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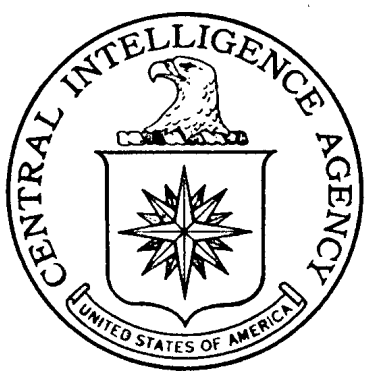
ECONOMIC INTELLIGENCE REPORT

THE ELECTRICAL MACHINERY INDUSTRY OF THE SOVIET BLOC



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S-E-C-R-E-T

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(ORR Project 36.520)

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FOREWORD

This report summarizes and brings up to date the available intelligence on the electrical machinery industry of the Soviet Bloc. For the purposes of this report, the electrical machinery industry includes motors, generators, power and distribution transformers, switchgear, switchboard equipment, and electric wire and cable.

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THE ELECTRICAL MACHINERY INDUSTRY OF THE SOVIET BLOC*

Summary

The estimated value of production of electrical machinery** in 1955 amounted to approximately US $2.8 billion*** for the entire Soviet Bloc. This figure includes $800 million for motors, $170 million for generators, and $240 million for transformers -- a total of $1.2 billion; $1.1 billion for electric wire and cable; and $390 million for switchgear. In 1955, Soviet production provided almost 65 percent of the total value of production, the remainder being divided among the European Satellites as follows: East Germany, 10 percent; Czechoslovakia, 9.3 percent; Poland, 7.5 percent; Hungary, 4.7 percent; Rumania, 2.3 percent; and Bulgaria, 1.3 percent. Albania does not produce significant quantities of electrical machinery. Based on a value added of 55 percent of the value of production, in 1955 production of electrical machinery in the Soviet Bloc was less than one-half that of the US in 1954.

By 1956 the estimated value of production of electrical machinery in the Soviet Bloc will increase to approximately US $3.0 billion. Of this total, motors, generators, and transformers will account for $1.4 billion; electric wire and cable, for $1.2 billion; and switchgear, for $440 million.

Because the entire economy of the Soviet Bloc is dependent upon electrical machinery for the generation, distribution, and application of electrical energy, any reduction in the production of electrical machinery will hinder future expansion of heavy industry or will

* The estimates and conclusions contained in this report represent the best judgment of ORR as of 15 July 1956.

** The term electrical machinery as used in this report includes motors, generators, power and distribution transformers, switchgear, switchboard equipment, and electric wire and cable.

*** Unless otherwise indicated, values are given in 1953 US dollars throughout this report.

necessitate reallocation of available electrical equipment to the more critical sectors of industry. The major potential vulnerabilities of the electrical machinery industry of the Bloc are the concentration of plants and personnel in a few industrial areas, shortages of high-quality material inputs, and a dependence upon imports to relieve these shortages.

The general level of technology in the electrical machinery industry of the USSR is only a few years behind that in the US, and the European Satellites are considerably behind the USSR in technology. The order of quantitative importance among the members of the Soviet Bloc is also indicative of the relative technological proficiency of the USSR and the European Satellites. The USSR, East Germany, and Czechoslovakia have highly developed industries producing complete lines of electrical machinery. Only the USSR is capable of producing very large generating machines comparable to those made in the US in the early 1950's, such as 150-megawatt turbogenerators. The Satellites do not build such large machinery, and the line of products becomes increasingly smaller among the less industrialized Satellites.

In terms of value the annual rate of increase in production of electrical machinery in the Soviet Bloc is presently about 12 percent in the USSR and ranges from 5 percent to 10 percent in the European Satellites, except in Rumania, where the rate is 25 percent. The value of production in Rumania is so small that the high rate of growth is relatively insignificant. These annual percentage rates are expected to decline slightly during 1955-60, but the absolute increase in the value of annual production probably will remain about the same.

I. Introduction.

A. Definition and Description.

1. Definition.

For the purpose of this report, electrical machinery is defined as including the following products of the electrotechnical industry:

a. Electric motors of all sizes which operate on alternating current (AC), single and polyphase, and on direct current (DC), but not starting motors for internal combustion engines or precision devices such as synchronous motors or gyro-motors.

b. Electric generators of all sizes, from small portable units to the largest machines used by central power stations, which operate on AC, single and polyphase, and on DC, but not battery-charging generators for internal combustion engines or precision devices such as synchronous generators or servorate generators.

c. Power and distribution transformers of all sizes, but not specialty transformers or those designed primarily for use in electronic equipment.

d. Switchgear including air and oil circuit breakers, power switches, switchboards, and associated equipment, but not small switches or equipment used in appliances and lighting fixtures.

e. Bare and insulated wire and cable for both power and communications transmission, but not bare conductor shapes (other than magnet wire) that enter directly into the construction of motors, generators, and transformers.

The basic units for rating the power of generators are the kilowatt (kw) and the megawatt (mw), which is 1,000 kw. These units are used also for motors because in the Soviet Bloc motors are rated in the electrical equivalent of their mechanical output. Transformers are reported in terms of the kilovolt-ampere (kva) and the megavolt-ampere (mva), which is 1,000 kva. The kva and the mva are comparable to the kw or the mw as measures of physical production. Production of switchgear is given in terms of dollars. Because of the heterogeneous nature of the equipment, there is no satisfactory single physical unit for rating switchgear.

2. Scope.

This report traces the development of the electrical machinery industry of the Soviet Bloc for the years 1946-55, compares this development with a selected year before World War II, and projects the development for the years 1956-60. The countries of the Bloc considered in this report are the USSR, Bulgaria, Czechoslovakia, East Germany, Hungary, Poland, and Rumania. Figures are

not given for Albania, because it has no known plants producing electrical machinery.

3. Importance of Electrical Machinery.

The types of electrical machinery considered in this report are the major items of equipment for the production and transmission of electrical energy and for the application of electrical energy to military, industrial, and agricultural purposes. Electrical energy likewise may be expected to become increasingly important in the development and use of atomic energy.

Production of electrical equipment for military end items does not account for a large percentage of the total production of electrical machinery. Many of the items produced are of high strategic importance, however, and in some cases there is no satisfactory substitute. Examples of such items are the following: propulsion motors for submarines; auxiliary motors for guided missiles, radar antennas, gun mounts, and tanks; and portable generator units for field forces and for remote radar stations.

The principal use of electrical machinery is in industrial production. Large generators, transformers, and electric wire and cable are necessary for the production and transmission of energy to industry. Typical industrial consumers of electrical energy are mining machinery, locomotives, rolling mills, and machine tools. Moreover, through the power used by industry, including the atomic energy program, electrical machinery also makes a substantial indirect contribution to military capabilities.

Agricultural uses account for only a small part of the production of electrical machinery. Because of the importance of agriculture to the economy of the Soviet Bloc, however, the use of electrical machinery by agriculture is more important than the quantity of machinery employed might indicate. The electrical machinery industry contributes to the development of agriculture by providing rural electrification, portable generating units in remote areas, electrically driven tractors, and other farm equipment.

B. History and Technology.

1. Electrical Machinery.

a. USSR.

During World War II, severe damage was suffered by the electrical machinery industry of the USSR, concentrated at that time in Leningrad, Moscow, and Khar'kov. It is estimated that 60 percent or more of the Soviet production of electrical machinery, together with a similar proportion of Soviet electrical generating capacity, was lost during the war. 1/*

After World War II, many of the damaged facilities were rebuilt. By 1947 or 1948 these facilities and the plants that had been evacuated from Leningrad and Moscow to the east had increased their productive capacity to the level of prewar production. (See Tables 9, 11, and 13.**) Since 1948, because of continued capital expansion and increased productivity, production of electrical machinery has increased much more rapidly than before World War II and also more rapidly than the 4- to 5-percent increase estimated for the Soviet economy as a whole. 2/

Although the technological level of the Soviet electrical machinery industry is continually improving and is substantially better than that of the European Satellites, this level is still behind that of the US industry. Soviet engineers and scientists devote considerable attention to automatic controls for industrial operations, but there is no evidence that in the electrical machinery industry of the USSR automatically controlled machines are being integrated into continuous production lines by means of automatic transfer equipment. This measure, known as "automation," has been introduced into the US electrical machinery industry for such operations as the manufacture of medium motors.

Soviet technology approximates that of the US in the production of hydrogenerators*** but is behind US technology

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** Pp. 30, 32, and 34, respectively, below, in Appendix A.
*** The term hydrogenerator refers to generators driven by hydraulic turbines.

in the production of turbogenerators.* If size alone is used as an equating factor, the USSR has produced a hydrogenerator as large as any produced in the US. This 123-mw hydrogenerator, however, operates at considerably fewer revolutions per minute (rpm) than its US counterpart. 3/ The USSR is presently designing hydrogenerators with capacities of 250 to 400 mw, 4/ has produced turbogenerators of 150-mw capacity, and plans to produce in 1960 a turbogenerator of 300-mw capacity. 5/

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[redacted] Although Soviet turbogenerators have utilized 50X1 hydrogen cooling for about 10 years, the USSR has indicated only recently that it intended to introduce the internal cooling of the generator windings by passing the hydrogen through hollow conductors. 7/ This practice has been in use in the US for several years and may explain the present US advantage over the USSR in the construction of turbogenerators.

The USSR is building a large power transformer rated at 180 mva. 8/ The capacity of this transformer is far below that of the 315-mva transformer which was installed in the US in 1955.

The Soviet plants which build the largest motors and generators have been, and may still be, short of large lathes, large vertical boring mills, and heavy presses. Much of the equipment acquired during World War II is obsolescent, but the new equipment being delivered is of high quality and includes some single-purpose machine tools for which there are no Western counterparts. These machines and the increased use of automatic controls are contributing to the continuing improvement of the productivity of the Soviet electrical machinery industry. 9/

The quality of Soviet electrical machinery generally appears to be adequate. Outer finish and appearance are sometimes below US standards, but materials and workmanship of the functional parts are good. 10/ Although there are occasional complaints about the poor quality of electrical machinery, these complaints are neither so frequent nor so universal in the USSR as in the European Satellites. 11/ In the USSR there is likewise no evidence of the forced substitution of less desirable materials such as is found in the Satellites -- for example, the use of aluminum for machine windings instead of copper.

* The term turbogenerator refers to generators driven by steam or gas turbines.

b. Bulgaria.

Bulgaria did not produce electrical machinery until after World War II. As a part of the general development of industry at that time, Bulgaria built new plants and began producing small and medium electric motors in 1948 and power and distribution transformers in 1949. Since 1950, Bulgaria has had an exportable surplus of motors, and since 1954 probably has been self-sufficient in the production of transformers, except for the largest sizes. Bulgaria produces transformers of capacities up to 20,000 kva, both high- and low-voltage switchgear, and small generators. All the large generators used by the central power stations for the power expansion program, however, must be imported. 12/

c. Czechoslovakia.

Before World War II the electrical machinery industry of Czechoslovakia included part of the Skoda combine and some other long-established enterprises dating back to 1900. After World War II, war damage was repaired, new facilities were built, and prewar levels of production were reached by about 1947. Rapid growth has continued since 1947.

Among the European Satellites, Czechoslovakia ranks first in the technological level attained. Czechoslovakia is capable of producing a hydrogen-cooled turbogenerator rated at 50 mw, and transformers of 100 mva at 220 kilovolts (kv) are also produced. A 125-mva turbogenerator was scheduled for design in 1955. 13/ Czechoslovakia produces a complete line of motors up to 2,200 kw, generators, transformers, switchgear, and modern control apparatus which are somewhat inferior to Soviet equipment in quality and design. In Czechoslovakia, as in the other Satellites, there is a shortage of winding copper, particularly for machinery built for countries other than the USSR, and the substitution of aluminum is becoming more common. Complaints of poor design and failure to meet operating specifications are especially common in reference to motors. Some of these complaints may be the result of attempts at a difficult-to-detect form of sabotage. 14/ The lack of transformer and dynamo sheet steel with lower power loss also contributes to inferior quality. 15/ Here again the quality of production in the Satellites ranks below that in the USSR, which, in turn, is somewhat below the US and other Western countries in the quality of its production.

d. East Germany,

Before World War II, Germany had one of the most highly developed electrical machinery industries in Europe, and many of the present plants in other European Satellites were part of large German combines such as AEG (Allgemeine Elektrizitaets Gesellschaft) or Siemens. After the partition of Germany, East Germany had some motor plants and facilities for the production of transformers but no plants capable of making large generators. Because of severe war damage to facilities and power plants and the dismantling of plants by the USSR, production of electrical machinery in East Germany did not begin to recover until after 1947. Production of generators was even more retarded because new plants had to be built and for several years had to devote most of their facilities to the repair of damaged generators. Substantial production of new generators was not begun until 1952 and 1953. Exceptions were the Soviet-controlled SAG (Sowjetische Aktiengesellschaft) plants, which were not dismantled but were quickly rehabilitated to produce solely for export to the USSR. 16/

Despite many obstacles, East Germany has far surpassed prewar levels of production for the area which it covers and is second only to Czechoslovakia among the European Satellites in technological proficiency. East Germany produces a complete line of motors of all sizes up to 3,800 kw, transformers up to 125 mva, and turbogenerators up to 50 mw. Development is in progress on 75-mw generators, and a 150-mva transformer has recently been completed. 17/ As in the other Satellites, copper and low-loss transformer and dynamo sheet steel are in short supply. Aluminum windings are substituted for copper in some classes of motors and, as of 1955, were to be used in transformers. Much of the delay in the development of the 150-mva transformer was attributable to overheating caused by poor-quality (high-loss) transformer sheet steel. The lack of satisfactory transformer oil also is a bottleneck. Complaints regarding the inferior quality of motors are numerous and even have been noted in one case of aluminum-wound motors delivered to the USSR. Failure of large transformers may have been caused by sabotage, as was publicly announced, or by poor workmanship. 18/

e. Hungary.

Before World War II the electrical machinery industry of Hungary was small compared with that of Czechoslovakia or East Germany. Approximately 70 percent of Hungary's most important plant was damaged in World War II. 19/ With the implementation of the Three and Five Year Plans, starting in 1947 and 1950, respectively, production in Hungary soon surpassed prewar levels and increased to such an extent that the position of Hungary as a producer is close to that of Czechoslovakia and of East Germany and about equal to that of Poland.

Hungary produces a complete line of motors, generators, transformers, and switchgear at a technological level somewhat below that of Czechoslovakia. The largest units are motors of 300 horsepower (hp) or larger, transformers up to 45 mva, and turbogenerators up to 32 mw, although none of the turbogenerators are known to use hydrogen cooling. 20/ Because of the shortage of copper, aluminum is being substituted in some machine windings. There are also shortages of alloy steel for generator rotor forgings and of electric power. The shortage of power, which appears to have been partly responsible for delays in production at electrical machinery plants, has been made acute by the loss of generating capacity removed to the USSR. Replacement of this lost generating capacity has been made more difficult because of the forced delivery to the USSR of new generators manufactured for Hungarian electric power stations. 21/

f. Poland.

The electrical machinery industry of Poland before World War II was somewhat larger than that of Hungary except in the production of generators. War damage to the major plants was severe, and prewar levels of production were not reached until about 1949. Production of motors and transformers in Poland has increased steadily since 1949 and is now greater than that in Hungary. Production of generators has increased much more slowly. Although a new plant was built in Warsaw in 1947-51 to manufacture turbogenerators of capacities up to 50 mw, actual production of this plant has fallen far short of its planned production. 22/

Poland stands in fourth place among the European Satellites in technological development, ranking below Czechoslovakia, East Germany, and Hungary, although surpassing Hungary in the volume

of production of some items. Poland produces a generally complete line of motors and transformers and a rather limited line of switchgear. Motors range up to 4,500 kw, and transformers, up to 31 mva. Transformers and switchgear are limited in voltage, however, to 110 kv, compared with the 220-kv designs used in Czechoslivakia and East Germany. Poland's capacity to produce large generators is limited by a lack of plant facilities. Poland plans to build turbogenerators of 100 mw by 1960. Inferior quality, resulting from poor workmanship and low-grade materials -- for example, low-loss transformer sheet steel of poor mechanical finish -- is one of the weaknesses designated for correction under a new plan initiated in 1954. Insulation materials, iron castings, and copper are in short supply. 23/

g. Rumania.

Before World War II and for several years after the war, the electrical machinery industry of Rumania was not very important, being limited to the production of small quantities of motors and transformers. About 1948, construction of new plants was begun. Upon the completion of these plants, production was substantially increased and was expanded to include generators and switchgear. 24/

Rumania ranks just above Bulgaria among the European Satellites in the production of electrical machinery, although Bulgaria probably produces more motors than Rumania. The new Rumanian plants, which were beginning production in the early 1950's, have advanced rapidly but are still far from the technological proficiency of the plants of Czechoslovakia and East Germany, which have had long experience in production of electrical machinery. In 1955 the largest machines in production in Rumania were 1,000-kw motors, 15-mva transformers, and generators of at least 3,000 kw and possibly as large as 6,000 kw. The electrical machinery industry is one of the less developed branches of the Rumanian economy in spite of technical aid from the USSR in the form of new automatically controlled machine tools and modern machining methods. Shortages of copper and skilled labor have hindered development in the past few years, and aluminum has been used in some motors since 1951. 25/

2. Electric Wire and Cable. 26/

Production of electric wire and cable is treated separately from that of electrical machinery because wire and cable require different and more specialized types of machinery in their production. The two most important types required are wire-drawing machinery and cabling and insulating machinery. Wire-drawing machinery is used to make wire from bulk conductor metal, and cabling and insulating machinery is used to weave the individual wires into various types of cable and to insulate this cable with nonconducting material.

Most of the Soviet Bloc relies heavily on machinery of German origin. The USSR, for example, uses German machinery acquired by purchase before World War II or confiscated at the end of the war from East Germany. Machinery of this same design is still produced in the USSR, although some machinery of Soviet design has been developed and produced since the war. 27/ The dependence of the Bloc upon outdated German machinery indicates that the average age of machinery probably is greater in the USSR than in the US, although the over-all quality of Soviet equipment is only slightly inferior to that of US equipment.

As a result of their reliance on old German and Hungarian machinery purchased before World War II, the European Satellites are handicapped with equipment which is even older than that of the USSR. Satellite technology therefore lags behind that of the USSR.

The purity of conductor metals and the electrical properties of the insulating materials limit the quality of electric wire and cable produced regardless of the superiority of the fabricating machinery used. As was true of electrical machinery, the European Satellites are substantially behind the USSR in the quality of materials used for wire and cable. The USSR, in turn, lags behind the US by a somewhat greater margin in the quality of wire and cable than in the quality of electrical machinery produced.

C. Administrative Structure and Personnel.

1. USSR.

The first organization in the USSR to have sole responsibility for the production of electrical machinery was the People's Commissariat of the Electrical Industry, established in 1939. This organization became the Ministry of the Electrical Industry (Ministerstvo Elektricheskoy Promyshlennosti) in 1946. After the death of Stalin

in 1953 the Ministry of the Electrical Industry was combined with the Ministry of Electric Power Stations and the Ministry of Communications Equipment into a single Ministry of Electric Power Stations and Electrical Industry. At the beginning of 1954 the electrical industry was again placed under a separate ministry which on 17 April 1954 was named the Ministry of the Electrotechnical Industry (Ministerstvo Elektrotekhnicheskoy Promyshlennosti). 28/

The Ministry of the Electrotechnical Industry is headed by I.T. Skidanenko 29/ and has jurisdiction over at least 10 main administrations.* Of these 10 main administrations, the following 7 are responsible for the production of the most important items of electrical machinery 30/: GLAVKABEL' (Wire and Cable), GLAVENERGOPROM (Power Equipment Industry**), GLAVELEKTROMASHPROM (Electrical Machinery Industry), GLAVELEKTROTRANSMASH (Electrical Transport Machines), GLAVELEKTROAPPARAT (Electrical Apparatus), GLAVELEKTROTOCHPRIBOR (Electrical Precision Instruments), and GLAVELEKTROIZOLYATORPROM (Electrical Insulator Industry).

The division of products among the main administrations is not entirely clear. GLAVELEKTROMASHPROM builds primarily motors and generators but also includes some plants building transformers. Plants under GLAVELEKTROTRANSMASHPROM build motors and generators for transportation equipment. Switchgear generally is produced by plants under GLAVELEKTROAPPARAT, but some of these same plants also build transformers. GLAVENERGOPROM is a new administration which apparently has taken over some of the plants making heavy electrical machinery. 31/

Some electrical equipment, particularly motors, which falls within the scope of this report is produced in plants subordinate to other all-union ministries -- such as the Ministry of Electric Power Stations, the Ministry of Shipbuilding, the Ministry of the Aviation Industry, and the Ministry of Automobile, Tractor, and Agricultural Machine Building -- or to ministries of local industry.

* Main Administration -- Glavnoye Upravleniye, or GLAV.
** Probable expansion of ENERGOPROM.

2. Bulgaria.

All electrical machinery plants in Bulgaria are subordinate to the Ministry of Electrification, headed by Kimen Georgiyev. This Ministry is responsible for the electric power system as well as for the production of electrical machinery. The subgroup responsible for the production of electrical machinery is called ELPROM (Elektricheska Promishlenost -- State Electrical and Industrial Association), and D. Stanev is the director of this organization. 32/

3. Czechoslovakia.

All electrical machinery plants of appreciable size are nationalized enterprises in Czechoslovakia. Plants with an average of more than 500 employees were nationalized in October 1945, and subsequently plants with more than 50 employees were nationalized. After a series of organizational changes, including splits and mergers of ministries, the present Ministry of Engineering was established on 11 September 1953, with Karel Polacek as Minister. The majority of electrical machinery plants are subordinate to the Main Administration of Electrical Engineering of this Ministry. It is possible that one or more small motor plants are under the Ministry of Light Industry. 33/

One of the largest generator plants, the electrical division of the V.I. Lenin Works at Doudlevce, was part of the former Skoda combine. It is not known whether or not this plant is subordinate to the Main Administration of Electrical Engineering or reports directly to the Ministry. Two groups of plants account for a large share of the production of the electrical machinery industry. One group is CKD (Ceskomoravska-Kolben-Danek), and the other is MEZ (Moravska Elektriche Zavody -- Moravian Electrotechnical Factories), which has been composed of several independent plants since 1949. 34/

4. East Germany.

The administrative structure of East German industry has changed several times since World War II. An important organizational change took place in late 1953 and early 1954 when three ministries were merged to form the Ministry for Machine Building. This Ministry, headed by Heinrich Rau, took over the formerly Soviet-controlled SAG

plants as they were returned to the East Germans. Under this system the following main administrations* were responsible for electrical machinery as defined in this report 35/: HV** Energie- und Kraftmaschinenbau (Power Machine Building) (includes some generator production), HV 8 Elektromaschinenbau (Electric Machine Building), HV 13 Radio- und Fernmeldetechnik (Radio and Communications) (includes some small motors), and HV 15 Kabel- und Apparatebau (Cable and Apparatus Building).

Since mid-1955 the former Ministry for Machine Building has been split into two elements, the Ministry for Heavy Machine Building and the Ministry for General Machine Building. 36/ It is not possible to identify the subordination of all main administrations and their plants within the new ministries. Moreover, for accounting purposes the old system has been used through 1955.

5. Hungary.

In Hungary, electrical machinery is produced in plants subordinate to the Ministry of Metallurgy and Machine Industry, headed by Janos Csergo. Some electrical machinery plants probably are under the Main Administration of Heavy Electrical Engineering, but whether there are other administrations for small machinery, electric cable, and switchgear is not known. 37/

6. Poland.

In Poland, electrical machinery plants are subordinate to the Ministry of the Machine Industry, headed by Julian Tokarski. The subgroup responsible for electrical machinery is the Central Administration of the Electrotechnical Industry (Centralny Zarzod Przemyshe Elektryeznego -- CZPE). 38/

7. Rumania.

In Rumania the Ministry of Electric Power and the Electrotechnical Industry, like its counterpart in Bulgaria, is responsible for the electric power system as well as for the production of electrical machinery. The Minister is Gheorghe Cioara. The electrical machinery plants are subordinate to the Main Administration of Electrical Equipment. 39/

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* Main Administration -- Hauptverwaltung, or HV.

** HV 6 (Boiler and Turbine Building) and HV 7 (Power Machinery Building) were combined on 1 January 1955. The number of the new HV is not known.

II. Production.

A. Facilities.

Electrical machinery plants may be classified as follows: (1) large plants which are well known and concerning which there is relatively complete information; (2) medium or small plants concerning which available information varies from minimal to relatively complete; and (3) plants of unknown size concerning which it is known only that they exist. It is also possible that there are other plants of which nothing is known.

In Appendix B, 43 plants in the USSR and 65 plants in the European Satellites, including all those in category 1, and the most important of those in category 2, above, are listed.* In addition, there are approximately 120 Soviet and 60 Satellite plants which are either minor producers or concerning which no detailed information is available. These plants and any unknown plants which may exist probably account for a very small proportion of the production of electrical machinery because of the small size of the plants and of the electrical machinery built in these plants.

B. Estimates of Production.

Detailed estimates of production of electrical machinery in the Soviet Bloc in 1946-60, by country, are shown in Appendix A, Tables 9 through 16.** In most of the tables, figures for a pre-war year are also shown for comparison. For each product except switchgear and electric wire and cable, 2 tables are included, 1 in terms of units produced and 1 in terms of value. Value figures only are shown for switchgear and electric wire and cable because the heterogeneous nature of this equipment precludes the use of a satisfactory single physical unit. The value figures, given in millions of 1953 US dollars, are the product of physical production times the value per physical unit of the product involved. Thus the value figures are really dollar measures of physical production and do not include

* As is discussed more fully in Appendix C, Methodology, estimates of production were made on a countrywide basis rather than by individual plant studies. Thus the list of plants in Appendix B serves to identify and locate the principal production facilities rather than to form a quantitative basis for estimates of production.
** Pp. 30-37, below.

such factors as variation in the product mix occasioned by trade between countries or by differences in quality of product or in manufacturing methods.*

The estimated volume of production of motors, generators, and power and distribution transformers of all sizes in the Soviet Bloc in 1955 is shown in Table 1.** This table shows that the USSR produced about 61 percent of the total and that Czechoslovakia and East Germany led the European Satellites in the production of the remaining 39 percent.

The estimated value of production of electrical machinery in the Soviet Bloc in 1946 and 1955 is shown in Table 2.*** This table shows that in 1955 the Bloc produced electrical machinery with a value of approximately $2.8 billion, compared with a value of approximately $410 million in 1946. The ratio of increase between 1946 and 1955 for the USSR was approximately 6, whereas those for Czechoslovakia and East Germany, the 2 European Satellites which had well-developed electrical machinery industries before World War II, were about 5 and 6, respectively. The ratios for the other Satellites were much larger, ranging from 19 for Poland to 33 for Bulgaria. In these countries, however, the electrical machinery industries had never been developed or had been damaged severely during World War II. Thus impressive rates of growth in these countries do not result in large absolute values of production. It is interesting to note also that the rapid increase in the rate of production in the less industrialized Satellites has been offset by the slower rate of increase in East Germany and Czechoslovakia, so that the relative contribution of the Satellites to the total production of the Soviet Bloc remained about the same in 1946 as in 1955.

By 1956 the estimated value of production of electrical machinery in the Soviet Bloc will increase to approximately US $3.0 billion. Of this total, motors, generators, and transformers will account for $1.4 billion; electric wire and cable for $1.2 billion; and switchgear for $440 million.

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* For a more complete discussion, see Appendix C, Methodology.
** Table 1 follows on p. 17.
*** Table 2 follows on p. 18.

If the value added is estimated at 55 percent of the value of production, production of electrical machinery in the USSR in 1953 represented 0.5 percent of the gross national product and 1.5 percent of total industrial production. 40/ Production of electrical machinery in the Soviet Bloc in 1955, based on the value added, was less than one-half that in the US in 1954. 41/

Table 1

Estimated Volume of Production
of Motors, Generators, and Power and Distribution Transformers
of All Sizes in the Soviet Bloc a/
1955

Country	Motors (Megawatts)	Generators (Megawatts)	Transformers (Megavolt-Amperes)	Total b/	Percent of Total
USSR	11,000	5,800	14,000	31,000	61
Bulgaria	470	17	300	790	1.6
Czechoslovakia	2,600	980	1,600	5,200	10
East Germany	1,800	1,000	3,200	6,000	12
Hungary	900	300	1,300	2,800	4.9
Poland	1,000	20	2,600	3,600	7.3
Rumania	430	190	850	1,500	3.0
Total	18,000	8,300	24,000	51,000	100

a. All data are rounded to two significant figures. Totals and percentages are derived from unrounded figures and do not always agree with rounded data shown.
b. Technically, megawatts and megavolt-amperes should not be added, but in this case their sum is a meaningful measure of total production in physical units.

Table 2

Estimated Value of Production of Electrical Machinery in the Soviet Bloc a/
1946 and 1955

Country	1946		1955		Ratio of Increase 1955 over 1946
	Million 1953 US $	Percent	Million 1953 US $	Percent	
USSR	290	71	1,800	65	6.2
Bulgaria	1.1	0.30	36	1.3	33
Czechoslovakia	53	13	260	9.3	4.9
East Germany	49	12	290	10	5.9
Hungary	4.4	1.1	130	4.7	34
Poland	11	2.7	210	7.5	19
Rumania	2.1	0.50	65	2.3	31
Total	410	100	2,800	100	6.8

a. All data are rounded to two significant figures. Totals and percentages are derived from unrounded figures and do not always agree with rounded data shown.

III. Use Pattern and Requirements.

A. Use Pattern.

The products of the electrical machinery industry that are concerned with the generation and distribution of bulk power -- for example, large generators and transformers, heavy switchgear, and power cable -- are used almost entirely by the electric power industry or by large industrial complexes that have their own generating plants. These products contribute to the atomic energy program in direct proportion to the power used for that purpose. Motors and the smaller sizes of transformers and switchgear have far more direct application in industry.

Table 3 shows the estimated use pattern of heavy electric motors and generators in the USSR in 1955. Table 4* shows the planned use pattern of AC motors of 1 to 100 kw in East Germany in 1951.

Table 3

Estimated Use Pattern of Heavy Electric Motors and Generators in the USSR a/
1955

Percent

Consuming Industry	Motors	Generators
Electric power, including the atomic energy program	23	87
Naval shipbuilding	5	5
Railroad transportation	10	3
Steel	18	b/
Chemicals and petroleum	16	b/
Mining	6	b/
Aviation	7	b/
Other	15	5
Total	100	100

a. 42/
b. Included under either "Electric power" or "Other."

* Table 4 follows on p. 20.

Table 4

Planned Use Pattern of Alternating Current Motors of 1 to 100 Kilowatts in East Germany a/ 1951

Consuming Sector	Percent Consumed
Industrial production	55.0
Industrial investment	19.1
Agriculture	0.6
Transportation	0.2
Reparations and government orders	0.6
Exports	20.7
Operational reserve	1.1
Other	0.7
Stockpile	2.0
Total	100.0

a. 43/

B. Requirements.

In the USSR, production of electrical machinery, together with imports from the European Satellites, appears to be meeting the requirements of the electric power program and the most important needs of industry. Large-scale production of consumer goods and a substantial export program, however, could not be undertaken, in addition to existing commitments, without a considerable increase in capital investment. There is evidence neither of overproduction nor of an undesired accumulation of inventory. There is also no evidence of a serious shortage of critical input materials, because the USSR has top priority for any such materials available within the Soviet Bloc.

The electrical machinery that remains in the European Satellites after export commitments to the USSR have been met falls far short of domestic needs. In Hungary and East Germany, production of generators available for the domestic power program is so small that repeated

reductions in plans for expansion or chronic shortages of power are caused. Rumania and Bulgaria build neither large generators nor the largest transformers, thus failing completely to meet the requirements of their power systems for these products.

As pointed out in I, B,* of this report, the European Satellites are chronically short of critical input materials, particularly high-grade electrical copper and low-loss transformer and dynamo sheet steel.

IV. Trade.

A. East-West.

Table 5** shows the estimated value of imports of electrical machinery from the West by the Soviet Bloc in 1954. These imports amounted to about $53 million, or a little less than 3 percent of the estimated value of production in the Bloc in 1954. (Exports of electrical machinery from the Bloc to the West, estimated at $5 million per year, are not shown in Table 5.) Although the value of imports into the Bloc is only a small percentage of Bloc production, these imports are important in meeting the need for specialized equipment not mass-produced in the Bloc. The estimates of value are based on reported items of open trade which are identifiable as electrical machinery. The estimates probably are conservative because both clandestine shipments and electrical machinery included in shipments reported only as "electrical equipment" are omitted. 44/

The present trend is toward a decreasing dependence upon Western sources of supply and an increasing dependence upon domestic production and trade within the Sino-Soviet Bloc. (See B, below.) The pattern of East-West trade is also changing. Switzerland and the UK are supplying proportionately less of the electrical machinery imported by the Soviet Bloc, whereas Sweden and West Germany are supplying proportionately more. Although the Soviet Bloc has repeatedly expressed a desire to increase imports of electrical machinery, its purchases have been limited by the export controls imposed by the US and other Western countries. Consequently, the Soviet Bloc has had to pay high prices that otherwise might have been reduced by strong competition in the West for markets in the Soviet Bloc. Although there has been no evidence that specific electrical

* Pp. 7-10.

** Table 5 follows on p. 22.

machinery has been imported for the sole purpose of learning new technological methods, such exploitation of imported machinery probably does occur.

Table 5

Estimated Value of Imports of Electrical Machinery from the West by the Soviet Bloc a/
1954

Million 1953 US $

Country	Exports to the Bloc
Austria	10
Belgium, Luxembourg	2
Finland	2
France	3
Italy	3
Netherlands	3
Sweden	6
Switzerland	5
UK	15
West Germany	4
Total	53

a. 45/

B. Within the Sino-Soviet Bloc.*

Table 6** shows the estimated value of trade in electrical machinery within the Sino-Soviet Bloc in 1954. As indicated by the table, the principal exporting Satellites are Czechoslovakia, East Germany, and Hungary. The USSR draws on these Satellites for some products, such as large generators up to 50,000 kw, while assisting the less industrialized countries of the Bloc. The total volume of

* Communist China is included in this section because it is a major importer of electrical machinery from other members of the Sino-Soviet Bloc.

** Table 6 follows on p. 23.

trade within the Bloc is approximately 7 times the imports from the West and involves about 19 percent of the production of electrical machinery by the Bloc. The estimated value of trade within the Sino-Soviet Bloc was derived from studies of individual installations. These estimates are probably conservative because some items of electrical machinery are included in end products, the final shipment of which is not reported as electrical equipment.

Table 6

Estimated Value of Trade in Electrical Machinery Within the Sino-Soviet Bloc a/
1954

Million 1953 US $

Country	Exports	Imports	Balance of Trade
USSR	120	155	-35
Albania	Negligible	9	-9
Bulgaria	6	19	-13
Czechoslovakia	81	9	+72
Communist China	Negligible	100	-100
East Germany	120	10	+110
Hungary	32	10	+22
Poland	8	29	-21
Rumania	3	29	-26
Total	370	370	

a. 46/

V. Inputs.

Table 7* shows the estimated requirements for selected inputs for the production of electrical machinery in the Soviet Bloc in 1955. The column headed Steel includes the carbon and the alloy steel mill shapes and steel castings that enter into the mechanical structure of electrical machinery. This column does not include transformer and dynamo sheet steel, which is shown separately in the column headed Electrical Sheet Steel. Electrical sheet steel has special magnetic properties and is used for the magnetic flux-carrying portion, or "core," of electrical equipment.

* Table 7 follows on p. 24. For methodology, see Appendix B.

Table 7

Estimated Requirements for Selected Inputs for Production of Electrical Machinery in the Soviet Bloc, by Country a/
1955

Thousand Metric Tons

Country	Steel	Electrical Sheet Steel	Iron Castings	Aluminum	Copper
USSR	170	240	78	71	240
Bulgaria	5.3	6.0	2.7	0.16	3.3
Czechoslovakia	26	46	17	10	28
East Germany	27	44	14	4.0	36
Hungary	13	18	6.1	4.0	16
Poland	17	22	6.2	1.7	21
Rumania	3.7	10	2.9	4.3	9.1
Total	260	390	130	95	350

a. All data are rounded to two significant figures. Totals are derived from unrounded figures and do not always agree with rounded data shown.

VI. Capabilities, Vulnerabilities, and Intentions.

A. Capabilities.

The USSR is technically capable of producing a complete line of electrical machinery of satisfactory quality in sizes up to the largest built in the US in the early 1950's. Over-all production meets planned goals, although occasionally goals for some specific items are not met. The need for imports from the European Satellites and from the West is evidence that production does not meet all requirements. Imports of generators especially are required for expansion of the power system, although exports to Communist China constitute a part of this requirement.

The capabilities of the European Satellites vary widely. Czechoslovakia and East Germany produce complete lines of electrical machinery, but the largest units are substantially smaller than those

made in the USSR. These countries are capable of producing machinery of good quality, but frequently the quality is not satisfactory because of shortages of good materials or because of inferior workmanship. Bulgaria produces a limited line of relatively small equipment, and Albania is not known to produce any electrical machinery at all. Hungary, Poland, and Rumania rank between East Germany and Czechoslovakia on the one hand and Bulgaria on the other.

Although the European Satellites generally report fulfillment of their plans, they fail to meet the actual requirements of their own power programs. Deliveries to the USSR and to Communist China contribute to the failure.

B. Vulnerabilities.

Because of the primary importance of electrical machinery in the supply and conversion of power for all industrial operations, any reduction in production of electrical machinery will hinder further expansion of heavy industry or will necessitate the reallocation of available electrical machinery to the more critical sectors of industry. The potential vulnerabilities of the electrical machinery industry itself are the geographical concentrations of plants and personnel, the shortages of materials, and the dependence upon imports.

Vital segments of the electrical machinery industry of the Soviet Bloc are geographically concentrated in the USSR. Plants located in Moscow, Leningrad, Khar'kov, Sverdlovsk, Yerevan, Baku, and Zaporozh'ye account for almost the entire production of the large generators and the transformers necessary to expand or rehabilitate the electric power system. In the European Satellites the concentration of the electrical machinery industry is even greater. There are only 1 or 2 plants in each country capable of making the larger types of equipment. Almost all of the Satellite production of electrical machinery is centered in the cities of Sofia, Prague, Pilsen, East Berlin, Dresden, Budapest, Wroclaw, Zychlin, and Craiova.

The vulnerability of the Soviet Bloc with regard to personnel is linked to the geographical concentration of plants. The skilled workers and engineers, without whom it would be most difficult to operate the electrical machinery industry, are concentrated in the same general areas as are the plant facilities.

The vulnerability of the Soviet Bloc with regard to shortages of materials is reflected in continuing reports of failures by the European Satellites to meet quotas for machinery because of the lack of high-grade copper, electrical sheet steel, and transformer oil. It is possible that these shortages could be overcome by lowering the standards for the input materials, but there has been no indication that the Bloc would accept the lower grade, higher cost end products that would result from lowered standards. For example, aluminum wire has been used to replace copper in certain instances, but the result has been negligible in overcoming the shortage of copper. The European Satellites depend upon imports for approximately 54 percent of the high-grade copper, 35 percent of the electrical sheet steel, and 33 percent of the transformer oil required for electrical machinery and electric wire and cable. The USSR, however, does not appear to be short of these materials and in rare cases even has delivered copper and electrical sheet steel to the Satellites for the purpose of expediting deliveries of electrical machinery to the USSR.

The effects of shortages of strategic materials are widespread. Delays in the delivery of electrical sheet steel and copper or non-delivery of these materials hinder the production of manufactured goods. Because the manufacturers of electrical machinery must reschedule their production on the basis of a limited supply of materials, the efficiency of their plants is lowered. The delivery schedules of other industries dependent upon electrical machinery in the manufacture of their products also are disturbed, and the Soviet Bloc may be forced to allocate additional investment funds for copper and other strategic materials in order to relieve the shortages.

A total embargo on exports of essential materials by the West might reduce the production of finished electrical machinery by the Soviet Bloc by a factor of 4 to 5 times the value of the materials themselves. There are no substitutes for most of the end products of the electrical machinery industry.

C. Intentions.

The increase in the value of production of electrical machinery in the Soviet Bloc, shown in Table 2,* indicates an intention

* P. 18, above.

to provide the power and the conversion equipment necessary for the continued expansion of heavy industry. The estimated annual rate of increase in production of electrical machinery in the Soviet Bloc from January 1954 through December 1955 is shown in Table 8. The figures in this table apply, within a margin of error of plus or minus 1.5 percent, both to the total volume of production of motors, generators, and transformers and to the total value of production of electrical machinery as defined in this report. These annual percentage rates are expected to decline slightly during 1955-60, but the absolute increase in the value of annual production probably will remain about the same.

Table 8

Estimated Annual Rate of Increase
in Production of Electrical Machinery
in the Soviet Bloc
January 1954-December 1955

Country	Percentage Increase
USSR	12
Bulgaria	5.0
Czechoslovakia	9.0
East Germany	8.0
Hungary	10
Poland	8.0
Rumania	25

The rate of increase in the USSR of 12 percent failed to meet the goal of 13 percent announced in the Fifth Five Year Plan (1951-55). This rate of increase was slightly less than the amount required to double production in 5 years, the goal set for the increase of electric-generating capacity. 47/

With one exception, the estimated rates of increase were smaller in the European Satellites than in the USSR. In Rumania the rate of increase is still high because of a late start in developing the industry. The 25-percent rate of increase shown for Rumania was calculated from the tables of estimated production and was confirmed by a Rumanian press release. 48/

APPENDIX A

STATISTICAL TABLES

Estimates of the volume of production of specific categories of electrical machinery in the Soviet Bloc are shown for a prewar year and for 1946-60 in Tables 9, 11, and 13.* Estimates of the value of production of specific categories of electrical machinery in the Soviet Bloc are shown for a prewar year and for 1946-60 in Tables 10, 12, 14, 15, and 16.**

* Pp. 30, 32, and 34, respectively, below.
** Pp. 31, 33, 35, 36, and 37, respectively, below.

Table 9

Estimated Volume of Production of Electric Motors of All Sizes in the Soviet Bloc a/
Prewar and 1946-60

Megawatts

Country	Prewar b/	1946	1947	1948	1949	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959	1960
USSR	2,300	2,300	3,300	5,200	7,100	8,500	8,900	9,300	9,800	10,000	11,000	12,000	13,000	14,000	15,000	17,000
Percent of total	(59)	(68)	(77)	(79)	(78)	(74)	(68)	(66)	(63)	(64)	(61)	(57)	(59)	(61)	(58)	(59)
Bulgaria	Negligible	Negligible	Negligible	30	110	200	250	320	380	450	470	500	520	550	570	600
Czechoslovakia	380	580	680	800	940	1,200	1,400	1,700	2,000	2,300	2,600	3,000	3,200	3,600	3,900	4,200
East Germany	1,000	400	200	300	500	900	1,500	1,400	1,600	1,800	1,800	2,000	2,200	2,300	2,400	2,600
Hungary	60	20	50	140	210	320	500	620	720	800	900	980	1,100	1,200	1,300	1,400
Poland	200	70	110	190	200	300	480	680	760	970	1,000	1,200	1,300	1,400	1,500	1,600
Rumania	10	2	5	10	15	45	120	190	260	340	430	500	580	660	740	830
Total	4,000	3,400	4,300	6,700	9,100	11,500	13,000	14,000	16,000	17,000	18,000	20,000	22,000	24,000	25,000	28,000

a. All data are rounded to two significant figures. Totals and percentages are derived from unrounded figures and do not always agree with rounded data shown.
b. East Germany, 1936; USSR, Bulgaria, Czechoslovakia, and Rumania, 1937; Hungary, 1938.

Table 10

Estimated Value of Production of Electric Motors of All Sizes in the Soviet Bloc a/
Prewar and 1946-60

Million 1953 US $

Country	Prewar b/	1946	1947	1948	1949	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959	1960
USSR	100	100	140	230	310	370	390	400	430	450	480	530	570	630	680	750
Bulgaria	Negligible	Negligible	Negligible	1.3	4.8	8.6	11	14	17	20	21	22	23	24	25	26
Czechoslovakia	17	25	30	35	41	52	62	75	87	100	110	130	140	160	170	180
East Germany	44	18	8.8	13	22	40	64	62	73	77	81	88	95	100	110	120
Hungary	2.6	0.88	2.2	6.2	9.2	14	22	27	32	35	40	43	47	51	55	60
Poland	8.8	3.0	5.0	8.1	8.8	13	21	30	33	43	46	52	56	62	66	70
Rumania	0.40	0.088	0.22	0.44	0.67	2.0	5.0	8.1	11	15	19	22	26	29	33	37
Total	170	150	190	290	400	500	580	620	680	740	800	890	960	1,000	1,100	1,200

a. All data are rounded to two significant figures. Totals are derived from unrounded figures and do not always agree with rounded data shown.
b. East Germany, 1936; USSR, Bulgaria, Czechoslovakia, and Rumania, 1937; Hungary, 1938.

Table 11

Estimated Volume of Production of Electric Generators of All Sizes in the Soviet Bloc a/
Prewar and 1946-60

Megawatts

Country	Prewar b/	1946	1947	1948	1949	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959	1960 c/
USSR	720	560	680	820	1,000	1,200	2,400	3,200	4,500	4,900	5,800	6,900	8,200	9,800	11,000	14,000
Percent of total	(65)	(67)	(65)	(58)	(61)	(61)	(70)	(70)	(72)	(69)	(70)	(71)	((72)	(74)	(76)	(78)
Bulgaria	Negligible	Negligible	Negligible	Negligible	4.0	7.0	9.0	11	14	16	17	19	21	23	25	27
Czechoslovakia	340	250	340	440	550	620	700	750	820	900	980	1,000	1,100	1,200	1,200	1,300
East Germany	35	20	10	15	20	50	140	350	560	890	1,000	1,200	1,300	1,400	1,500	1,600
Hungary	20	10	20	40	70	100	160	200	230	260	300	340	370	410	440	480
Poland	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	5	15	20	45	70	100	120	150
Rumania	Negligible	Negligible	Negligible	105	0.8	8	15	75	110	150	190	220	250	270	320	350
Total	1,100	840	1,000	1,400	1,600	2,000	3,400	4,600	6,200	7,100	8,300	9,700	11,000	13,000	15,000	18,000

a. All data are rounded to two significant figures. Totals and percentages are derived from unrounded figures and do not always agree with rounded data shown.
b. East Germany, 1936; Bulgaria, USSR, Czechoslovakia, and Rumania, 1937; Hungary, 1938.
c. Based on Plan data where available.

Table 12

Estimated Value of Production of Electric Generators of All Sizes in the Soviet Bloc a/
Prewar and 1946-60

Million 1953 US $

Country	Prewar b/	1946	1947	1948	1949	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959	1960
USSR	15	12	14	17	21	25	51	67	94	100	120	140	170	200	250	300
Bulgaria	Negligible	Negligible	Negligible	Negligible	0.084	0.14	0.19	0.23	0.29	0.34	0.36	0.40	0.44	0.48	0.53	0.57
Czechoslovakia	7.1	5.3	7.1	9.2	12	13	15	16	17	19	21	22	23	24	25	27
East Germany	0.74	0.42	0.21	0.32	0.42	1.1	2.9	7.4	12	19	22	25	27	29	31	34
Hungary	0.42	0.21	0.42	0.84	1.5	2.1	3.4	4.2	4.8	5.5	6.3	7.1	7.8	8.6	9.2	10
Poland	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	0.10	0.32	0.42	0.95	1.5	2.1	2.6	3.1
Rumania	Negligible	Negligible	Negligible	Negligible	Negligible	0.17	0.31	1.6	2.3	3.1	3.9	4.6	5.2	5.7	6.7	7.2
Total	23	18	22	27	35	42	72	96	130	150	170	200	230	270	330	380

a. All data are rounded to two significant figures. Totals are derived from unrounded figures and do not always agree with rounded data shown.
b. East Germany, 1936; Bulgaria, USSR, Czechoslovakia, and Rumania, 1937; Hungary, 1938.

Table 13

Estimated Volume of Production of Power and Distribution Transformers of All Sizes in the Soviet Bloc a/
Prewar and 1946-60

Megavolt-Amperes

Country	Prewar b/	1946	1947	1948	1949	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959	1960
USSR	2,700	1,900	2,900	4,500	6,100	7,300	8,300	9,500	11,000	12,000	14,000	16,000	19,000	22,000	25,000	29,000
Percent of total	(47)	(59)	(67)	(67)	(66)	(62)	(63)	(58)	(56)	(58)	(58)	(60)	(62)	(64)	(66)	(68)
Bulgaria	Negligible	Negligible	Negligible	Negligible	20	80	130	170	260	280	300	320	340	360	380	400
Czechoslovakia	600	450	600	800	980	1,100	1,200	1,300	1,400	1,500	1,600	1,700	1,800	2,000	2,000	2,200
East Germany	1,900	700	400	500	1,000	1,700	1,800	2,300	2,900	3,000	3,200	3,400	3,500	3,600	3,800	4,000
Hungary	100	60	130	210	320	480	750	930	1,100	1,200	1,300	1,500	1,600	1,800	1,900	2,000
Poland	390	75	300	700	810	1,100	1,400	1,800	2,300	2,400	2,600	2,800	2,900	3,000	3,200	3,300
Rumania	30	10	15	25	50	90	200	360	500	680	850	1,000	1,200	1,400	1,500	1,700
Total	5,700	3,200	4,300	6,700	9,300	12,000	14,000	16,000	19,000	21,000	24,000	27,000	30,000	34,000	38,000	43,000

a. All data are rounded to two significant figures. Totals and percentages are derived from unrounded figures and do not always agree with rounded data shown.
b. East Germany, 1936; Bulgaria, USSR, Czechoslovakia, and Rumania, 1937; Hungary, 1938.

Table 14

Estimated Value of Production of Power and Distribution Transformers of All Sizes in the Soviet Bloc a/
Prewar and 1946-60

Million 1953 US $

Country	Prewar b/	1946	1947	1948	1949	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959	1960
USSR	27	19	29	45	61	73	83	95	110	120	140	160	190	220	250	290
Bulgaria	Negligible	Negligible	Negligible	Negligible	0.20	0.8	1.3	1.7	2.6	2.8	3.0	3.1	3.4	3.6	3.8	4.0
Czechoslovakia	6.0	4.5	6.0	8.0	9.8	11	12	13	14	15	16	17	18	20	21	22
East Germany	19	7.0	4.0	5.0	10	17	18	23	29	30	32	34	35	37	38	40
Hungary	1.0	0.60	1.3	2.1	3.2	4.8	7.5	9.3	11	12	13	15	16	18	19	20
Poland	3.9	0.75	3.0	7.0	8.1	11	14	18	23	24	26	28	29	30	32	33
Rumania	0.30	0.10	0.15	0.25	0.50	0.90	2.0	3.6	5.0	6.8	8.5	10	12	14	15	17
Total	57	32	43	67	93	120	140	160	190	210	240	270	300	340	380	430

a. All data are rounded to two significant figures. Totals are derived from unrounded figures and do not always agree with rounded data shown.
b. East Germany, 1936; Bulgaria, USSR, Czechoslovakia, and Rumania, 1937; Hungary, 1938.

Table 15

Estimated Value of Production of Electric Wire and Cable in the Soviet Bloc a/
1946-60

Million 1953 US $

Country	Prewar b/	1946	1947	1948	1949	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959	1960
USSR	110	130	180	240	310	360	440	540	660	710	780	860	950	1,000	1,100	1,300
Bulgaria	Negl.	Negl.	Negl.	0.4	0.8	1.0	1.7	2.2	5.1	5.6	6.1	6.8	7.4	8.2	9.0	9.9
Czechoslovakia	30	13	18	24	30	37	45	54	65	75	87	97	110	120	140	150
East Germany	150	44	44	53	58	72	79	92	100	92	100	110	120	130	140	160
Hungary	7.0	4.0	5.0	6.0	8.0	11	15	20	27	34	41	47	54	59	65	68
Poland	20	9.0	18	31	34	41	44	48	52	57	63	69	76	84	92	100
Bulgaria	3.0	2.0	3.0	6.0	9.0	15	17	24	26	29	32	36	40	44	49	55
Total	320	200	270	360	450	540	640	780	940	1,000	1,100	1,200	1,400	1,400	1,600	1,800

a. All data are rounded to two significant figures. Totals are derived from unrounded figures and do not always agree with rounded data shown.
b. All countries, 1938.

Table 16

Estimated Value of Production of Switchgear and Switchboard Equipment in the Soviet Bloc a/
Prewar and 1946-60

Million 1953 US $

Country	Prewar b/	1946	1947	1948	1949	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959	1960
USSR	50	30	50	80	110	130	150	170	190	210	240	280	330	380	440	510
Percent of total	(53)	(59)	(71)	(73)	(71)	(66)	(64)	(61)	(59)	(60)	(61)	(63)	(66)	(68)	(70)	(72)
Bulgaria	Negligible	Negligible	Negligible	Negligible	0.35	1.5	2.4	3.1	4.7	5.1	5.5	5.7	6.2	6.5	6.9	7.3
Czechoslovakia	10	8.8	10	14	17	19	21	23	25	26	28	30	32	34	36	38
East Germany	33	12	7.0	8.8	17	30	32	40	51	52	56	59	61	63	66	70
Hungary	2.1	0.70	1.8	5.0	7.4	11	18	22	26	28	32	34	38	41	44	48
Poland	Negligible	Negligible	1.0	2.3	4.0	5.5	11	21	25	27	29	31	32	33	35	37
Rumania	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	1.0	1.4	1.7	2.0	2.4	2.7	3.0	3.4
Total	100	50	70	110	160	200	230	280	320	350	390	440	500	560	630	710

a. All data are rounded to two significant figures. Totals and percentages are derived from unrounded figures and do not always agree with rounded data shown.
b. East Germany, 1936; USSR, Bulgaria, Czechoslovakia, and Rumania, 1937; Hungary, 1938.

APPENDIX B

PRINCIPAL ELECTRICAL MACHINERY PLANTS IN THE SOVIET BLOC

The principal electrical machinery plants in the Soviet Bloc are listed below. The size, location, and most important products of these plants are shown.

City	Plant	Size*	Principal Products
USSR			
Leningrad (Ia)**		N.A.	Transformers up to 500 kva, generators up to 100 kw, small motors. 49/
Leningrad		L	Current transformers and switchgear for up to 500 kw. 50/
Leningrad		N.A.	Power system switchboards. 51/
Leningrad		VL	Turbogenerators up to 150 mw, hydrogenerators up to 123 mw, motors up to 7,000 hp. 52/
Leningrad		L	Motors up to 100 hp. 53/
Riga (IIa)		L	Power, control, and communications cable; bare, weatherproof, field, and magnet wire; coaxial cable. 54/
Tallinn (IIa)		N.A.	Traction motors, portable generators. 55/
Dnepropetrovsk (III)		N.A.	Motors up to 660 kw. 56/
Khar'kov (III)		M	Motors up to 7 kw. 57/
Khar'kov		VL	Magnet wire. 58/
Khar'kov		VL	Hydrogenerators up to 25 mw, motors up to 4,500 kw, switchgear. 59/
Khar'kov		N.A.	Hydrogen-cooled turbogenerators up to 150 mw. 60/
Kiev (III)		N.A.	Small and medium motors. 61/
Pervomaysk (III)		L	Power, control, and communications cable; bare, weatherproof, field, and magnet wire. 62/
Zaporozh'ye (III)		L	Motors up to 150 kw. 63/
Baku (V)		M	Transformers up to 20 mva, transformers and circuit breakers for up to 400 kv. 64/
Yerevan (V)		L	Motors up to 120 kw, transformers up to 350 kva, mobile generators. 65/
		N.A.	Power cable; bare, weatherproof, and magnet wire. 66/

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* Size designations are: S, small, 100 to 500 employees; M, medium, 501 to 1,000 employees; L, large 1,001 to 5,000 employees; VL, very large, more than 5,000 employees. In the case of plants primarily engaged in nonelectrical work, the designation is based on the electrical portion only.

** Numbers in parentheses refer to the economic regions defined and numbered [redacted] USSR: Administrative Divisions and Economic Regions, January 1955.

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*** This plant name has been observed: the plant appears to be associated with, or part of, the Khar'kov complex.

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City	Plant	Size	Principal Products
USSR (Continued)			
Yerevan			
Yerevan		L	Distribution transformers, mobile generators. 67/
Kuybyshev (VI)		N.A.	Medium motors, mobile generators. 68/
Bryansk (VII)		N.A.	Power and telephone cable, magnet wire. 69/
Kirs (VII)		N.A.	Turbogenerators up to 25 mw. 70/
Kol'chugino (VII)		N.A.	Power cable. 71/
Moscow (VII)		N.A.	Power, control, and communications cable. 72/
Moscow		VL	Traction and mill motors up to 250 kw. 73/
Moscow		VL	Motors 40 to 400 kw, rural station generators. 74/
Moscow		L	Power cable, bare and weatherproof wire. 75/
Moscow		VL	Transformers up to 180 mva, 400 kv; switchgear. 76/
Podol'sk (VII)		VL	Gas-filled power cable; control and communications cable; bare, weatherproof, and magnet wire. 77/
Tambov (VII)		N.A.	Power, control and communications cable; bare, weatherproof, and field wire. 78/
Yaroslavl' (VII)		N.A.	Medium motors, portable generators. 79/
Baranchinskiy (VIII)		L	Medium motors. 80/
Sverdlovsk (VIII)		N.A.	Motors up to 340 kw. 81/
Sverdlovsk		VL	Hydrogenerators up to 21 mw, motors up to 2,370 kw, medium transformers, switchgear, power rectifiers. 82/
Ufa (VIII)		L	Power and telephone cable, field and magnet wire. 83/
Kemerovo (IX)		L	High- and low-voltage wire and cable. 84/
Tomsk (IX)		L	Mine motors up to 250 hp. 85/
Tomsk		L	Telephone cable, magnet wire. 86/
Stalinabad (X)		VL	Motors up to 100 kw, small generators. 87/
Tashkent (X)		N.A.	Motors, generators, transformers for agriculture. 88/
Atka (XII)		L	Power, control, communications cable; bare, weatherproof, field, and magnet wire. 89/
Vladivostok (XII)		N.A.	Medium motors and transformers. 90/
		S	Medium motors and switchboards. 91/

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City	Plant	Size	Principal Products
Bulgaria			
Burgas	Vasil Kolarov Wire Plant	S	Power cable, telephone wire. 92/
Sofia	Vasil Kolarov High-Current Plant	L	Motors up to 160 hp, hydrogenerators up to 4,000 kw, transformers up to 20,000 kva, switchgear. 93/
Czechoslovakia			
Bratislava	Electrotechnical Plant (BEZ) (formerly CKD Krivan)	L	Medium motors and transformers. 94/
Bratislava	Kablo Plant	L	Power, control and communications cable; bare, weatherproof, and field wire. 95/
Brno	Julius Fucik Electrotechnical Plant	L	Current transformers, high- and low-voltage switchgear. 96/
Brno	MEZ -- Zidenice (formerly Svet)	L	Motors up to 5 hp, amplidynes. 97/
Decin/Podmokly	CKD -- Podmokly (formerly AEG)	L	Motors up to 5 kw, welding transformers. 98/
Decin/Podmokly	Kablo Plant	M	Telephone and high-voltage cable. 99/
Doudlevce	V.I. Lenin Plant, "Gigant" (formerly Skoda)	VL	Turbogenerators up to 45 mw, motors up to 2,200 kw, transformers up to 20 mva, switchgear. 100/
Frenstat	MEZ -- Frenstat	L	Medium induction and synchronous motors. 101/
Kladno	Kablo Plant	L	Power cable. 102/
Mohelnice	MEZ -- Mohelnice (formerly Siemens)	L	Small and medium motors. 103/
Prague/Vysocany	CKD -- Stalingrad (formerly "Marshal Tito")	VL	Hydrogen-cooled turbogenerators up to 50 mw, motors up to 2,000 kw, transformers up to 100 mva, switchgear. 104/
Prague	Kablo Plant	L	Coaxial, power, control, and communications cable; field wire. 105/
Vsetin	MEZ -- Vsetin (formerly Sousedik)	L	Generators up to 5,000 kw, motors up to 600 hp. 106/
East Germany			
Berlin/Oberschoenweide	Kabelwerk Oberspree	VL	Power, control and communications cable; bare, weatherproof, and magnet wire. 107/
Berlin/Oberschoenweide	Karl Liebknecht Transformer Plant (TRO)	L	Transformers up to 125 mva, current and potential transformers up to 220 kv, high-voltage switchgear. 108/
Berlin/Koepenick	Kabelwerk Koepenick	L	Coaxial, power, control and communications cable; bare, weatherproof, and magnet wire. 109/
Berlin/Treptow	J.W. Stalin Plant (EAW)	VL	Industrial switchboards. 110/
Berlin/Weissensee	Karl Liebknecht Transformer Plant II (formerly Ziehl-Abegg)	M	Switchboards and switchgear. 111/

City	Plant	Size	Principal Products
East Germany (Continued)			
Berlin/Wilhelmsruh	Bergmann-Borsig Plant	L	Turbogenerators up to 32 mw (turbines). 112/
Dessau	VEB Elektromotorenwerk Dessau (formerly Bamag)	L	Motors up to 1,000 kw. 113/
Dresden	Transformatoren and Roentgenwerk (Tra Roe) (formerly Koch and Sterzel)	L	Transformers up to 70 mva, instrument and X-ray transformers, switchgear. 114/
Finsterwalde	Fimag Machine Plant	L	Generators up to 60 kw, portable generators. 115/
Gruenhain	Elektromotorenwerk Gruenhain	L	Motors, 0.25 to 250 kw; generators, 40 to 100 kw. 116/
Hartha	VEB Kleinstmotorenwerk (formerly Alfred Oemig and Company)	M	Small precision motors, gyroscopes, converters. 117/
Heidenau	VEB Elmo Werk (formerly Elbtalwerk)	L	Motors up to 250 kw, motor generators. 118/
Leipzig	VEB Galvanotechnikwerk Plant II (formerly Langbein and Pfannhaeuser)	L	Motors and generators up to 200 kw. 119/
Hennigsdorf	VEB Hans Beimler (LEW)	L	Turbogenerators up to 25 mw, traction motors (locomotive). 120/
Meissen	Kabelwerk Meissen	M	Power, control and communications cable; bare, weatherproof, and magnet wire. 121/
Muskau	Switch Plant	M	High-voltage switchgear. 122/
Niedersedlitz	Sachsenwerk Niedersedlitz	VL	Turbogenerators up to 12 mw, motors up to 3,800 kw. 123/
Oschersleben	Electric Motor Plant	S	Medium motors. 124/
Plauen	Leitungwerk Plauen	M	Power cable; bare, weatherproof, and magnet wire. 125/
Radeberg	Sachsenwerk Radeberg	L	Small motors (electronic equipment). 126/
Reichenbach	Rectifier and Transformer Plant	S	Transformers up to 200 kva. 127/
Thurm	VEB Elektromotorenwerk Thurm (formerly Stephan Werke)	M	Small and medium motors. 128/
Wernigerode	VEB Elektromotorenwerk Wernigerode	L	Motors up to 250 kw. 129/
Hungary			
Budapest	Cable and Synthetic Materials Plant (formerly subsidiary of Felton and Guilleaume)	L	Power, control and communications cable; field wire. 130/
Budapest	Cable and Wire Rope Plant (formerly Felton and Guilleaume)	L	Power, control and communications cable; field and magnet wire. 131/
Budapest	Electric Motor and Cable Plant (formerly Siemens)	L	Medium motors; power, control and communications cable; field and magnet wire. 132/
Budapest	Ganz Switch and Apparatus Plant	M	Switchgear and switchboards. 133/

City	Plant	Size	Principal Products
Hungary (Continued)			
Budapest	Kisforgogebgyar Plant	M	Small motors. 134/
Budapest	Klement Gottwald Electrical Plant	VL	Turbogenerators up to 34 mw, motors up to 3,000 hp, transformers up to 45 mva, switchgear. 135/
Budapest	Transzvil Transformer Plant	L	Transformers up to 1,500 kva, current transformers, switchgear. 136/
Poland			
Bedzin	Wire and Cable Plant	N.A.	Telephone and high-voltage cable; field wire. 137/
Bielsko	M4 Electric Motor Plant	L	Motors up to 55 hp. 138/
Bydgoszcz	Polish Cable Company	M	High- and low-voltage cable. 139/
Cieszyn	M2 Electric Motor Plant	L	Motors up to 250 hp. 140/
Dziedzice	State Cable Plant	N.A.	Telephone wire. 141/
Krakow	Krakow Cable Plant	L	Power cable, field wire. 142/
Lodz	M3 Transformer Plant	L	Transformers up to 25 mva, 110 kv; motors up to 250 hp. 143/
Miedzylesie	A10 High-Voltage Switch Plant	L	High-voltage switchgear. 144/
Ozarow	Ozarow Cable Plant	L	Power cable, field and magnet wire. 145/
Tarnow	Southern Electric Motor Plant	M	Medium motors. 146/
Warsaw	Gheorghi Dimitrov Electrical Plant (formerly Zwann)	L	Current transformers for up to 220 kv, high-voltage switchgear. 147/
Wroclaw	M5 Heavy Electrical Machinery Plant imeni F. Dzierzynskiego	L	Turbogenerators up to 2 mw, motors up to 2,800 hp. 148/
Zychlin	M1 Electric Machine and Transformer Plant imeni Wilhelm Pieck (formerly Rohn-Zielinsky)	M	Motors up to 4,500 hp; transformers up to 31 mva, 110 kv. 149/
Rumania			
Brasov (Stalin)	Electro-Precisia	M	Motors, 0.15 to 22 kw. 150/
Bucharest	Dynamo	L	Generators up to 300 kw, motors up to 480 hp, transformers up to 5,000 kw. 151/
Bucharest	Electrocablul	M	N.A. 152/
Bucharest	Klement Gottwald	M	Medium motors, transformers up to 300 kva, generators up to 25 kw. 153/
Craiova	Electroputere	L	Generators up to 3,000 kw, motors up to 1,000 kw, transformers up to 15 mva, switchgear. 154/
Recita	Sovrom Utilaj Petrolifer Plant (former Caros Judet)	L	Turbogenerators up to 3,000 kw, motors up to 600 kw. 155/
Timisoara	Electromotor Timisoara	M	Motors, 1 to 30 hp. 156/

APPENDIX C

METHODOLOGY

1. Accuracy.

All data in the tables on production in this report are rounded to two significant figures. Totals and percentages are derived from unrounded figures and do not always agree with rounded data shown. The range of error in the estimates varies up to plus or minus 20 percent for the years through 1955 and up to plus or minus 30 percent for the years 1956-60.

The data for the USSR generally represent officially published statistical information as do the data for East Germany in many cases. Among the other members of the Soviet Bloc, statistical information at the industry level was relatively complete except for Czechoslovakia. The over-all totals of electrical machinery for each country and for the Soviet Bloc as a whole probably are more accurate than the individual estimate of a single product in a particular country.

2. Motors and Generators.

After all the available data on plans and their fulfillment were assembled, the production of motors and generators in each year was expressed in terms of a base year. The overlapping sets of data were then combined into a single time series of index numbers. The index numbers were converted to estimates of production by the use of the production year for which the most accurate information was available. The resulting figures were checked for order of magnitude and reasonableness against the capacity of known facilities for production on the basis of individual plant studies or of number of employees.

Absolute figures on production usually were derived from published data on production or plans for 1 or 2 types of machinery and projected to cover all types of machinery by means of an assumed product mix. The completeness of the available data varied widely from one country to another, but the procedure used in deriving estimates for the USSR is typical.

a. USSR.

The USSR has published absolute figures for the two main categories of motors for prewar years and for the years 1950, 1954, and 1955. 157/ Percentage increases were available for the years 1946-50, 158/ leaving only three years for which no figures were available. Prewar data from the USSR and postwar data from the US indicated that the two main categories of motors represented about 80 percent of the total production of all motors. 159/ The output of all motors was estimated to be 1.25 times the total of the two main categories of motors. The figures for motors reasonably check with correlation factors associating electric power, generators, and transformers with motors. The figures for motors also were checked by reconstructing the end use requirements of major categories of motors other than the two main categories for which data were available. In these estimates an average value was assigned to groups of motors such as fractional-horsepower motors for consumer goods and direct-current traction motors, for which end product requirements were approximately known. Estimates of possible production of various categories of motors in 1960 were derived from Plan figures by the use of corelation factors, and the entire series was extrapolated from 1956 to 1960.

The USSR has published prewar data, data for 1950, 1954-55, and 1960 Plan data for the two major categories of large generators. 160/ Data on Plan fulfillment were published in the form of percentage increases for the years from 1951-53, 161/ but data for 1946-49 were not given. These latter years were estimated by correlation factors associating electric power and turbines with generators. All years were checked by plant estimates. Plant estimates were most complete for the years 1946-49 [redacted] These data were further checked by estimates of the production of generators used in equipment and of engine-driven generators. The resultant totals represent 95 percent of all generators. The planned output of large generators was given for 1960, and the years 1956-60 were obtained by semilogarithmic extrapolation. 162/

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b. European Satellites.

A procedure similar to that used in deriving estimates for the USSR was used to estimate production of motors and generators in Czechoslovakia, 163/ East Germany, 164/ Poland, 165/ and Rumania. 166/ For these European Satellites, some data usually were available in terms of kilowatts of motors or generators, instead of numbers of units. In some cases, figures on actual production, as contrasted with planned goals, were available. In the case of Hungary, 167/ the reported production of the one major electrical machinery plant was used as the basis for determining production in several plants. In the case of Bulgaria, 168/ a much less satisfactory method was employed. In the absence of any quantitative data, production of motors was estimated at 2.5 times the annual increase in generating capacity, a ratio somewhat lower than that of the US or the USSR because Bulgaria does not make or use so many large motors as a more industrialized country.

3. Transformers and Switchgear.

a. Transformers.

Absolute figures for postwar production of transformers in the USSR were not available. Because the relationship between 1950, 1955, and plans for 1960 was expressed, however, it was possible to set up a complete production series for transformers once the figure for 1955 had been established. Several methods were used to obtain the figure for production of transformers in 1955, as follows:

(1) Estimates of production in specific plants were totaled;
(2) Production of kw of large motors was multiplied by a factor of 1.75 to give kva of transformers;
(3) Production of kw of large generators was multiplied by a factor of 3.25 to give kva of transformers;
(4) The annual power increase in 1,000 kwh was multiplied by a factor of .78 to give kva of transformers.

All these methods yielded closely comparable outputs. With 1955 as a base year, the figures for 1956-60 were extrapolated and modified by possible limits on production. Given the 1955 relationship to 1950, it was only necessary to interpolate between 1950-55 and to extrapolate back to 1946 to complete the series. All figures were checked against production of the individual plants.

The general procedure for estimating production of transformers in the Satellites was similar to that for production of motors and generators. Absolute figures for at least one year were available for Czechoslovakia, East Germany, Poland, and Rumania in the same sources given for the estimates of production of motors and generators. In the case of Hungary, production of the two known major plants was used. In the case of Bulgaria, the estimate was based on the annual increase in generating capacity, allowing for the fact that Bulgaria imported the larger transformers until 1954. 169/

b. Switchgear.

Switchgear, considered as a function of generating capacity, may be measured by transformer capacity inasmuch as switchgear and transformers are often ordered as a unit. There were enough data to establish a ratio between switchgear and transformers in several countries. For countries such as Hungary, however, where the production of transformers was not known, switchgear was valued at 0.3 times motors, based on US data for 1947. On the same basis, a value ratio for switchgear of 1.76 times the value of transformers was used in the USSR, and a ratio of 1.75 was used for East Germany, Bulgaria and Czechoslovakia. Information on Poland was sufficient to permit independent estimates. Information on Rumania indicates very limited production of switchgear, which was estimated at a nominal figure of 20 percent of the value of transformers, based on employment totals in manufacturing plants.

4. Electric Wire and Cable. 170/

a. General.

Estimates for each member of the Soviet Bloc were made on the basis of plant studies covering a prewar year and the period 1946-55. Total production for selected years was established for the various countries by adding plant estimates. Time series of annual production in each country were established on the basis of published indexes, 171/ reference to data on utilization of capacity in given years, probable war damage, and interpolation between years on the basis of plant studies. 172/ The country estimates were checked by analogy with the US. The relationship of the value of insulated electric wire and cable to the value of selected items of electrical machinery and electronic and telecommunications equipment was computed for the US and the USSR for selected years and compared. This comparison and a similar comparison

for the ratio of increase in the annual value of production of insulated wire and cable over the increase in production of electric power during selected years indicated that the Bloc estimates were of a reasonable order of magnitude. The estimates were then extended to 1960 on the basis of rates of increase obtaining in the past, modified by information on expansion plans and possibilities. 171/

b. Plant Studies.

The value of production of individual plants in the Soviet Bloc was derived by estimating the labor productivity of the plants in relation to the average labor productivity obtaining in four Soviet plants. The estimated labor productivity times the estimated labor force produced the estimated value of production for each Bloc plant studied. The reasonability of the estimates was checked by reference to the labor productivity of eight East German plants. An estimate of labor productivity was then made for the 4 Soviet and the 8 East German plants because the value of production and the labor forces of the various plants could be independently estimated. 172/ Because electric wire and cable is a non-homogeneous product, only value was used to measure its production.

5. Estimates of Value.

Estimates of the value of annual production of electrical machinery in the Soviet Bloc are given in 1953 US dollars and are proportional to estimates of physical production of motors, generators, and transformers. Estimates of the value of production of switchgear were discussed above.* Coefficients such as dollars per kilowatt were derived from the US figures for 1947 adjusted to 1953. 173/ These coefficients are based on US costs, methods, and product mix and do not reflect differences in these factors between the US and the various countries of the Soviet Bloc. The specific coefficients are: $44 per kw for motors, $21 per kw for generators, and $10 per kva for transformers.

6. Projections.

Estimates of production of electrical machinery in the Soviet Bloc in 1954-60 were projected on a straight-line basis for all items except electric wire and cable. Estimates of wire and cable were extended to

* P. 48, above.

1960 by the use of rates of increase of electric power as a correlation coefficient. The totals were modified on the basis of expansion capabilities. Because current information on plants indicates the continuing expansion of manufacturing facilities, production is expected to increase. The very high rate of annual increase in production since 1946, however, may be attributed in part to the low initial value of an industry badly damaged by war, and this rate may not be sustained indefinitely.

7. Estimates of Selected Inputs.

a. Motors, Generators, Transformers, and Switchgear.

Inputs of steel, iron castings, aluminum, and copper for production of electrical machinery in the Soviet Bloc in 1955 were calculated from estimates of the value of production in 1955, and input factors in terms of metric tons per million dollars of value were obtained from the 1947 US Census of Manufactures. Transformer and dynamo sheet steel factors were based on the reported requirements of the USSR and East Germany and the estimate of production in each country in the year for which the requirement was given. 174/ Table 17* shows estimates of selected input factors for production of electrical machinery in the Soviet Bloc in 1955.

b. Electric Wire and Cable.

Estimates of inputs for production of electric wire and cable are revisions derived directly from estimates for 1955 [redacted] 50X1 Approximately 9 percent of the copper input represents magnet wire, which is used principally in the manufacture of electrical machinery and apparatus.

8. Estimates of Trade.

a. East-West Trade.

[redacted] 50X1

* Table 17 follows on p. 51.

Table 17

Estimates of Selected Input Factors for Production of Electrical Machinery in the Soviet Bloc, by Type of Product
1955

Metric Tons per Unit of Production

Product	Unit of Production	Steel [a]	Transformer Sheet Steel	Dynamo Sheet Steel	Iron Castings	Aluminum	Copper [b]
Motors and generators	Million 1953 US $	420			120	6.9	29
	Megawatts			11			
Transformers	Million 1953 US $	450			7.7	1.4	71
	Megawatts		4				
Switchgear	Million 1953 US $	180			8.1	3.1	35

a. Includes carbon and alloy steels, steel castings, and transformer and dynamo sheet steel.
b. Includes wire mill shapes and forms but not magnet wire.

b. Trade Within the Sino-Soviet Bloc.

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The information from these studies and documents relates either to the relative value of plant production shipped to other Bloc countries or to specific pieces of equipment produced for delivery within the Bloc. All information obtained was converted to percentages of total production, representing trade within the Bloc. For this purpose the estimated average of exports of several large and typical plants in each country were considered to be representative of the country being studied. The value of production of electrical machinery for each country, shown in Table 2,* was multiplied by the percentage contributed by that country to trade within the Bloc.

Another pattern of distribution of trade within the Sino-Soviet Bloc was derived by estimating the total imports received by each country without regard to the country of origin. The value of such imports for each country then was adjusted on the basis of the estimated value of trade within the Bloc. The necessary adjustment downward was less than 10 percent for each country.

The margin of error of the estimates for trade is plus or minus 30 percent.

* P. 18, above.

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