as the estimated labor force of the Soviet instrument industry in 1959.

* The year 1959 has been chosen because it is midway between the 1957 and 1960 data of these plants.

APPENDIX E

RESEARCH ORGANIZATIONS OF CONSIDERABLE IMPORTANCE TO THE INSTRUMENT INDUSTRY OF THE USSR AS OF 1961*

Designation	Area of Responsibility
NIIAVTOPriborov (Nauchno-Issledovatel'skiy i Eksperimental'nyy Institut Avtomobil'nogo Elektrooborudovaniya, Karbyuratorov i Priborov -- Scientific Research and Experimental Institute of Automobile Electrical Equipment, Carburetors, and Instruments)	Instruments and electrical equipment for automobiles and tractors
VNIIEP (Vsesoyuznyy Nauchno-Issledovatel'skiy Institut Elektroizmeritel'nykh Priborov -- All-Union Scientific Research Institute of Electrical Measuring Instruments)	Electrical measuring instruments
NIKIMP (Nauchno-Issledovatel'skiy i Konstruktorskiy Institut Ispytatel'nykh Mashin, Priborov i Sredstv Izmereniya Mass -- Scientific Research and Design Institute of Testing Machines, Instruments, and Devices for the Measurement of Volume)	Testing machines and devices for the measurement of volume
NIIChASPROM (Nauchno-Issledovatel'skiy Institut Chasovoy Promyshlennosti -- Scientific Research Institute of the Watch Industry)	Watches, watch movements, jewels for watches, and technical instruments
NIITeplopribor (Nauchno-Issledovatel'skiy Institut Teploenergeticheskogo Priborostroyeniya -- Scientific Research Institute of Thermal Power Engineering Instrument Making)	Instruments for the thermal control and measurement of the levels and amounts of liquids and gases
KB "Termopribor" (Konstruktorskoye Byuro po Proyektirovaniyu Priborov dlya Izmereniya Temperatury -- Design Office for the Planning of Instruments for the Measurement of Temperature)	Thermocouples, resistance thermometers, and pyrometers

* 146/

Designation	Area of Responsibility
TsNIIKA (Tsentral'nyy Nauchno-Issledovatel'skiy Institut Kompleksnoy Avtomatizatsii -- Central Scientific Research Institute of Over-All Automation)	Standardization of means of automation and parts and units used in general instrument manufacture
SKBAP (Spetsial'noye Konstruktorskoye Byuro Analiticheskogo Priborostroyeniya -- Special Design Office for Analytical Instrument Making)	Analytical instruments
GOI (Gosudarstvennyy Opticheskiy Institut imeni S.I. Vavilova -- State Optical Institute in the Name of S.I. Vavilov)	Optical and optical-mechanical instruments, cameras, and lenses
NIKFI (Vsesoyuznyy Nauchno-Issledovatel'skiy Kinofoto Institut -- All-Union Scientific Research Institute of Motion Picture Photography)	Movie apparatus and supplies
SKTBSP (Samostoyatel'noye Konstruktorsko-Tekhnologicheskoye Byuro po Proyektirovaniyu Priborov i Apparatov iz Stekla -- Independent Design and Technological Bureau for Planning Glass Instruments and Apparatus)	Instruments and apparatus made of glass
NIIGMP (Nauchno-Issledovatel'skiy Institut Gidrometeorologicheskogo Priborostroyeniya -- Scientific Research Institute of Hydrometeorological Instrument Making)	Hydrometeorological instruments and apparatus
NIISChETMASh (Nauchno-Issledovatel'skiy Mashinostroyeniya -- Scientific Research Institute of Computer Machine Building)	Computers
IAT AN SSSR (Institut Avtomatiki i Telemekhaniki Akademii Nauk SSSR -- Institute of Automatics and Telemechanics of the Academy of Sciences, USSR)	Automation techniques

APPENDIX F

ESTIMATED VALUE OF OUTPUT OF INSTRUMENTS IN THE US IN 1958*

The heterogeneity of instruments and the fact that they are produced by many different industries in the US make computation of the value of output difficult. Although the following categories of instruments may include items of equipment that in the USSR would not be included in the value figures for production of instruments, such exceptions are believed to be of minor importance.

Industry Code	Instrument Industry	Value of Output in 1958 (Million US $)
3831	Optical instruments and lenses industries	109
3821	Mechanical measuring instruments industry	1,061
3613	Electrical measuring instruments industry	643
36162	Electrical control apparatus industry	426
3811	Scientific instruments industry	946
3571	Office, computing, and accounting machinery industry (not including typewriters and duplicating machines)	1,096
3576	Scales and balances industry	82
	Total	4,363

* 147/

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