SECRET

'Y NO. 53 D/R
ASSISTANT DIRECTOR
FOR RESEARCH AND REPORTS

50X1

# ECONOMIC INTELLIGENCE REPORT

# THE ELECTRONIC COMPONENTS INDUSTRY IN THE SOVIET BLOC

CIA/RR 14

19 November 1952

50X1

## CENTRAL INTELLIGENCE AGENCY

OFFICE OF RESEARCH AND REPORTS

SECRET

WARNING

This material contains information affecting the National Defense of the United States within the meaning of the espionage laws, Title 18, USC, Secs. 793 and 794, the transmission or revelation of which in any manner to an unauthorized person is prohibited by law.

Declassified in Part - Sanitized Copy Approved for Release 2013/08/12 : CIA-RDP79R01141A000100170002-9

S-E-C-R-E-T

50X1

ECONOMIC INTELLIGENCE REPORT

# THE ELECTRONIC COMPONENTS INDUSTRY IN THE SOVIET BLOC

CIA/RR 14

CENTRAL INTELLIGENCE AGENCY

Office of Research and Reports

S-E-C-R-E-T

CONTENTS

Page

Page

Appendixes



50X1



Declassified in Part - Sanitized Copy Approved for Release 2013/08/12 : CIA-RDP79R01141A000100170002-9

# THE ELECTRONIC COMPONENTS INDUSTRY IN THE SOVIET BLOC*

## Summary

This report, in general, has been directed toward an analysis of production in the Soviet Bloc of fixed capacitors and fixed electronic resistors, which are the primary components industries needed to support an electronics program. Although shortages of a few specific components have appeared in some sectors of the Bloc economy, the present output is quite adequate to meet current requirements. These electronic components appear to be more freely available within the Bloc than are electron tubes. The production pattern indicates a heavy consumption for military electronics applications.

Manufacturing techniques employed in the electronic components industry in the Soviet Bloc vary somewhat from those in the US. An increasing proportion of the fixed capacitor production is of the metallized paper construction developed in Germany by the Robert Bosch Company, and the predominant part of the Soviet paper capacitor output is of an indigenous Soviet hermetically sealed construction. Nearly all the fixed resistors are of the deposited film construction developed before World War II by another German firm, Siemens-Halske AG. Although a result of these differences in technology is to raise labor cost and unit prices in the Bloc industry, components so constructed are more suited to rigorous military applications than are most of those produced in the US.

The estimated Soviet Bloc output in 1951 of the electronic components considered in this report is valued at $48.2 million -- $32.3 million for fixed electronic capacitors, $14.1 million for fixed electronic resistors, and $1.8 million for alternating-current power capacitors. Of the total Bloc production of these components in 1951, the USSR supplied about 70 percent. There are strong indications that a significant increase in output may be anticipated. Within 2 years the Bloc capabilities for producing these products are expected to reach $95 million per year.

* This report contains information available to CIA as of 1 February 1952.

There is no evident shortage in the Soviet Bloc of technical and factory personnel or of basic plant machinery within the electronic components industry. The weak point of the industry at present is the dependence of the Bloc industry on the West for high-quality thin capacitor paper. This dependence is likely to continue for some time. A complete and effective embargo against the shipment of this item to the Bloc would reduce Bloc capabilities by 50 percent, with a corresponding effect on Soviet military electronics programs.

Several conclusions are indicated by this report: (1) an earlier estimate of Soviet tube production 1/* is supported, with the strong probability that actual 1951 output may be higher rather than lower than this earlier estimate; (2) the total Soviet electronics program in 1951 was at least equal to the estimated $300 million and may have been greater; (3) the Soviet electronics program is predominantly military, and capabilities exist for quantity manufacture of components required for radars, missile controls, and proximity fuses; and (4) output of components will be increased significantly over the next 2-year period.

---

## I. Introduction.

The electronic components industry and the electron tube industry together form the major segment of the electronics industry in the Soviet Bloc. The electronic components industry produces a variety of products that are primarily designed for use in the manufacture of electronic equipment. The data provided in Table 1** are an indication of the relative value of output in the West of selected items, including electron tubes, which are of significance to the electronics industry.

In an analysis of the electronic components industry of the Soviet Bloc, two electronic components, fixed electronic capacitors and fixed electronic resistors, have been selected for primary consideration.***

50X1

** Table 1 follows on p. 3.

*** Other components of significance to the electronics industry include magnetic components, such as transformers, chokes, and small rotating machines; piezoelectric crystals; coaxial cable and wave guides; batteries; switch gear and hardware; and indicating instruments. These components are not dealt with in this report.

Table 1

Illustrative Data on the Value of Selected Items Produced by the Electronics Industry in the West in Percentages of Total Value of End-Equipment Production a/

| Item | US 1944 b/ | US 1947 c/ | NATO Estimate 1952-53 d/ |
|---|---|---|---|
| Fixed Electronic and Power Capacitors | 4.3 | 4.7 | 9.0 |
| Fixed and Variable Electronic Resistors | 1.7 | 2.0 | 7.0 |
| Magnetic Components (Transformers, Chokes, Fractional Horsepower Rotating Devices) | 5.0 | 6.5 | 5.0 |
| Miscellaneous Components (Radio-Frequency Coils, Piezoelectric Crystals, and Others) | N.A. | 15.0 e/ | 7.0 |
| Electron Tubes 2/ | 14.0 | 12.0 | 17.0 |

a. End-equipment production value is in terms of net f.o.b. sales prices.
b. $2,834 million end-equipment shipments.
c. $1,100 million end-equipment shipments.
d. Preliminary estimate for $500 million NATO electronics requirements.
e. Approximate figure.

These two components are used in certain ways in almost all circuits in electronic equipment, are more readily identified than other components, and are generally produced in discrete sectors of the electronics industry. Capacitors and resistors represent, after tubes, the major economic effort in the industry. Statistically, a more or less fixed consumption ratio exists among capacitors, resistors, and tubes. Thus a knowledge of the output of capacitors and resistors supplements an analysis of the output of electron tubes in measuring any electronics program.

## A. Nature and Uses of the Principal Electronic Components and Related Products.* 3/

### 1. Fixed Capacitors.

Fixed capacitors, in general, are divided into two major groups: electronic capacitors and power capacitors. Electronic capacitors are further subdivided into four subgroups: paper dielectric capacitors, mica capacitors, ceramic capacitors, and electrolytic capacitors. Only one type of power capacitor will be considered, the oil-filled paper dielectric capacitor.

#### a. Electronic Capacitors.

##### (1) Paper Dielectric Capacitors.

The most common of the electronic capacitors is the paper dielectric capacitor employed in electronic and communications circuits. This type of capacitor is intended primarily for filter, by-pass, and blocking purposes where the alternating component of the impressed voltage is small with respect to the direct voltage rating. To make this type of capacitor, high-purity kraft paper may be impregnated with minor crystalline mineral oil, synthetic chlorinated oil, or plastics. Impregnated paper dielectric capacitors are usually made up in a multiple-layer metal foil and paper structure of rolled construction and are impregnated after winding. They are then placed in nonmetallic cases or are hermetically sealed in metallic cases. US Joint Army-Navy Specifications JAN-C-25 and JAN-C-91 provide a complete definition of the forms of paper dielectric capacitors covered in this report. (US Joint Army-Navy Specifications are given in Appendix A1.) In the USSR this category of paper dielectric capacitors includes the Soviet type KB**

* Certain types of capacitors and resistors will be mentioned in the text, tables, and appendixes but will not be given detailed treatment in the text. These include induction heating capacitors (heavy industrial units), trimmer capacitors (small variable units), electrolytic capacitors (relatively small units employing wet or dry chemical solutions to increase the dielectric action of the dielectric and thus to achieve greater capacitance in less space), plastic film capacitors (similar to mica capacitors but with a plastic film for the dielectric material), filter and pulse-forming capacitors (large paper dielectric capacitors), and wire-wound resistors (resistors employing high-resistance wire for the resistive element).
** For the purposes of this entire report, letters designating Soviet types of components have been transliterated from the Cyrillic alphabet.

paper tubular capacitor, the type BIK noninductive paper tubular capacitor, and the metal-cased bathtub types BP, MK, and MKV. (A catalogue of some Soviet electronic components is given in Appendix A2.)

(2) Mica Capacitors.

Mica capacitors are useful in electronic circuits because of their low alternating-current (AC) losses and their high electrical stability over a wide temperature range. These characteristics of mica capacitors, along with the fact that they are constructed to very close capacitance tolerances, make them ideally suited for use in frequency-determining circuits. US Joint Army-Navy Specification JAN-C-5 provides a complete definition of the mica capacitor covered in this report. (See Appendix A1.) There are three types of mica capacitors: molded capacitors, wherein the capacitor element is molded in the case material; molded-case potted capacitors, wherein the capacitor element is supported within a case of molded material and embedded in some potting compound; and ceramic-case potted capacitors, in which the case is an inclosure of ceramic material. In the USSR the mica capacitor includes Soviet types KSO molded units and SAM stacked-plate flat mica units. (See Appendix A2.)

(3) Ceramic Capacitors.

Ceramic capacitors compete with mica capacitors in certain general applications where the temperature coefficient is unimportant. One type of ceramic capacitor is used for temperature compensation of timed circuits as well as for many other applications. Another type of ceramic capacitor offers the advantage of very high capacitance in a small physical volume, but it has other properties that limit its use to noncritical applications. One of the more common types of ceramic capacitor is a hollow cylinder with the electrodes placed on the inner and outer surfaces in the form of silver coating. Capacitance values of the latter type are usually low, less than 2,000 micro-microfarads (mmfd), and the dielectric constant and temperature coefficient of a ceramic body can be varied widely to give capacitors with negative, positive, or zero temperature coefficients of capacitance. US Joint Army-Navy Specification JAN-C-20A provides a complete definition of this product category. (This specification is not covered in Appendix A1.) The units covered by this specification are of one grade, in several body designs, and of styles commonly but not necessarily used as temperature-compensating devices. In the USSR this product category includes Soviet standard-type KTK tubular ceramic capacitors and type KDK disk ceramic capacitors. (See Appendix A2.) Other Soviet varieties have been reported infrequently.

b. Oil-Filled Paper Dielectric Power Capacitors.

When the load of distribution circuits of an electric power system has a power factor below 85 percent during the higher load periods of the day, it is desirable to make use of capacitors to supply the lagging component of the current. Raising the power factor from 75 to 90 percent reduces power-line current by 20 percent, thereby reducing distribution and transmission losses and permitting a large saving in copper consumption. To raise the power factor, 0.397 kilovolt-ampere (kva) of power-factor correction capacitance is required per kva of load. In both the US and the USSR this correction is now being supplied by installations of oil-filled paper dielectric capacitors, designed for AC operation at voltages from 220 to 11,000 volts. In the US these units are available in standard sizes of 5, 10, 15, and 25 kva. In the USSR, units are available in standard sizes of 3, 5, 8, and 10 kva. Prewar Soviet types included the KK, KOM, and KOS series, and postwar units are the standard KM type. (See Appendix A2.) In addition to normal power-factor correction use in power systems, a recent heavy consumer of the oil-filled paper dielectric capacitor is the atomic energy program, where the AC power capacitors are required for particle-accelerator installations. One cyclotron or betatron may use up to 50,000 kva of such capacitors. Although this class of capacitor is not, strictly speaking, a component used in the electronics industry, it is closely related to some of the larger electronic capacitors, may be produced in similar facilities, and consumes similar production materials.

2. Fixed Electronic Resistors.

a. Composition Resistors.

Fixed electronic resistors, in general, are of two types: composition resistors and deposited film resistors.* The great majority of electronic resistors produced in the US and the UK are generally of a type which has a resistive element composed of a combination of finely divided carbon or graphite; a nonconducting filler, such as talc; and synthetic resin used as a binder. These resistors are available in sizes of $\frac{1}{4}$, $\frac{1}{2}$, 1, and 2 watts, insulated and uninsulated, and are made in large quantities on automatic equipment at very low cost. US Joint Army-Navy Specification JAN-R-11 provides a complete definition of this product. (See Appendix A1.) In the USSR this class of resistor is available as type LS fixed composition radio resistor but is used far less widely than in the US. (See Appendix A2.)

* General-purpose wire-wound resistors (low-power and high-power types) and precision wire-wound resistors are not covered in this report.

b. Deposited Film Resistors.

The second broad class of electronic resistors is that comprising a conducting film deposited on the surface of a cylindrical core of insulating material. This design, originated as a commercial product in Germany, is widely used on the European Continent, including the USSR. Until recently the use of this resistor in the US has been limited to precision applications -- a small part of the total requirements. The deposited film resistor, technically interchangeable with the fixed composition resistor, possesses the advantages over the fixed composition resistor of better stability, greater resistance to moisture, and greater ability to withstand temporary overload. It is intended primarily for precision applications rather than for a general use. Proposed US Joint Army-Navy Specification Project No. 166 defines this type completely. (See Appendix A1.) In the USSR the deposited film resistor is available as the Kaminskiy and TO types. (See Appendix A2.) Existing manufacturing facilities would permit a partial substitution of the fixed composition resistor in place of the deposited film resistor. The latter, however, is generally considered as the industry standard in the Bloc and compares unfavorably with the composition resistor only in the greater labor requirement. It is not likely that any significant substitution will be made.

B. Organization of the Industry.

1. USSR.

Fixed electronic capacitors and resistors are manufactured in the USSR by enterprises of the Ministry of Communications Equipment Industry.* The manufacture of fixed electronic capacitors and resistors appears to be concentrated in departments of a limited number of electronic equipment plants, plus a few specialized components plants. Power capacitors, and probably some of the larger high-voltage units for electronics, are manufactured in a single capacitor plant of the Ministry of Electrical Industry.

Much of the capacitor and resistor manufacturing capacity in the USSR is provided by installations of special machinery removed from Germany in 1946 and 1948. These facilities, supplemented by additional Soviet machinery and supported by the intensive postwar exploitation of German technology, have formed the foundation for a large and competent components manufacturing industry in the USSR.

---

* It is reported that the Deputy Minister responsible for capacitors in this Ministry is A.A. Shchurganin.

The major portion of the fixed electronic capacitors and resistors produced in the USSR is used in the manufacture of electronic apparatus at electronic equipment assembly plants of the Ministry of Communications Equipment Industry, the Ministry of Shipbuilding Industry, the Ministry of Armaments, the Ministry of Agricultural Machine-building, and probably the Ministry of Aircraft Production.

2. East Germany. 4/

The quantity production of fixed electronic capacitors and fixed electronic resistors in East Germany is restricted to a few enterprises which are former factories or branch plants of German electrical concerns previously supplying these items. In East Germany at the end of World War II, many of the facilities for manufacturing these components, including most of the facilities for manufacturing deposited film resistors and fixed paper capacitors, were dismantled and removed to the USSR in 1946 or 1948. The present facilities have been rebuilt since that time.

The single East German factory manufacturing fixed electronic resistors and the three factories manufacturing fixed paper capacitors are all important firms of the Association of People-owned Enterprises, Radio and Communications Industry (VVB-RFT), and are, therefore, East German plants. The single supplier of mica and ceramic capacitors is a member firm of the Soviet-owned SAG (Sowjetische Aktien Gesellschaft) Kabel.

The East German manufacturers of fixed electronic capacitors appear to be heavily dependent on the West for key production materials. Although this dependence has resulted in production losses in the past, these capacitor and resistor firms are adequately equipped and reasonably efficient, and they are operating at levels adequate to meet requirements.

3. Hungary. 5/

In Hungary the only significant producer of fixed electronic capacitors and fixed electronic resistors is the Remix Electrotechnical Works Company Limited, Budapest. In 1947 the stock of this company was owned jointly by the Hungarian Wolfram Company (Orion) and Agrolux Limited, both companies in turn being entirely owned by Egyesült Izzolampaés Villamossagi R.-T. (United Incandescent Lamp Company), commonly known as UILCO "Tungsram." At that time the plant manager was N.J. Fodor.

After the socialization of industry in Hungary late in 1947, this plant was retained in the UILCO "Tungsram" nationalized complex. One document states that this plant was nationalized as an independent enterprise, but most evidence indicates that it is still operated in conjunction with UILCO "Tungsram."

4. Czechoslovakia. 6/

There are two plants in Czechoslovakia engaged in the manufacture of fixed electronic capacitors and resistors. The Lanskroun Electrical Equipment Works in Lanskroun was formed by the combination of the former German-owned Siemens-Halske AG plant and several smaller Czechoslovakian companies taken over by the Communist government after the coup. The Hloubetin Electrical Equipment Plant, formerly the German-owned Always plant, is located in Prague (Hloubetin). Both of these plants are now under the Tesla combine, which embraces all of the electronics industry in Czechoslovakia.

C. Technology.

1. Fixed Capacitors.

Technological discussion is limited to fixed paper dielectric electronic and oil-filled paper dielectric power capacitors because they represent the bulk of the production effort and because there is more reliable information available on production techniques and input requirements for these types of capacitors than for the other components discussed in this report. 50X1

50X1

a. Paper Dielectric Electronic Capacitors. 7/

(1) Aluminum Foil and Paper Dielectric Capacitors.

The principal manufacturing method employed in the USSR for the production of fixed paper dielectric electronic capacitors appears to be similar to current US practices. Thin aluminum foil and kraft capacitor paper which have been cut to proper widths on rolls are wound on a motor-driven arbor to form a cylindrical capacitor section of the required number of total turns. Alternate metal foils are separated by two, three, or more paper thicknesses. To this capacitor section, held together by several turns of lacquered adhesive paper, terminal connectors are added by soldering them to the foil. A great many capacitor sections are dried by baking and are impregnated in a vacuum chamber. In the USSR, paraffin wax impregnant probably is used for tubular paper-cased types of capacitors, and mineral oil for metal-cased types. The drying and impregnating cycle may run from several hours to more than a day. Most of the Soviet production is reported to consist of hermetically sealed metal-cased capacitors, which would be satisfactory over a temperature range of from minus 50°C to plus 60°C and would pass all US Joint Army-Navy Specifications.

Materials used to manufacture the aluminum foil and paper capacitors in the USSR appear to be primarily aluminum foil, 7 microns (0.00028 inch) thick; kraft capacitor paper, 8 to 14 microns (0.00030 to 0.00055 inch) thick; and impregnants consisting of either mineral oil or paraffin wax. There are also some indications of requirements for 0.00025-inch-thick paper for special applications.

The Soviet use of mineral oil impregnation for metal-cased types of capacitors is strongly indicated by the lack of evidence that any significant use is made in Europe, including the USSR, of anthraquinone stabilizer, which must be used to insure satisfactory life in direct-current (DC) capacitors impregnated with the synthetic capacitor liquids (chlorinated diphenyl) widely used in the US. The use of mineral oil as an impregnant results in a requirement of 50 percent more paper and aluminum foil per capacitor than would be required if synthetic capacitor liquids were used. The mineral oil capacitor, however, should have good life for normal DC applications without requiring the addition of special stabilizers. It should have the further advantage of a permissible operating temperature range greater than would be obtained by using the stabilized chlorinated diphenyl impregnants employed in the US. These drop off in capacitance value in low temperatures, reaching as much as minus 20 percent to minus 30 percent at minus 50°C. For this reason, these impregnants are unsatisfactory for certain military applications where the value of capacitance is critical.

For the production of aluminum foil and paper dielectric capacitors, basic factory machinery includes motor-driven hand-winders for making capacitor sections, each winder producing on the order of 1,000 capacitor sections per day; vacuum drying and impregnating systems, with suitable pumps and controls; and electrical test equipment.

(2) Metallized Paper Capacitors.

It has been reported that the USSR has adopted a second method for manufacturing DC electronic capacitors. In this method the electrode is composed of a thin layer of zinc evaporated on the surface of the paper dielectric. This method, developed before World War II by the Robert Bosch Company, Stuttgart, Germany, and licensed to Siemens-Halske AG, Hydra AG, and AEG (Allgemeine Elektrische Gesellschaft), was used widely in Germany during World War II. The process was adopted and improved in both the US and the UK, where it is used now to a limited extent.

The Bosch method of manufacture uses high-density kraft paper in rolls, in thicknesses of 8 and 14 microns. The surface of the paper must be prepared by coating with a cellulose lacquer. The lacquered paper is spooled through a vacuum chamber at pressures under 100 microns, and the zinc is evaporated on one surface in strips of proper width and location. The metallized paper roll is slit and then made into capacitor coil sections in an operation identical to that used in making the aluminum foil and paper capacitors. The foil edges of the capacitor section are rolled in and sprayed with a metallic deposit to permit the soldering of terminal leads. A large group of sections is then dried by vacuum baking and impregnated with molten paraffin wax. The time for this cycle is from 18 to 24 hours. Before casing and testing, it is necessary to age all capacitor sections on a DC supply at 10 percent above the nominal test voltage in order to clear faults. These units are assembled either in paper or in metal cases, with or without hermetic seals, in a fashion similar to that used in assembling the aluminum foil and paper units. Metallized paper capacitors of four voltage ratings are produced in the USSR: 160, 250, 400, and 600 working volts direct current (WVDC). Test voltages of 250 volts DC are used for the 160-WVDC units, and 2,000 volts DC for the 400-WVDC units. The 160-WVDC capacitor uses a single layer of high-density paper 8 microns thick; the 400-WVDC capacitor uses two layers of the same paper, one of which is metallized, the other plain.

The metallized paper capacitor has several advantages over the aluminum foil and paper capacitor: the size of the unit is smaller for a given voltage rating, especially for low-voltage ratings; the unit does not require aluminum foil; and the unit, because of the special processing it receives, is generally self-healing when operated at normal working voltage. The metallized paper capacitor also has notable disadvantages: the high-density paper required is more difficult to manufacture than the kraft paper used in the aluminum foil capacitor; the lacquering and evaporation process cycles are costly; the unit cannot use chlorinated diphenyl impregnants; and for medium- and higher-voltage ratings, neither the size nor the life expectancy of metallized paper capacitors is better than for standard paper construction using a stabilized synthetic impregnant. Capacitance value ranges reported for the USSR are from 0.1 to 30 microfarads, indicating a probable intent to use this capacitor construction primarily for applications requiring larger capacitance and lower voltages. Such applications might include low-voltage filter capacitors to be used in place of electrolytic capacitors, and special compact devices, such as proximity fuses. Key items of manufacturing equipment required for the metallized paper capacitor include lacquering facilities, metal evaporation equipment, vacuum systems, motor-driven hand-winders, vacuum drying and impregnating systems, and electrical test equipment.

b. Oil-Filled Paper Dielectric Power Capacitors. 8/

These high-current AC paper capacitors for power-factor correction were first produced in the USSR about 1938. The production of this type of capacitor developed out of the manufacture of similar units for use in industrial induction heating. By World War II, Soviet output of the power capacitor had reached sizable proportions at two plants, one in Moscow and one in Kiev. There are indications that the life and performance of these earlier units were not up to expectations. Manufacture was discontinued during World War II and reestablished about 1948 on a new standard product line which was designed more conservatively.

Except for differences in construction details, postwar Soviet power-factor capacitors are manufactured by methods similar to those employed in the US. Capacitor units are metal-cased assemblies of a multiple of capacitor coil sections internally connected in series and parallel, filled with oil, and sealed. Two basic coil section designs are employed in the USSR -- one for the low-voltage (220- to 500-volt) product line; one for the high-voltage (3- to 10-kilovolt) product line. As in the US, the capacitor coil sections in the USSR are produced in a manner similar to that used in making the coil sections of paper electronic capacitors, with a motor-driven hand-controlled winder. Each section is wound individually on a cylindrical arbor, and two layers of aluminum foil and several interleaved layers of capacitor paper precut to the proper width are fed in from spools. To the capacitor coil sections, which may be either cylindrical or be pressed flat and clamped, connectors are added. The required number of sections is inserted into a rectangular capacitor case and covered. Both standard Soviet product lines use 18 coil sections per capacitor assembly, connected in various series and parallel arrangements to meet the rated voltage requirements. Then, while still under vacuum, the assembly is filled with impregnating oil and sealed. The final assembly is tested at three times the rated operating voltage. For use in large installations, the most frequent application, groups of standard capacitor units are assembled in cabinets complete with controls and switchgear.

At present, most Soviet production of power-factor capacitors appears to be concentrated on making high-voltage (3- to 10-kilovolt) units, which can be produced at a lower cost, and with less material, than low-voltage (220- to 500-volt) units. The two standard postwar lines of power-factor capacitors are described in Table 2.*

* Table 2 follows on p. 13.

Table 2

Present Standard Soviet Power-Factor Capacitors

| Type of Unit | Rated Voltage (RMS AC Volts, 50 Cps) a/ | Rating (Kvar) b/ | Capacitance (Microfarads) | Weight (Kilograms) | Net Price (Rubles) |
|---|---|---|---|---|---|
| High-Voltage Line (Single-Phase Units) | | | | | |
| KM 10-10-1 | 10,000 | 10 | 0.38 | 23 | 760 |
| KM 6-10-1 | 6,000 | 10 | 1.00 | 23 | 760 |
| KM 3-10-1 | 3,000 | 10 | 4.20 | 23 | 760 |
| Low-Voltage Line (Three-Phase Units) | | | | | |
| KM 0.5-8-3 | 500 | 8 | 110.00 | 23 | 1,150 |
| KM 0.38-5-3 | 380 | 5 | 110.00 | 23 | 1,150 |
| KM 0.22-3-3 | 220 | 3 | 220.00 | 23 | 1,150 |

a. Root mean square AC volts at 50 cycles per second.
b. Kilovolt-amperes-reactive.

A line of large capacitor units has been proposed but presumably not produced, with 25-kva high-voltage ratings when impregnated with mineral oil or with 40-kva ratings when impregnated with Sovol -- the Soviet synthetic capacitor impregnant, chlorinated diphenyl (noninflammable, with a dielectric constant of 5.1).

These postwar Soviet power-factor capacitors use aluminum foil, type AO or A1, 99.6 or 99.5 percent pure, in 0.0004-inch thickness, and sulphate-pulp kraft paper, per Soviet Specification GOST (State All-Union Standard) 1908-42, in 0.0003-inch thickness for low-voltage units and 0.00044-inch thickness for high-voltage units (replacing the prewar rag-stock paper). Since Soviet production appears to be concentrated in high-voltage units, consumption is predominantly of paper of the 0.00044-inch thickness and is estimated at 1.76 pounds per kva per capacitor.

Mineral oil is used as the impregnant (inflammable, with a dielectric constant of 2.2) in the Soviet power-factor capacitor. A few prewar units were impregnated with Sovol. It appears that difficulty was experienced with these capacitors, caused by contamination of the impregnant and ending in resultant shortened field life. At present it is probable that mineral oil is generally used, with considerable effort devoted to developing a stabilized Sovol for general future use.

The essential differences between these Soviet power-factor capacitors and present US units are two: (1) the Soviet coil section is designed to operate at lower-voltage stress, about 300 volts per mil instead of 400 volts per mil; (2) the Soviet units use mineral oil instead of synthetic impregnant, resulting in an effective dielectric constant of 3.5 instead of 5.5. These differences result in the Soviet use of 18 coil sections per capacitor instead of 12, in a kva rating of 10 volts rather than 25 volts per capacitor, and in the consumption of more than 2.5 times the weight of paper and aluminum foil per kva of capacitor.

Table 3 illustrates the significant differences between typical US and Soviet postwar capacitor designs.

Table 3

Comparison of Soviet and US High-Voltage Power-Factor Capacitors
1948

| | Voltage | Frequency (Cps) a/ | Kvar b/ | Number of Coils | Volts per Coil | Capacitance per Coil (Microfarads) |
|---|---|---|---|---|---|---|
| USSR | 3,000 | 50 | 10 | 18 | 1,000 | 2.1 |
| US | 2,400 | 60 | 25 | 12 | 1,200 | 3.3 |

| | Thickness of Paper Used (Inches) | Volts per Mil | Paper Required (Lbs per Kva) | Aluminum Foil Required (Lbs per Kva) | Net Price per Kva |
|---|---|---|---|---|---|
| USSR | 7 x 0.00044 | 300 | 1.76 | 0.44 | 76 Rubles |
| US | 6 x 0.0005 | 400 | 0.65 | 0.13 | $6.00 |

a. Cycles per second.
b. Kilovolt-amperes-reactive.

The major items of factory machinery required for the manufacture of high-current power capacitors are motor-driven hand coil-winders, vacuum drying and impregnating tanks and controls, and heavy electrical test installations. In the USSR design the estimated average output of the coil-winder is 200 coil sections per 8-hour day as compared with an average US output for trained operators of 600 coil sections per day per machine.

In view of the great advantage in saving materials and cost by the use of high-voltage power-factor capacitors rather than the low-voltage units, most of the Soviet production appears to be concentrated in the 3- to 10-kilovolt units. For power-factor capacitors the Soviet consumption is predominately of kraft capacitor paper of a thickness of 0.00044 inch (10 to 12 microns) and is estimated at 1.76 pounds of paper per kva per capacitor.

The Soviet plant manufacturing power capacitors is also the supplier of related high-current capacitors, including power-factor capacitors for induction heating systems; high-voltage AC capacitors for carrier current applications to power lines; medium- and high-voltage DC filter capacitors; and high-voltage pulse capacitors, including units from 0.002 to 0.03 microfarad and 40- to 300-kilovolt ratings.

2. Fixed Electronic Resistors.

a. Composition Resistors. 9/

Although the composition resistor is the most commonly used component in the US electronics industry, this product is not of primary importance in the Soviet Bloc. In 1938 and 1943 the US supplied the USSR with a complete complement of manufacturing equipment and provided the technical assistance required for the quantity production of composition resistors in sizes of $\frac{1}{4}$, $\frac{1}{2}$, 1, and 2 watts. It is believed that the present technology on this item does not differ greatly from the technology now used in the US.

b. Deposited Film Resistors. 10/

It appears that most fixed electronic resistors produced in the USSR, East Germany, and probably the other Satellites are basically related to the deposited film unit developed by Siemens-Halske AG in the mid-1920's. In the USSR, standard types of this construction are reported to be available in the 0.5-watt size, with 5-, 10-, and 20-percent tolerances.

The manufacturing process for the electronic resistor of this type follows. Special hard-porcelain cylindrical core rods, which are controlled for temperature coefficient of expansion, impact strength, surface smoothness, and chemical properties, are inserted into a vacuum cracking chamber at 950°C, and a hydrocarbon vapor is introduced. With proper control over temperature, pressure, and time, a hard-carbon conducting film is deposited on the ceramic rod, and this film provides the resistive element of the unit. After removal from the chamber the resistor units are coated at the ends with graphite or silver, and metal terminal caps are placed over these coated ends. Capped resistors are loaded, one at a time, into a small bench lathe, and a spiral groove is cut through the conducting film by a high-speed grinding wheel. The total turns and length of the resulting conducting spiral are set by a mechanical stop to provide the predetermined resistor values, within the 5- or 10-percent tolerances. When the unit is to be used as a precision resistor, the length of spiral must be determined by using a Wheatstone Bridge test set connected to the resistor during the grooving operation. Flexible leads are soldered to the terminal caps of the grooved resistor units. The complete assembly is twice coated with a protective insulating lacquer.

Certain principal features of the fixed electronic deposited film resistor should be noted. Because of the special porcelain cores, the control problem in depositing the film, and the manual labor of grooving, these resistors are relatively expensive. This type of resistor is well suited to the needs of an industry requiring medium quantities of a wide variety of resistance ranges, since the flexibility of the process permits the production of resistors to required values. The finished resistor, furthermore, has good stability and is superior to the composition resistor for effects of short-time overload, high humidity, and variations during life.

This product, which is not a precision resistor, is used for general-purpose applications in the Soviet Bloc. Resistors with 10-percent tolerances are quite acceptable for the majority of electronics applications. The deposited film resistor should be definitely superior to the composition resistor in use in US military electronics.

The two major items of factory machinery required for the manufacture of deposited film resistors are as follows: a vacuum cracking system, with controls, for film depositing and hand-controlled, motor-driven bench lathes for grinding the spirals. On the assumption of general conformity with East German procedure throughout the Soviet Bloc, the accepted rate per lathe is estimated at 350 to 500 resistors per hour.

II. Supply.

A. Production.

1. USSR.

a. General.

There are good indications that the expansion of Soviet capacity for the production of fixed electronic capacitors and resistors, which was initiated in 1946-47, has been carried out quite successfully. It appears that the output of these products increased significantly during 1948 and 1949 and that the domestic Soviet supply of these electronic components is generally now quite adequate to meet planned requirements. By the end of 1950, good manufacturing facilities -- on a par with those of Western Europe -- had been established for metallized paper capacitors, for paper and aluminum foil capacitors of both the tubular wax and hermetically sealed styles, and for deposited film resistors. Composition resistors are also manufactured in the USSR, but in much smaller quantities.

Production of high-current power capacitors, especially AC designs of paper and aluminum foil units for power-factor correction, was reestablished about 1948. Although the output of these units has been increased, there are indications that supply did not meet planned requirements in 1951.

b. Facilities. 11/

Fixed paper capacitors and fixed resistors are produced either in departments of plants producing a general line of components or in a few specialized plants which have been constructed for the sole purpose of producing capacitors and resistors. Although the facilities making capacitors and resistors are not so concentrated as the plants producing electron tubes in the USSR or as the electronic components industries in the Satellites, there is no indication that they are widely distributed over a large number of apparatus plants.

High-current power-factor capacitors are produced in only one factory, probably Plant [redacted] in Kiev. 50X1

Fixed electronic paper capacitors are produced in the following plants: the Lenin Plant [redacted] the Frunze Plant [redacted] 50X11 the Lenin Institute OKB (Experimental Design Bureau), and the Frunze NII (Scientific Research Institute), comprising the Myza complex located at

Myza near Gor'kiy; the condenser plant of NII [redacted] departments of 50X1
the Kazitskiy Radio Plant [redacted] departments of the Komintern Radio 50X1
Plant [redacted] probably departments of the Radio Plant [redacted] and 50X1
departments of associated Leningrad plants; the Serpukhov Condenser
Plant, Serpukhov, Moscow Oblast; and in Radio Plant [redacted] 50X1
Novosibirsk.

Fixed electronic mica and ceramic capacitors are produced
at the Myza complex near Gor'kiy; at the NII [redacted] and associated 50X1
Leningrad plants; and at the Radio Plant [redacted] Novosibirsk. 50X1

Fixed composition resistors are believed to be manufactured at the Radio Parts Plant in Novosibirsk, and fixed deposited film resistors at the Myza complex and at NII [redacted] and associated Leningrad plants. 50X1

Less certain information indicates probable additional manufacturing sources of some of these components at the Krasnaya Zarya Telecommunications Plant, Leningrad; at the Elektrosignal Radio Plant, Voronezh; at the Moscow Radio Plant imeni Krassin; and at another unidentified capacitor plant in the general Moscow area.

c. Total Production.

Intelligence background on Soviet electronic components facilities is largely qualitative, with occasional reference to output or to installed machinery. The most important source of information which provides a means of estimating output is the Soviet consumption of capacitor paper, largely imported.

A necessarily approximate estimate of Soviet production of fixed capacitors and resistors in 1949-51, based primarily upon consumption of paper, as supported by spot data on plants, is provided in Table 4.* (Production of electronic components in the USSR is given by plant in Appendix B1.)

An estimate of Soviet capacity in 1952-53 to produce fixed capacitors and resistors, projected from the production estimates given in Table 4, follows in Table 5.**

---

* Table 4 follows on p. 19.
** Table 5 follows on p. 20.

Table 4

Estimated Soviet Production of Fixed Capacitors and Resistors
1949-51

| | Electronic Capacitors | | | | Electronic Resistors | | | | Power-Factor Capacitors | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Volume (Million Units) | | | | Volume (Million Units) | | | | | | |
| Year | Paper | Ceramic and Mica | Total | Value ($ Million) a/ | Deposited Film | Composition | Total | Value ($ Million) a/ | Volume (Thousand Kva) | Value ($ Million) a/ | Total Value ($ Million) a/ |
| 1949 | 30 | 20 | 50 | 7.4 | 40 | 15 | 55 | 3.2 | 50 | 0.3 | 10.9 |
| 1950 | 80 | 50 | 130 | 19.5 | 90 | 20 | 110 | 7.1 | 100 | 0.6 | 27.2 |
| 1951 | 100 | 65 | 165 | 24.5 | 110 | 20 | 130 | 8.6 | 300 | 1.8 | 34.9 |

a. Dollar values are based on average current US f.o.b. prices for equivalent product categories: unit prices of $0.20 for fixed paper capacitors, 50 percent of which are hermetically sealed; $0.015 for general-purpose composition resistors; an estimated $0.075 for general-purpose film resistors; and an average of $6 per kva for high-voltage power-factor capacitors.

Table 5

Estimated Soviet Capacity for the Production of Fixed Capacitors and Resistors
1952-53

| Electronic Capacitors | | | | Electronic Resistors | | | | Power-Factor Capacitors | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Volume (Million Units) | | | | Volume (Million Units) | | | | | | |
| Paper | Ceramic and Mica | Total | Value ($ Million) a/ | Deposited Film | Composition | Total | Value ($ Million) a/ | Volume (Thousand Kva) | Value ($ Million) a/ | Total Value ($ Million) a/ |
| 250 | 100 | 350 | 57.0 | 250 | 25 | 275 | 19.2 | 500 | 3.0 | 79.2 |

a. Dollar values are based on average current US f.o.b. prices for equivalent product categories: unit prices of $0.20 for fixed paper capacitors, 50 percent of which are hermetically sealed; $0.015 for general-purpose composition resistors; an estimated $0.075 for general-purpose film resistors; and an average of $6 per kva for high-voltage power-factor capacitors.

2. East Germany. 12/

Until early 1951 the output of fixed electronic capacitors and resistors in East Germany was seriously hampered by lack of plant equipment and by recurring shortages in the supply of specialized production materials. More recently, the materials problem appears to have been eased, in part through increased imports. Although 1951 plans have been reported for the initiation of East German production of capacitor paper and aluminum foil, no significant results were obtained in 1951.

Certain classes of electronic components, such as precision resistors and high-voltage paper filter capacitors, remained in short supply through 1951 and had to be imported. In the aggregate the output of the components industry increased in 1951, and 1952 plans are reported to be for a considerably higher output.

The manufacture of fixed electronic capacitors and resistors is even more highly concentrated in a few specialized plants in East Germany than is typical in the US. Little or no effort has been noted toward output in these product lines in departments of end-item manufacturers or of other large complexes.

Fixed resistors, in product quantities, are manufactured solely in a single plant near Berlin, the RFT Dralowid-Werk VEB Teltow, Teltow. Fixed paper capacitors are produced in one main plant, the RFT Kondensatorenwerk VEB Gera, Gera, Thuringia, and two smaller plants, the RFT Kondensatorenwerk VEB Freiberg, Freiberg, Saxony, and the RFT Kondensatorenwerk VEB Soemmerda, Soemmerda, Thuringia.

Fixed ceramic and mica capacitors are produced solely by the Keramisches Werk Hescho-Kahla plant in Hermsdorf, with subsidiaries in Gera, Kahla, and Koeppelsdorf, near Sonneberg, all located in Thuringia.

The annual production of fixed electronic capacitors and resistors in East Germany in 1949-51 is estimated in Table 6.* (Production of electronic components in East Germany is given by plant in Appendix B2.)

An estimate of East German capacity in 1952-53 to produce fixed electronic capacitors and resistors, projected from the production estimates given in Table 6, follows in Table 7.**

* Table 6 follows on p. 22.
** Table 7 follows on p. 23.

Table 6

Estimated East German Production of Fixed Electronic Capacitors and Resistors
1949-51

| | Electronic Capacitors | | | | | | Electronic Resistors | | | Total Value | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Volume (Thousand Units) | | | | Value | | Volume | Value | | | |
| Year | Paper | Ceramic and Mica | Electrolytic | Total | ($ Thousand) a/ | (Thousand East DM) b/ | (Thousand Units) | ($ Thousand) a/ | (Thousand East DM) b/ | ($ Thousand) a/ | (Thousand East DM) b/ |
| 1949 | 3,950 | 7,000 | 410 | 11,360 | 883 | 17,190 | 15,000 | 1,125 | 6,000 | 2,008 | 23,190 |
| 1950 | 6,750 | 8,600 | 556 | 15,906 | 1,252 | | 20,000 | 1,500 | | 2,752 | |
| 1951 | 10,150 | 14,400 | 720 | 25,270 | 1,871 | | 30,000 | 2,250 | | 4,120 | |

a. Dollar values are based on average current US f.o.b. prices for equivalent product categories: unit prices of $0.09 and $0.10 for fixed paper capacitors; $0.05 for ceramic capacitors; $0.30 for electrolytic capacitors; and an estimated $0.075 for general-purpose film resistors.
b. East Deutsche Mark values are based on East German official data giving averaged product values for statistical purposes.

Table 7

Estimated East German Capacity for Producing Fixed Electronic Capacitors and Resistors
1952-53

| Electronic Capacitors | | | | | Electronic Resistors | | |
|---|---|---|---|---|---|---|---|
| Volume (Thousand Units) | | | | Value | Volume | Value | Total Value |
| Paper | Ceramic and Mica | Electrolytic | Total | ($ Thousand) a/ | (Thousand Units) | ($ Thousand) a/ | ($ Thousand) a/ |
| 18,000 | 20,000 | 1,000 | 39,000 | 3,060 | 50,000 | 3,750 | 6,810 |

a. Dollar values are based on average current US f.o.b. prices for equivalent product categories: unit prices of $0.09 and $0.10 for fixed paper capacitors; $0.05 for ceramic capacitors; $0.30 for electrolytic capacitors; and an estimated $0.075 for general-purpose film resistors.

3. Hungary. 13/

The Remix Electrotechnical Works Company, Limited, is the only known supplier of electronic components in Hungary. The only data on production at this plant are as of 1947, at which time total capacitor production was 3 million per year, while total resistor production per year was 4.2 million. This information and estimates of Hungarian production of electron tubes in 1947 and 1950-51, forming the basis of an estimate of annual Hungarian production of fixed electronic capacitors and resistors in 1947-51, are presented in Table 8.* (Production of electronic components in Hungary is given by plant in Appendix B3.)

An estimate of Hungarian capacities in 1952-53 to produce fixed electronic capacitors and resistors, projected from the production estimates given in Table 8, follows in Table 9.**

4. Czechoslovakia. 14/

Electronic components production in Czechoslovakia is centered in the Lanskroun Electrical Equipment Works and the Hloubetin Electrical Equipment Plant. Although some information as to output at the Lanskroun plant is available, there is none available on the Hloubetin Plant. For purposes of this report, the Hloubetin production is represented by the addition of a conservative figure to the Lanskroun production figure. Thus the estimates of the total production for Czechoslovakia are probably on the conservative side. Taken in conjunction with the capacitor-tube ratio and the resistor-tube ratio discussed below, however, these estimates do not appear to be excessively conservative. An estimate of Czechoslovak production of fixed electronic capacitors and resistors in 1948-51, developed from the available information, is presented in Table 10.*** Since there is no evidence of plans for expansion after 1951, the production figures for 1951 may be taken to indicate production for 1952-53. (Production of electronic components in Czechoslovakia is given by plant in Appendix B4.)

5. Other Satellites. 15/

a. Poland.

Mention is made of possible capacitor production at the former Philips-Wola plant in Poland, but the extent of this production is not known.

---

* Table 8 follows on p. 25.
** Table 9 follows on p. 26.
*** Table 10 follows on p. 27.

Table 8

Estimated Hungarian Production of Fixed Electronic Capacitors and Resistors 1947-51

| Year | Electronic Capacitors | | Electronic Resistors | | |
|---|---|---|---|---|---|
| | Volume (Million Units) | Value a/ ($ Million) | Volume (Million Units) | Value a/ ($ Million) | Total Value a/ ($ Million) |
| 1947 | 3.0 | 0.24 | 4.2 | 0.32 | 0.56 |
| 1948 b/ | 3.9 | 0.31 | 5.5 | 0.41 | 0.72 |
| 1949 b/ | 4.9 | 0.39 | 6.9 | 0.53 | 0.92 |
| 1950 c/ | 5.8 | 0.46 | 8.2 | 0.62 | 1.08 |
| 1951 c/ | 6.6 | 0.53 | 9.3 | 0.71 | 1.24 |

a. Dollar values are based on average current US f.o.b. prices: unit prices of $0.08 for capacitors and $0.075 for resistors.
b. Figures for these years are interpolated between the figures for 1947 and those for 1950 and 1951.
c. Figures for 1950 and 1951 are based on the estimated ratios for 1947 between electron tubes and fixed electronic capacitors and resistors produced in Hungary applied to estimates of electron tubes produced in Hungary in 1950 and 1951.

Table 9

Estimated Hungarian Capacity for Producing Fixed Electronic Capacitors and Resistors 1952-53

| Electronic Capacitors | | Electronic Resistors | | |
|---|---|---|---|---|
| Volume (Million Units) | Value a/ ($ Million) | Volume (Million Units) | Value a/ ($ Million) | Total Value a/ ($ Million) |
| 8.3 | 0.66 | 11.7 | 0.88 | 1.54 |

a. Dollar values are based on average current US f.o.b. prices: unit prices of $0.08 for capacitors and $0.075 for resistors.

Table 10

Estimated Czechoslovak Production of Fixed Electronic Capacitors and Resistors
1948-51

| Year | Electronic Capacitors | | Electronic Resistors | | Total Value a/ ($ Million) |
|---|---|---|---|---|---|
| | Volume (Million Units) | Value a/ ($ Million) | Volume (Million Units) | Value a/ ($ Million) | |
| 1948 | 50.0 | 4.0 | 15 | 1.13 | 5.13 |
| 1949 b/ | 55.8 | 4.46 | 20 | 1.5 | 5.96 |
| 1950 b/ | 61.6 | 4.93 | 25 | 1.9 | 6.83 |
| 1951 | 67.5 | 5.4 | 30 | 2.3 | 7.7 |

a. Dollar values are based on average current US f.o.b. prices: unit prices of $0.08 for capacitors and $0.075 for resistors.
b. Figures for these years are interpolated between the figures for 1948 and those for 1951 on a linear basis.

b. Bulgaria.

The Elprom plant, located in Illiyantsi, 5 kilometers from Sofia, employs 3,500 workers who manufacture electric motors, lamps, and radio parts. It is believed that this plant may manufacture radio capacitors, but it is not possible to tell the extent of this production.

c. Communist China.

It is believed that the production of components is negligible in Communist China. Orders for condensers, resistors, and volume controls of all sizes have been received from China by US firms. This fact, together with the lack of any substantial evidence of component production, indicates the high probability of negligible production in China of components.

The Central Radio Manufacturing Works in Kunming may be making capacitors and rheostats of low quality. The extent of this production is not known, but it is believed to be small.

B. Costs and Prices. 16/

If among several economic areas there exist conditions of free exchange rates and free movement of resources, then it will tend to be true that the prices of goods in one area will be the same as the prices of the same goods in every other area -- at any rate, the differentials could never be greater than the transportation cost necessary to bring goods from one region to another. If a differential should exist, it would cause productive resources to flow from the high-cost or low-price area to the low-cost or high-price area, thus over a period of time equalizing conditions among the areas. This analysis can apply to relations among different countries or among the areas of a single country. Where these conditions of free exchange rates and free movement of resources exist among different countries, prices of the same goods in the different countries will bear the same ratio to each other as the rate of exchange of the currencies of the different countries.

When these conditions exist within a country, as they do in the US, it can be said that the unit of currency indicates equal efficiency from industry to industry or area to area. If among countries these conditions do not exist, however, there will be differences among the price ratios of the different commodities. Where one of the countries has a currency of constant efficiency significance from industry to industry, then all the discrepancies among the price ratios of the two countries must be explained on the basis of either differences in efficiency or differences in the manner of arriving at prices among the industries of the second country. Evidence exists that the prices of electronic components in the USSR are set at approximately the same ratio to cost for all electronic components. (This is largely true in the US.) Therefore, differences among the price ratios of goods produced in the US and the USSR may indicate relative efficiency in the production of the different goods in the USSR. The same rationale applies to East Germany.

For purposes of comparing efficiencies, it is necessary to have comparable products. Comparable sizes of fixed hermetically sealed paper dielectric capacitors, power-factor capacitors, and nonprecision deposited film resistors have been chosen for estimating the relative efficiency in producing the three types in the US, the USSR, and East Germany. Table 11 shows the ruble-dollar and East Deutsche Mark-dollar ratios of the prices of these commodities. It should be noted that since there is no production of nonprecision deposited film resistors in the US, the ratios given for this product in Table 11 involve an estimate of what this product would cost in the US.

Table 11

Price Ratios of Selected Goods: US, USSR, East Germany

| Product | Rubles per Dollar | East Deutsche Mark per Dollar |
|---|---|---|
| Nonprecision Deposited Film Resistor | 14.6 | 5.7 |
| Hermetically Sealed Paper Dielectric Capacitor | 10.0 | 12.5 |
| Power-Factor Capacitor | 12.7 | |

The order of relative efficiency in the USSR finds the hermetically sealed paper capacitor produced under the most efficient conditions, with the power-factor correction capacitor and the nonprecision deposited carbon resistor following in that order. In East Germany the nonprecision deposited carbon resistor is produced under more efficient conditions than the hermetically sealed paper capacitor.

C. Imports and Exports of Electronic Components. 17/

1. East-West Trade.

In spite of the large production of electronic components in the Bloc, and in spite of the fact that some components are exported from the Bloc (Czechoslovakia, for example, has offered resistors to the US and Denmark), there is considerable effort by the Bloc to obtain these commodities from the West.

Hungary obtains a large quantity of fixed capacitors from Switzerland, Austria, and Sweden, and resistors from Austria and Sweden. There is evidence that Philips in Switzerland supplies Bulgaria with capacitors, while China has made inquiries as to the availability of electrolytic capacitors in the US. In addition, East Germany is dependent on West Germany for its requirements of high power capacitors.

Although the USSR appears not to deal in the trade with the West involving finished components, it does import considerable amounts of capacitor paper from France and Switzerland. West Germany supplies East Germany with paper and aluminum foil and ceramic material for capacitor production. The Bloc also obtains from the West vital raw materials such as capacitor paper and mica.

2. Inter-Bloc Shipments.

The USSR apparently does not take an active role in inter-Bloc trade, except that it does make demands on the Dralowid-Werk VEB Teltow plant in East Germany for supplies of precision deposited carbon resistors. These items are also made in the USSR, but Dralowid-Werk is the plant which originated this type of resistor, and presumably its advanced ability in this field makes it profitable for the USSR to assign a part of its requirements to that firm.

In addition, the Keramisches Werk Hescho-Kahla firm is East Germany's sole producer of capacitors for radio-frequency application and ships them to the USSR and various other Bloc countries. Czechoslovakia exports both capacitors and resistors within the Bloc.

## III. Input Requirements.

### A. Capacitor Paper.

#### 1. 1951 Requirements.

Capacitor paper is a special grade of high-quality kraft paper, included with cigarette paper, carbon paper, and bible paper in the broad category of thin tissues. Fixed paper capacitors require paper in thicknesses of from 6 to 20 microns. Paper of from 8 to 11 microns, which is especially free from pinholes and conducting particles, is used mostly in the manufacture of electronic capacitors, while 12- to 15-micron paper, which has an especially uniform dielectric constant at higher temperatures, is used in power capacitors. Electrolytic capacitors use a relatively smaller amount of heavier paper, manufactured to different specifications.

The manufacture of thin capacitor paper, with its rigorous mechanical, chemical, and electrical specifications, is the most difficult operation of the paper industry. This manufacturing process demands the use of the best quality of wood-pulp fiber, of the purest mill water, and of extended beating, varying from 12 hours for thick papers to 70 hours for thin papers. The paper machinery used must be capable of handling stocks as thin as 9 grams per square meter, and capable of closely controlling the calendaring process -- compressing when moist. The production capacity of the paper machine is quite limited and decreases rapidly for the thinner papers: for 14-micron paper, machine capacity averages 2 metric tons per day; for 8-micron paper, 1 metric ton per day; and for 6-micron paper, 0.17 metric ton per day. Owing to the need for special equipment, high-quality raw materials, technical competence, and familiarity with the electrotechnical industry, the potential suppliers of capacitor paper have been limited to a few fine paper mills.

An extensive volume of good intelligence information concerning Soviet Bloc imports and consumption of capacitor paper exists, especially covering the period since 1948. The quantity of capacitor paper produced in the USSR has been small, and the output has been limited presumably to the thicker grades. An analysis of import data and of occasional reports concerning Soviet electronics plants indicates the possibility that the USSR, at least from 1948 through 1951, has been allocating most of its domestic paper for the production of power-factor capacitors and has imported all of its requirements for electronic capacitors. Table 12* gives an estimate of the percentage distribution of Soviet attempts to purchase capacitor paper as determined from an incomplete list of Soviet orders and inquiries.

* Table 12 follows on p. 32.

Table 12

Pattern of Soviet Attempts to Purchase Capacitor Paper
1949-51

| Thickness (Microns) | Distribution of Total Orders and Inquiries (Percentage) |
|---|---|
| 6 | 0 |
| 7 | 4.3 |
| 8 | 71.2 |
| 10 to 11 | 19.2 |
| 12 | 5.3 |
| 14 and Up | 0 |

As indicated in Table 12, the primary Soviet interest has been to acquire capacitor paper in thicknesses of 8 to 11 microns, mainly 8-micron high-density paper, the specified material for metallized paper capacitors. There has been little indication of requirements for 6-micron paper, which is predominantly used in fixed electronic capacitors, or for papers heavier than 11 microns thick, such as those used for power-factor capacitors.

A sizable proportion of reported Soviet imports of capacitor paper have been completely confirmed, and there is strong, but unconfirmed, evidence of additional shipments. These data, as modified by the Soviet requirements for certain thicknesses, are summarized in Table 13.

Table 13

Confirmed and Probable Soviet Imports of Capacitor Paper
1949-51

Metric Tons

| Thickness (Microns) | Probable Imports | | | Confirmed Imports | | |
|---|---|---|---|---|---|---|
| | 1949 | 1950 | 1951 | 1949 | 1950 | 1951 |
| 7 to 11 | 250 | 770 | 850 | 50 | 200 | 250 |
| 12 and Up | 60 | 100 | 250 | 40 | 90 | 150 |

The manufacture of power-factor capacitors in the Soviet electrical industry is primarily concentrated in high-voltage units using papers of 12- to 14-micron thicknesses. Quantity production of power-factor capacitors was common in 1948 and by 1951 is believed to have reached 300,000 kva, about 15 percent of the domestic increment of generator capacity. Capacitor paper for this production would total 260 metric tons, a quantity adequately covered by some domestic production along with a small share of imports.

If the 1951 production of fixed electronic paper capacitors is estimated at 100 million units, a total of 250 metric tons of 7- to 11-micron thicknesses of capacitor paper is required, mostly in the 8-micron thickness. It is almost certain that the annual capacitor paper imports have greatly exceeded these industry requirements, possibly by 400 to 600 metric tons. It is possible that these additional significant quantities of thin capacitor paper could be consumed in the manufacture of three special categories of capacitor products: large capacitors needed for an extensive military radar and communications transmitter program; energy storage capacitors, required for a quantity production program of expendable units, including proximity fuses; and high-current AC power capacitors, used for particle accelerators.

2. Sources of Supply in the Bloc.

a. USSR.

Little is known about Soviet factories producing capacitor paper. It is apparent that the supply was limited through 1951 and was of poor quality through 1950. Possible producers, as indicated by unconfirmed sources, may include the Serpukhov Paper Mill, Serpukhov, reported as one of the first Soviet users of power-factor capacitors; the Oji Paper Mill in South Sakhalin, formerly a large Japanese manufacturer of fine papers; the Soyez Paper Factory in Moscow, reported as producing special electrical insulating paper; and a mill in the Riga area. Recently, two modern Tervakoski thin-paper machines were shipped from Finland to the USSR. These machines when installed and properly functioning will provide an annual capacity of approximately 600 metric tons of thin capacitor papers, principally of 8-micron thickness. As a result, the present Soviet dependence upon paper suppliers in Western Europe eventually could be eliminated.

b. Czechoslovakia.

The West Bohemian Paper Mill in Vrany, Czechoslovakia, on the Vltava River, is a leading European producer of capacitor paper, first producing this item in 1923 or 1924. Paper is manufactured as thin as 8 microns. In the past this mill normally exported capacitor paper to Switzerland, the Netherlands, France, and Austria. At present, in addition to meeting the domestic needs of the Tesla combine, this paper mill in Vrany is believed to supply a significant amount of paper to the USSR. The estimated annual capacity, expanded by the installation of one new thin-paper machine in 1947, is believed to be about 600 metric tons of capacitor paper, probably in the thinner grades.

3. Western Sources.

a. Finland.

The Tervakoski Paper Company, Tervakoski, Finland, with offices in Helsinki, is one of the world's leading suppliers of quality capacitor paper. The firm supplies high-quality thin papers, including both cigarette and capacitor papers, and manufactures some of the best specialized paper-making machinery. Capacitor paper production of the company totalled 730 metric tons in 1949, 705 metric tons in 1950, and 800 metric tons in 1951. Tervakoski can produce capacitor paper as thin as 6 microns, although little of its output has been under 8 microns. The firm has exported extensively to Sweden, the Netherlands, Belgium, the UK, and Hungary and now also supplies the USSR through direct exports, through Finnish reparations, and probably as transshipments through Sweden. In late 1950 it was reported that Tervakoski paper was difficult to purchase in Western Europe, and it has been definitely established that at least 75 to 100 metric tons are shipped annually to the USSR. It is probable that one-half of the 1951 Tervakoski output, about 400 metric tons, was made available to the USSR.

b. France.

There are two capacitor paper mills in France: Papeterie des Champagnes, with offices in Paris and a mill in Britanny, and the Papeterie Bollore, with offices in Paris and a mill in Odet. In the past, French capacitor paper was not of the best quality, and much of the French industry's requirements were imported from the US. Since 1948 the quality has been improved and meets most domestic requirements. Papeterie Bollore has been a heavy supplier to the USSR since mid-1950 and shipped some paper to Hungary and to Poland in 1951. Confirmed shipments to the USSR totalled

200 metric tons in 1951, and evidence indicates that possible shipments directly to the USSR may have totalled 300 metric tons in 1950 and 350 metric tons in 1951.

c. West Germany.

Two affiliated firms in the French Zone of Germany provide the sole source of thin capacitor paper in West Germany. Of a combined output of approximately 1,200 metric tons per year of thin (7.5 to 12 microns) capacitor paper, Schoeller and Hoesch, Gernsbach, Baden, produces 900 metric tons, and Julius Glatz, Niedenfels, produces the remainder. Part of this paper is consumed in West Germany, and the remainder is exported to Italy, Switzerland, Austria, the Netherlands, Belgium, and India. Exports directly to East Germany and indirectly through Switzerland to East Germany have been reported. Some indirect exports from West Germany to the USSR also have been reported.

d. Other Sources.

Two mills in Sweden produce heavier papers which are used primarily for power capacitors and are, in the main, for consumption in Sweden and the UK. Three firms in the US produce capacitor paper and have led the world in quality and quantity. There are indications that transshipments of US paper have reached the USSR through Swiss and Italian firms. In the past, Italy has imported capacitor paper from the US, Germany, and Finland. During 1950, however, in addition to increased imports, three Italian mills were reported to be engaged in manufacturing capacitor paper. [redacted] 50X1 the Soviets have attempted to procure large quantities of capacitor paper in Rome.

It is estimated that during 1951 a minimum of 100 metric tons, and probably 200 metric tons, of capacitor paper originating from German, US, and Italian sources were imported by the USSR.

B. Aluminum Foil. 18/

1. 1951 Requirements.

The 1951 requirements of each of the countries in the Soviet Bloc for aluminum foil, based on the output figures appearing in Section II, above, and on the input coefficients appearing in Appendix C, are as follows: USSR, 270 metric tons; Hungary, 13.2 metric tons; East Germany, 45 metric tons; Czechoslovakia, 134 metric tons; and the total for the Bloc, 462 metric tons.

2. Sources of Supply in the Bloc.

As far as is known, the only producer of aluminum foil within the USSR is the Glavsvetmetobrabotka plant in Moscow. The VEB Metal Works in Merseburg, East Germany, has probably been supplying some aluminum foil since late in 1951. Before that time there was no production of that commodity in East Germany. Although the East Germans have imported some aluminum foil from Czechoslovakia, the location of the Czechoslovak facilities manufacturing this aluminum foil are not known. There is no evidence of domestic production of this product in Hungary.

3. Western Sources.

East Germany, having been unable to produce aluminum foil domestically until late in 1951, has had to rely on Western sources, principally Switzerland, for its supplies. Large quantities of aluminum foil have been sent to East Germany from Fritz Unger, Zurich, Switzerland.

There is little evidence available concerning Hungary's sources of supply, although it is known that Hungary has made inquiries of Italy with regard to this product.

Czechoslovakia produces some aluminum foil domestically and imports some from Switzerland.

C. Mica. 19/

1. Sources of Supply in the Bloc.

The only country in the Bloc which has domestic production of mica is the USSR. There are two major plants within the USSR: the "8th of March" Mica Factory at Petrozavodsk and the Irkutsk Mica Factory at Irkutsk. Two smaller processing shops are in Leningrad. Mica of good quality is mined in several places in the USSR. It is believed that the USSR does not import substantial amounts of good-quality mica and that it does not export to the Satellites, the implication being that its supply is just sufficient for its needs.

None of the Satellite countries has domestic production of mica.

2. Western Sources.

Since the Satellites have no domestic sources of mica, they are obliged to secure it from the West. Hungary has a treaty with Argentina which provides for the supply of this commodity. Czechoslovakia obtains mica from India and perhaps also from Argentina. East Germany, typically short of strategic mica, obtains it from India and Argentina and also substitutes ceramics for mica wherever possible.

It is thought that an embargo of this commodity, effectively operated, would cause a tightening of the mica situation in the Bloc as a whole, since presumably the USSR would have to divert some of its output to the Satellites. The success of such an embargo would depend on how easily the USSR could increase its own production of mica.

D. Other Critical Inputs.

Clear mineral oil and paraffin are employed in the Soviet Bloc industry as impregnants for fixed paper capacitors. The 1951 requirement for the Bloc is estimated to be 500 to 600 metric tons of mineral oil and paraffin, and there is no apparent limitation in the supply of this material. It is believed that the use of chlorinated diphenyl impregnants will be encouraged, particularly in the USSR.

The Soviet Bloc production of fixed electronic resistors is predominantly in the form of deposited film units, and a sizable requirement exists for the ceramic body cylinders. The porcelain used must have special properties, for which a review of supply sources should be made. At this time, however, there is no apparent evidence indicating any quantitative limit in the current availability.

E. Significance of Critical Inputs.

One of the most significant features brought out by this analysis of the Soviet Bloc electronic components industries is an unusually high requirement for capacitor paper. This is particularly true of the USSR but also applies to a lesser degree for East Germany, where reported requirements for both paper and aluminum foil are higher than would be expected. The probability of an extensive stockpiling program of capacitor paper, over and beyond the build-up of normally high working inventories, is not considered likely. There is no reported indication of the existence of large capacitor paper stocks in the USSR, although Soviet imports have been considerable as far back as 1948 and were large in 1951.

In view of the apparent absence of extensive stockpiling of capacitor paper, and of the additional production from new Soviet mills, along with Finnish and Czechoslovak production, it must be concluded that the output of fixed paper capacitors in the Soviet Bloc reached very high proportions by 1951 and that a considerable future increase has been planned. It is believed that the quantitative output estimates provided in Sections III A, above, and V A, below, represent most conservative conclusions.

Soviet Bloc imports of capacitor paper have been papers of thicknesses and specifications, indicating predominant use in the manufacture of DC electronic capacitors. A small proportion of the imported paper, supplemented by Soviet-produced paper, is consumed in the manufacture of a limited volume of power-factor capacitors. The pattern of imports also indicates a probable heavy output of low-voltage DC capacitors, including special metallized paper types.

A possible substitute for the fixed paper dielectric electronic capacitor is the plastic film unit, which would avoid the use of capacitor paper. Especially for low-voltage application, the plastic capacitor is relatively more expensive and bulky. Although polystyrene film capacitors are produced in both East Germany and the USSR, it is not probable that any general substitution program is contemplated.

Metallized paper fixed capacitor construction eliminates the need for aluminum foil, and, when mineral oil impregnants are used, the metallized paper capacitor requires appreciably less capacitor paper than the paper and foil construction. Extensive production plans have been reported in the Bloc for the metallized paper type of electronic capacitor, and it may be expected that this construction will begin to replace the standard paper and aluminum foil design in increasing quantities, especially for low- and medium-voltage DC electronic applications.

## IV. Distribution of Output.

### A. Electric Power Industry.

The most important products used by the Soviet Bloc electric power industry from the electronic capacitor and resistor industries are AC power-factor capacitors and motor-starting capacitors. For obvious reasons of economy, most of the power-factor capacitors in the Bloc are produced in the 3-kv, 6-kv, and 10-kv ratings to match distribution voltage. Although the 1951 supply was insufficient to meet needs, it appears probable that the output of this product will be increased to reach a kva figure comparable to 25 percent of the annual increment to generating capacity. It is estimated that AC power capacitors comprise about 7 percent of the total Bloc output value of fixed capacitors.

B. Electronic Equipment Industry.

The balance of the capacitors and the total production of the resistors covered in this report are used in the manufacture or in the repair and maintenance of Bloc electronic equipment. The detailed information available is inadequate to permit an estimate of distribution by class or by end use of equipment.

C. Indications of Specific Production Programs.

From an analysis of the Soviet fixed capacitor industry, three general trends appear in the production of electronic end items:

1. The magnitude and type of paper used, plus the preponderance of hermetic seals, indicate the industry effort to be devoted largely to military electronics production.

2. Heavy consumption of special 8-micron paper, together with installation of metallized paper capacitor facilities, indicates the probable quantity production of compact, low-voltage DC capacitors of types generally required for proximity fuses and missile controls.

3. The Soviet capacitor industry is manufacturing in quantity high-voltage, high-capacity units of types generally required as filter and pulse-forming capacitors in military transmitters and radar equipment.

V. Summary of the Bloc as a Whole.

A. Capabilities.

Table 14* gives the estimated production of the Soviet Bloc of electronic components in terms of quantity and value for 1951. A comparison of the output figures for components production in the Bloc in 1951 with the production of electron tubes in the Bloc in the same year 20/ reveals a resistor-tube ratio and a condenser-tube ratio substantially higher than in the US. The implication of this comparison of ratios is that any

* Table 14 follows on p. 40.

Table 14

Estimated Soviet Bloc Production of Fixed Capacitors and Resistors
1951

| | Electronic Capacitors | | Electronic Resistors | | Power-Factor Capacitors | |
|---|---|---|---|---|---|---|
| | Volume (Million Units) | Value ($ Million) a/ | Volume (Million Units) | Value ($ Million) a/ | Volume (Thousand Kva) | Value ($ Million) a/ |
| USSR | 165.0 | 24.5 | 130.0 | 8.6 | 300 | 1.8 |
| East Germany | 25.3 | 1.9 | 30.0 | 2.3 | | |
| Hungary | 6.64 | 0.53 | 9.32 | 0.71 | | |
| Czechoslovakia | 67.5 | 5.4 | 30.0 | 2.3 | | |
| Total | 264.0 | 32.3 | 199.0 | 14.1 | 300 | 1.8 |

a. Based on average current US f.o.b. prices for equivalent products.

electronics programs which the Bloc is able to undertake from the point of view of electron tube requirements, it is also able to undertake from the point of view of components requirements.

An estimate of Soviet Bloc capacities in 1952-53 to produce fixed capacitors and resistors, projected from the production estimate for 1951 and earlier years, is given in Table 15.*

B. Output of Electronic Components as Related to Electron Tubes and to Electronic End-Equipment Production. 21/

The composition of electronic equipment implies the possibility of a relatively fixed ratio between quantities of primary circuit components -- resistors and capacitors -- and quantities of tubes. For defense planning in the US there has been assumed for the electronics industry a requirement figure of four fixed capacitors per tube and about the same ratio for fixed resistors per tube. In 1951 the US industry produced about 3.7 fixed capacitors and 4.0 fixed resistors per tube. These ratios are meaningful

* Table 15 follows on p. 41.

Table 15

Estimated Soviet Bloc Capacity for the Production of Fixed Capacitors and Resistors 1952-53

| | Electronic Capacitors | | Electronic Resistors | | Power-Factor Capacitors | |
|---|---|---|---|---|---|---|
| | Volume (Million Units) | Value ($ Million) a/ | Volume (Million Units) | Value ($ Million) a/ | Volume (Thousand Kva) | Value ($ Million) a/ |
| USSR | 350.0 | 57.0 | 275.0 | 19.2 | 500 | 3.0 |
| East Germany | 39.0 | 3.1 | 50.0 | 3.8 | | |
| Hungary | 8.3 | 0.66 | 11.7 | 0.88 | | |
| Czechoslovakia | 67.5 | 5.4 | 30.0 | 2.3 | | |
| Total | 465.0 | 66.2 | 367.0 | 26.5 | 500 | 3.0 |

a. Based on average current US f.o.b. prices for equivalent products.

for the USSR: an analysis of four models of Soviet military radio equipment and five models of Soviet civilian radio receivers averaged 3.8 fixed capacitors used per tube and 3.4 fixed resistors per tube. These ratios may be compared with those provided by the 1951 output estimates, which indicate ratios of 4.7 capacitors and 3.7 resistors per tube in the USSR and 5.7 capacitors and 4.4 resistors per tube for the Bloc as a whole.

Further analysis of the interrelationships existing within the electronics industry can be made by comparing the total production value of end equipment with the total production values of tubes and primary components. Table 16* illustrates these relationships, for different areas at different times.

Since the estimates provided in this report for the Soviet Bloc production rates of fixed capacitors are believed to be quite conservative, examination of the above ratios indicates two probabilities: the estimate

* Table 16 follows on p. 42.

Table 16

Soviet Bloc Production of Tubes and Components in Percentages of the Total Value a/ of End-Equipment Production

| | US 1944 b/ | US 1951 c/ | USSR 1951 d/ | NATO Estimate e/ 1952-53 |
|---|---|---|---|---|
| Electron Tubes | 14.0 | 14.3 | 13.5 | 17.0 |
| Fixed Electronic Capacitors | 4.3 | 4.3 | 8.4 | 9.0 |
| Fixed Electronic Resistors | 0.9 | 1.1 | 3.0 | 3.5 |

a. End-equipment production value is in terms of f.o.b. sales prices.
b. Records for 1944: 2,834 million end-equipment shipments.
c. Preliminary industry estimate based upon $3,500 million end-equipment shipments.
d. Preliminary estimate for $500 million NATO electronics requirements, at an annual rate of $200 million.
e. Estimate based upon $300 million annual end-equipment shipments.

of Soviet tube production is supported, with the strong probability that actual 1951 output may have been higher than estimated, rather than lower; the total Soviet electronics program in 1951 was at least equal to the estimated $300 million and may have been greater.

C. Reliability of the Estimate.

The absence of adequate information on Soviet Bloc plant operations limits the reliability of the quantitative estimates for output. However, relatively good information on the consumption of special production materials by the capacitor industry indicates that the estimated outputs are quite conservative and can be considered as close to minimum values. Three general conclusions may be made:

1. The accuracy of the estimate for the East German industry output is reasonably good; the estimates for other Bloc areas are subject to much wider tolerances.

2. The accuracy of the output estimate for fixed capacitors is better than that for fixed resistors.

3. The accuracy of the several country estimates of output is better when expressed in terms of production value than when expressed in units.

The 1951 Soviet Bloc output for fixed electronic capacitors is estimated at $32.3 million; the range in possible output is believed to lie between $30 million minimum and $50 million maximum. The 1951 Soviet Bloc output for fixed electronic resistors is estimated at $14.1 million; the range in possible output is believed to lie between $9 million minimum and $20 million maximum.

D. Vulnerabilities.

The principal vulnerability of the Soviet Bloc electronic components industry lies in the incapacity of the Bloc as a whole to produce capacitor paper of suitable quality or in sufficient quantity. The USSR is thus far unable to make capacitor paper which is suitable for use in electronic capacitors. The only two plants which are able to make this commodity and which are subject to a degree of Soviet control are the Vrany plant in Czechoslovakia and the Tervakoski plant in Finland.

Although this shortage may be somewhat relieved by the recent shipment of paper-making machinery from Finland to the USSR, it is probable that it will be some time before the engineering problems peculiar to the manufacture of this product are ironed out and production is established on a quantity basis. Large imports of strategic-grade paper have so far supplied the Bloc with its needs, and it is believed that the supply of capacitor paper will be a continuing vulnerability for some time to come. It appears, therefore, that an effective embargo of this commodity would cut the Soviet Bloc ability to produce capacitors by 50 percent.

A second vulnerability from the points of view of transportation, logistics, and bombing is the relative concentration of the plants of the electronic components industry in the Soviet Bloc, particularly in East Germany, Hungary, and Czechoslovakia. Czechoslovakia and East Germany have two main plants each, and Hungary has one. The Soviet components industry is more dispersed, however, with at least seven principal components suppliers. The vulnerability of Soviet Bloc facilities for the production of electronic components is lessened, moreover, by the relative ease with which such facilities may be established and reestablished after damage has been inflicted.

E. Conclusions.

1. The USSR has developed a capable and efficient electronic components industry which is able to produce high-quality items which are suitable for military use.

2. Production figures for electronic components developed in this report support the estimate of high Soviet output of electronic equipment, and especially electron tubes [redacted] 50X1 50X1

3. The major effort in the Soviet electronics industry is devoted to the production of military equipment. There are two main pieces of evidence for this finding:

a. The kinds of capacitor paper imported by the USSR are not usually found in cheaper capacitors for home radios. In addition, there is a large effort devoted to the production of metallized paper capacitors in the USSR, and these types are also not used in home radio receivers.

b. Even assuming the USSR produces no capacitor paper, and assuming the minimum level of imports, the USSR still disposes of more capacitor paper per year than it possibly could if it were devoting its main efforts to other than military applications. The implication is clear that there is a high level of production of the larger types of capacitors which are more commonly used in military applications.

# APPENDIX A

## DESCRIPTIVE DATA FOR ELECTRONIC COMPONENTS

### 1. US Joint Army-Navy Specifications. 22/

US Joint Army-Navy (JAN) Specifications have become the standard for the manufacture of electronic components used in military electronic equipment in the US. There is reason to believe that some of these specifications are followed in the USSR on some of their components. Thus, although it is not clear on which components the Soviets will follow JAN specifications, nor to what extent, it is felt that descriptions of the JAN specifications for a few of the more common components will add materially to an understanding of the products under discussion.

#### a. Fixed Composition Resistors: JAN-R-11.

JAN-R-11 covers fixed composition resistors having nominal power ratings under 5 watts. These are resistors with a resistant composition mixture having tinned 1.5-inch leads, either embedded in the ends of the composition, as in the insulated resistors which are of usually 1 watt or less, or leads which are wrapped around the ends of the tubular composition structure, as in the uninsulated types, which are usually larger than 1 watt. The insulated types are color-coded with colored rings, whereas the uninsulated types are color-coded by means of the color of the body, one end, and a dot on the body.

Table 17* shows some of the typical specifications found in the more important tests which these resistors must undergo. The table includes, for comparison, the corresponding specifications in Project 166, prepared by the US Armed Services Electro Standards Agency (ASESA) for applications involving fixed composition resistors of greater stability and accuracy than JAN-R-11.

* Table 17 follows on p. 46.

Table 17

Comparative Specifications for Fixed Resistors
JAN-R-11, ASESA Project 166

| Specified Test | JAN-R-11 | Project 166 |
|---|---|---|
| Resistance Tolerance | 5%, 10%, and 20%. | 1%, 2%, and 5%. |
| Power versus Ambient Temperature Rating | 100% rated load at 40°C, 0% rated load at 110°C. | 100% rated load at 40°C, 0% rated load at 120°C. |
| Maximum Voltage Rating | Power X resistance except, e.g., for ½-watt resistances 350 DC working voltage. Other maximum voltage ratings for other sizes. | Power X resistance except, e.g., for ½-watt resistances 350 DC working voltage. Other maximum voltage ratings for other sizes. |
| Temperature Cycling Test Requirement | When subjected to temperature cycles from -55°C to 85°C, resistors must not show mechanical injury, and average permanent resistance change shall not exceed 5%. | When subjected to temperature cycles from -55°C to 85°C, resistors must not show mechanical injury, and average permanent resistance change shall not exceed 1.5%. |
| Short Time Overload | With 2.5 times rated voltage applied for 5 seconds, resistance change shall not exceed 5%. | With 2.5 times rated voltage applied for 5 seconds, resistance change shall not exceed 0.75%. |
| Humidity | Resistance change shall not exceed 10% after exposure to an atmosphere of 40°C and 95% relative humidity for 250 hours. | Resistance change shall not exceed 5% after exposure to an atmosphere of 40°C and 95% relative humidity for 250 hours. |
| Voltage Coefficient (for resistances in excess of 1,000 ohms) | The voltage coefficient shall not exceed 0.035% per volt for ½- and ¼-watt sizes, and 0.02 volts per volt for sizes in excess of ½ watt. | Characteristic R, 0.002% per volt; Characteristic W, 0.006% per volt; Characteristic X, 0.02% per volt. |

Table 17

Comparative Specifications for Fixed Resistors
JAN-R-11, ASESA Project 166
(Continued)

| Specified Test | JAN-R-11 | Project 166 |
|---|---|---|
| Insulation Strength | Resistors shall be able to withstand twice the rated working voltage applied between the insulation and the leads without damage. | Not available. |
| Load Life | Resistance change after 1,000 hours of intermittent operation at ambient temperature of 40°C at maximum continuous DC working voltage shall not exceed 10% between any two successive measurements. | Resistance change after 1,000 hours of intermittent operation at ambient temperature of 40°C at maximum continuous DC working voltage shall not exceed 3% between any two successive measurements. |
| Temperature Coefficient | Percentage change in resistance for 1,000-10,000 ohm resistors at -55°C for characteristic maximum voltage rating, 20%; for characteristic F, 10%. At 105°C, characteristic maximum voltage rating, 12%; characteristic temperature coefficient, 6%. | Under 1 megohm: Type R, 0.05%/°C; Type W, 0.08%/°C; Type X, 0.08%/°C<br>Over 1 megohm: Type R, 0.08%/°C; Type W, 0.14%/°C; Type X, 0.14%/°C |

b. Fixed Paper Dielectric Capacitors: JAN-C-91 and JAN-C-25.

JAN-C-91 covers fixed paper dielectric capacitors inclosed in nonmetallic cases for use in blocking, bypass, and filter applications where a low value of dissipation factor is not essential. Insulating and impregnating materials for these capacitors include waxes, varnishes, and the like. The dielectric material of capacitors covered by this specification is made of impregnated or treated paper or an adequate substitute. Where the voltage rating is in excess of 150 volts, a minimum of three layers of 0.0003-inch paper must be used. Provision is made to color-code these capacitors according to capacitance and characteristic.

JAN-C-25 covers fixed paper dielectric capacitors hermetically sealed in metallic cases, for use primarily in blocking, bypass, and filter applications where the alternating component of the impressed voltage is small with respect to the DC rating. The dielectric element of these capacitors consists of two or more layers of fine-grade capacitor paper. When the rated voltage is in excess of 250 DC working voltage, three or more layers are used. The specifications applicable to this type of capacitor, as to the nonmetallic cased capacitors, must be fulfilled after the capacitor has been dried, impregnated, and sealed in the container.

Table 18* shows some of the more important specifications which must be met by capacitors of these two classifications. These specifications have been arranged to show the comparison between the two sets, where appropriate.

c. Fixed Mica Capacitors: JAN-C-5.

Capacitors covered by JAN-C-5 are fixed mica capacitors primarily for use in radio-frequency applications. They are molded, molded-case potted, and ceramic-case potted capacitors. Provisions are made for color-coding these capacitors by means of colored dots to indicate capacitance, working voltage, and tolerance. Leads are made of wire which have been tinned to provide ease of soldering.

Table 19** indicates some of the specifications for these capacitors found in JAN-C-5.

* Table 18 follows on p. 49.
** Table 19 follows on p. 50.

Table 18

Comparative Specifications for Fixed Paper Dielectric Capacitors
JAN-C-91 and JAN-C-25

| Specified Test | JAN-C-91 | JAN-C-25 |
|---|---|---|
| Dissipation Factor | Shall not exceed 0.8%. | Shall not exceed 1%. |
| Insulation Resistance | Capacitors shall withstand a voltage of at least 100 volts but not more than rated voltage applied between the terminals. | Terminal to terminal: 1,500 to 6,000 megohms, depending on characteristic of capacitor; terminals to case (where case is not a conductor): 3,000 megohms. |
| Voltage Breakdown | Each capacitor shall withstand without breakdown or flashover 200% of rated DC working voltage applied across the terminals for 1 minute. 400%-rated voltage shall be applied between the terminals and the case of capacitors rated at less than 600 DC working voltage without breakdown or flashover, and 200% plus 1,000 volts applied to capacitors rated in excess of 600 DC working voltage, where the case is a terminal. | Same as that for JAN-C-91. |
| Capacitance Tolerances (Percentages) | Type K: plus or minus 10<br>Type M: plus or minus 20<br>Type N: plus or minus 30 | Type K: plus 10, minus 10<br>Type L: plus 15, minus 15<br>Type V: plus 20, minus 10<br>Type M: plus 20, minus 20<br>Type W: plus 25, minus 0<br>Type X: plus 40, minus 15<br>Type Y: plus 60, minus 25 |

Table 19

Specifications for Fixed Mica Capacitors
JAN-C-5

| Specified Test | Specification |
|---|---|
| Capacitance Tolerance (Percentages) | Type G: plus or minus 2<br>Type J: plus or minus 5<br>Type K: plus or minus 10<br>Type M: plus or minus 20 |
| Dielectric Strength | Molded capacitors must withstand 200% of the rated working voltage between 1 and 5 seconds. Potted capacitors must withstand the rated working voltage for not less than 5 seconds. |
| Insulations Resistance | Not less than 7,500 megohms |
| Life Test | Molded capacitors: after being subjected to 1,000 hours of life test at 150% of rated DC working voltage in an ambient temperature of at least 85°C, shall be able to pass all other tests.<br><br>Potted capacitors: after life test of 1,000 hours at a 60-cycle voltage equal to the rated DC working voltage at an ambient temperature of 75°C, shall be able to pass all other tests. |

2. Catalogue of Some Soviet Electronic Components. 23/

A catalogue of some Soviet resistors and capacitors, with pertinent characteristics, is given in Tables 20, 21, 22, 23, and 24.*

* Table 20 follows on p. 52; Table 21, on p. 53; Table 22, on p. 54; Table 23, on p. 55; Table 24, on p. 56.

Table 20

Catalogue of Some Soviet Electronic Components: Resistors

| Type | Description | Tolerance (Percentage) | Power Rating (Watts) |
|---|---|---|---|
| Kaminskiy | Fixed carbon composition or deposited carbon types with capped ends and flat terminals. | Plus or minus 5, 10, and 20 | $\frac{1}{2}$ |
| TO | Fixed or deposited carbon types with wire leads. | Plus or minus 5, 10, and 20 | $\frac{1}{4}$, $\frac{1}{2}$, and 3/4 |
| LS | Fixed composition resistors. | Plus or minus 5, 10, and 20 | $\frac{1}{4}$, $\frac{1}{2}$, 1, and 2 |
| VK | Variable composition resistor, without switch. | Not applicable | Not available |
| TK | Variable composition resistor, with switch. | Not applicable | Not available |
| Omega | Variable composition resistor. | Not applicable | Not available |
| Vitreous Wire-Wound | These are wire-wound resistors varying from 10 to 30,000 ohms for use in circuits where high-power dissipation is required. | Not available | Not available |

Table 21

Catalogue of Some Soviet Electronic Components: Electronic Capacitors

| Type | Description | Capacitance (Micro-microfarads) | Tolerance (Percentage) | Temperature Stability |
|---|---|---|---|---|
| SAM | Flat, mica. | 10-10,000 | Plus or minus 2, 5, 10, and 20 | Not available |
| KSO | Molded, mica (in 13 groups, depending on size and design). | 10-50,000 | Plus or minus 2, 5, 10, and 20 | Unlimited |
| KB | Tubular, paper dielectric. | 0.005-0.2 | Plus or minus 2, 5, 10, and 20 | 0.5, 0.2, 0.1 |
| BIK | Tubular, anti-inductive construction; paper dielectric. | 0.005-0.5 | Plus or minus 2, 5, 10, and 20 | Not available |
| BP | Bathtub type; paper dielectric. | 0.1-2 | Plus or minus 2, 5, 10, and 20 | Not available |
| MK | Bathtub type of smaller size than BP type; paper dielectric. | 0.25-2 | Plus or minus 2, 5, 10, and 20 | Not available |
| MKV | Same as MK type, except specially resistant to moisture. | 0.25-2 | Plus or minus 2, 5, 10, and 20 | Not available |
| KES-1 a/, KES-2 | Electrolytic types. | 5-2,000 | Not available | Not available |
| KTK-1 through 5 | Tubular ceramic (in five types). | Not available | Not available | Four unknown ratings b/ |
| KDK-1, KDK-2, KDK-3 | Disc ceramic. | Not available | Not available | Four unknown ratings b/ |

a. A number after a type designation indicates operating voltage.
b. The transliterated letters Zh, M, R, and S are the symbols of the ratings. The numerical values of these ratings are unknown.

Table 22

Catalogue of Some Soviet Electronic Components: Filter and Pulse-Forming Capacitors

| Type | Working Voltage (Kilovolts) | Capacitance (Microfarads) | Test Voltage (Kilovolts) | Weight (Kilograms) |
|---|---|---|---|---|
| FM 12-2 | 12.0 | 2.0 | 36.0 | 24.0 |
| FM 6-8 | 6.0 | 8.0 | 18.0 | 24.0 |
| FM 3-32 | 3.0 | 32.0 | 9.0 | 24.0 |
| FM 24-0.5 | 24.0 | 0.5 | 60.0 | 25.0 |
| FM 12-1 | 12.0 | 1.0 | 36.0 | 13.0 |
| FM 6-4 | 6.0 | 4.0 | 18.0 | 13.0 |
| FM 3-16 | 3.0 | 16.0 | 9.0 | 13.0 |
| FM 24-0.25 | 24.0 | 0.25 | 60.0 | 13.5 |
| FM 6-2 | 6.0 | 2.0 | 18.0 | 5.8 |
| FM 3-8 | 3.0 | 8.0 | 9.0 | 5.8 |
| FM 12-0.5 | 12.0 | 0.5 | 36.0 | 6.2 |
| FM 6-0.25 | 6.0 | 0.25 | 12.0 | 0.6 |
| FM 3-1 | 3.0 | 1.0 | 9.0 | 0.6 |
| FM 4-4 | 4.0 | 4.0 | 12.0 | 5.5 |
| FM 8-1 | 8.0 | 1.0 | 20.0 | 5.5 |
| FM 3-2 | 3.0 | 2.0 | 9.0 | 1.5 |
| FM 3-1 plus 1 | 3.0 | 1 plus 1 | 9.0 | 1.5 |
| FM 6-0.5 | 6.0 | 0.5 | 12.0 | 1.5 |
| FM 1.5-2 x 20 | 1.5 | 2 x 10 | 4.5 | 5.5 |
| FM 1.5-20 | 1.5 | 20.0 | 4.5 | 5.5 |
| FM 1.5-10 | 1.5 | 10.0 | 4.5 | 3.5 |
| FM 1.5- 2 | 1.5 | 2.0 | 4.5 | 0.6 |
| FMT 4-5 | 4.0 | 5.0 | 12.0 | 18.55 |

Table 23

Catalogue of Some Soviet Electronic Components: Power-Factor Capacitors

| Type | Voltage (Kilovolts) | Capacitance (Microfarads) | Power (Kilovolt-Amperes) | Weight (Kilograms) | Cost per Kilovolt-Ampere (Rubles) |
|---|---|---|---|---|---|
| KM-10-10-1 | 10.0 | 0.38 | 10 | 23 | 76 |
| KM-6-10-1 | 6.0 | 1.0 | 10 | 23 | 76 |
| KM-3-10-1 | 3.0 | 4.2 | 10 | 23 | 76 |
| KM-0.5-8-3 | 0.5 | 110.0 | 8 | 23 | 145 |
| KM-0.38-5-3 | 0.38 | 110.0 | 5 | 23 | 225 |
| KM-0.22-3-3 | 0.22 | 220.0 | 3 | 23 | 380 |

S-E-C-R-E-T

Table 24

Catalogue of Some Soviet Electronic Components: Induction Heating Capacitors

| Type | Cooling | Voltage (Kilovolts) | Capacitance (Microfarads) | Power (Kilovolt-Amperes) | Frequency (Cycles per Second) | Weight (Kilo-grams) | Cost per Kilovolt-Ampere (Rubles) |
|---|---|---|---|---|---|---|---|
| PM 1-0-5 | Natural | 1.0 | 3.84 | 12 | 500 | 14 | 28 |
| PM 2-0.5 | " | 2.0 | 0.45 | 12 | 500 | 14 | 28 |
| PM 3-0.5 | " | 3.0 | 0.42 | 12 | 500 | 14 | 28 |
| PM 1.5-2 | " | 1.5 | 0.42 | 12 | 2,000 | 14 | 22 |
| PMV 1-1 | Water | 1.0 | 11.2 | 70 | 1,000 | 25 | 15 |
| PMV 0.75/1.5 - 1 | " | 0.75/1.5 | 29.0 | 100 | 1,000 | 25 | Not available |
| PMV 2.4-2 | " | 2.4 | 0.98 | 70 | 2,000 | 25 | 15 |
| PMV 1.5-2 | " | 1.5 | 3.0 | 85 | 2,000 | 25 | 15 |
| PMV 0.66-2.5 | " | 0.66 | 8.8 x 4.4 | 90 | 2,500 | 25 | 15 |
| PMV 0.35/0.750 - 2.5 | " | 0.375/0.750 | 58.0 | 125 | 2,500 | 25 | Not available |
| PMV 0.750/1.5 - 2.5 | " | 0.750/1.5 | 16.0 | 125 | 2,500 | 25 | Not available |
| PMV 0.375/0.750 | " | 0.375/0.750 | 22.0 | 150 | 8,000 | 25 | Not available |



S-E-C-R-E-T

Page Denied

Next 1 Page(s) In Document Denied

Declassified in Part - Sanitized Copy Approved for Release 2013/08/12 : CIA-RDP79R01141A000100170002-9

# APPENDIX B

## ELECTRONIC COMPONENTS PLANTS IN THE SOVIET BLOC

1. USSR. 25/

a. Radio and Telephone Plant [redacted] imeni Lenin, Frunze Radio Plant [redacted] Lenin Institute OKB, and Frunze NII [redacted] Comprising the Myza Complex, Myza, near Gor'kiy. 50X1 50X1

The Myza complex is one of the largest electronics centers in the USSR, engaged primarily in design and manufacture of military electronic apparatus, test equipment, and components. It is comprised of four units. Established in 1916 and enlarged in 1939, the complex has been further reorganized and expanded in the postwar years. It is located in a factory area approximately 1,500 by 800 feet, about 7 kilometers south of the center of Gor'kiy. A new plant addition is planned between the present factory area and Gor'kiy. 50X1

Prewar employment has been estimated at 5,000 to 10,000 and postwar estimates vary, but it is believed that about 4,000 to 5,000 persons were employed in 1946 and 6,000 to 7,000 in 1950.

Although most of the effort is devoted to the assembly of apparatus, there is a model shop for metallized paper capacitors and deposited film resistors in the Lenin Institute OKB section and quantity production facilities in Lenin Plant [redacted] and possibly in Frunze Plant [redacted] 50X11 for the manufacture of fixed paper dielectric capacitors, mica capacitors, and fixed deposited film resistors. It is believed that most of the paper capacitor machinery removed from Germany was divided between the Myza complex and plants in the Leningrad area. Additional Soviet-made machines were installed after 1947.

The lack of manufacturing details, together with the broad manufacturing program in the complex, makes an accurate production estimate for components impossible. The few data known indicate the probability of an extensive resistor production, and the manufacture of paper dielectric capacitors employing metallized paper and aluminum foil, with a probably capacity of 10 million to 20 million capacitors per year.

b. Scientific Research Institute (NII) [redacted] Sosnovka District, Leningrad. 50X1

The design, development of manufacturing methods, and plans for production of fixed deposited film resistors and of fixed electronic capacitors were initiated in 1946 at NII [redacted] with the assistance of German technical personnel. 50X1 One capacitor plant affiliated with NII [redacted] is now located in a factory building across the street. 50X1 Close contact is maintained between NII [redacted] and the three major Leningrad electronics plants: 50X1 Kazitskiy Radio Plant [redacted] Komintern Radio Plant [redacted] and the secret military equipment establishment, Radio Plant [redacted] 50X1 50X1 50X1 In view of this interplant liaison, and in view of reported production materials and operations at these latter radio plants, it is believed that the quantity manufacture of fixed capacitors and fixed resistors is distributed between departments of these several facilities.

Fixed electronic components manufactured include aluminum foil and paper dielectric capacitors, metallized paper capacitors, deposited film resistors, and probably ceramic capacitors. This Leningrad complex includes the oldest radio enterprises in the USSR, and in addition to the manufacture of electronic components, the complex is engaged in a small production of civilian radio and telephone sets and a large production of a wide variety of military electronic equipment. Together, the several plants form a very large facility and are generally subject to a very high degree of security. Total employment may be on the order of 10,000 to 20,000. It is probable that the manufacturing capacity for components exceeds that of the Myza complex, and may be on the order of 20 million to 30 million capacitors per year, plus a large output of fixed capacitors.

c. Serpukhov Condenser Plant, Serpukhov, Moscow Oblast.

[redacted] the Serpukhov Condenser Plant is a medium-sized plant concentrating on the manufacture of capacitors -- primarily small fixed electronic paper dielectric capacitors and the larger size of filter and high-voltage fixed electronic paper dielectric capacitors. 50X1 The plant includes one prewar building and several new postwar buildings. Manufacturing equipment is comprised mostly of machinery dismantled from the Hydra AG in Germany, supplemented by postwar Soviet machines. The exact location requires confirmation.

Several hundred workers are employed, and the estimated output is believed to be from 3 million to 6 million capacitors, valued at approximately $1 million to $1.5 million per year.

d. Radio Parts Plant, Novosibirsk.

Facilities were moved into the Radio Parts Plant from Leningrad in 1941 and were set up to make the component parts for other electronic assembly facilities moved into Novosibirsk at the same time. During World War II the plant employed 1,500 and was equipped with good factory machinery, much of it from the US, and probably including the composition resistor manufacturing equipment supplied by the US in 1938 and 1943. Production has been continued in the postwar years and includes fixed electronic mica capacitors, some fixed electronic paper dielectric capacitors, probably composition resistors, plus other sundry components. An approximate estimate of the annual output is 10 million to 20 million fixed capacitors and 15 million to 25 million fixed electronic resistors.

e. Radio Plant [redacted] Novosibirsk. 50X1

The Radio Plant [redacted] one of the major electronics producers in 50X1
eastern USSR, includes a department manufacturing fixed paper dielectric capacitors and possibly some types of fixed mica capacitors. This department is reported to have been expanded in 1946. Possible output may now total 3 million to 6 million capacitors per year.

f. Plant [redacted] of the MEP (Ministry of Electrical Industry), Kiev 67. 50X1

Several published documents have referred to Plant [redacted] of the 50X1
MEP as the producer of fixed power-factor capacitors and related high-current fixed electronic paper dielectric capacitors. It is known that prewar capacitors of these types were manufactured in a Kiev plant "Kzeta." In 1951 the Soviet-owned firm in Berlin, SAG Kabel, shipped galvonometers and a capacitance bridge to Plant [redacted] Kiev, for the production testing 50X1
of fixed capacitors. It appears probable that this facility in Kiev is the primary Soviet source for high-current fixed power-factor capacitors; further details are lacking, and the location of the plant requires confirmation.

g. Other Producers.

Occasional reports referring to the manufacture of fixed electronic capacitors and resistors indicate the probability of additional Soviet producers. Most frequently, the information is not specific and may well refer to other unrelated types of radio components, many of which are normally manufactured by most of the larger radio set and electronic equipment assemblers. Additional potential producers of fixed capacitors and resistors may include the Krasnaya Zarya Telecommunications Plant in the Vyborg district of Leningrad; the Elektrosignal Radio Plant in Voronezh; the Moscow Radio Plant imeni Krassin, Moscow; and another unidentified capacitor plant in the general Moscow area.

2. East Germany. 26/

a. RFT Kondensatorenwerk VEB Gera, Parkstrasse 1, Gera, Thuringia.

RFT Kondensatorenwerk VEB Gera, the former Siemens-Halske Wernerwerk Gera, is now the largest East German manufacturer of fixed electronic capacitors. This plant was twice dismantled by the Soviets, in 1946 and in 1948. By May 1948 the second dismantling was almost completed, and all important machinery, together with a number of key personnel, were removed to the USSR. It was reequipped by the fall of 1948 and has operated since then as a member plant of the VVB-RFT.

Located in a large four-story building near the center of Gera, the firm was reequipped to manufacture fixed electronic paper dielectric capacitors, fixed electronic plastic film capacitors, and electrolytic capacitors; by early 1951 the plant reached 30 percent of its World War II capacity. In mid-1951, additional facilities were installed for the production of fixed electronic metallized paper capacitors, with a probable annual capacity of $\frac{1}{2}$ million units or more. Before it was dismantled in 1948, employment was reported to be between 900 and 1,500. In 1949 the number of employees varied between 340 and 450, increasing during 1950 to reach 700 by the beginning of 1951. During 1949 and 1950, output of capacitors was limited by recurring shortages of capacitor paper and aluminum foil. With increased imports obtained from Switzerland and West Germany the situation improved in 1951. It is apparent, however, that no domestic sources of capacitor paper and aluminum foil in effective quantities had been established by late 1951.

Table 25* outlines the annual volume of production for this factory for different periods.

b. RFT Kondensatorenwerk VEB Freiberg, Silberhofstrasse 80, Freiberg, Saxony.

RFT Kondensatorenwerk VEB Freiberg, the former Hydra AG Freiberg branch plant, is located in a single large building in Freiberg near the center of town and produces all varieties of low-voltage and

* Table 25 follows on p. 63.

Table 25

Fixed Electronic Capacitor Production of the East German Plant
RFT Kondensatorenwerk VEB Gera
1949-53

| Year | Paper Dielectric Capacitors | | | Electrolytic Capacitors | | |
|---|---|---|---|---|---|---|
| | Volume (Thousand Units) | Value (Thousand $ US) a/ | Value (Thousand EDM) b/ | Volume (Thousand Units) | Value (Thousand $ US) a/ | Value (Thousand EDM) b/ |
| 1949 | 2,200 | 220 | 2,600 | 200 | 60 | 600 |
| 1950 | 3,350 | 335 | N.A. | 250 | 75 | N.A. |
| 1951 | 5,500 | 550 | N.A. | 300 | 90 | N.A. |
| 1952-53 | 11,000 | 1,100 | N.A. | 500 | 150 | N.A. |

a. Dollar value data expressed in thousands, based upon current US f.o.b. prices for equivalent products: average of $0.10 per paper capacitor and $0.30 per electrolytic capacitor.
b. DM value data expressed in thousands of East Deutsche Mark, based upon an average unit price of DM 1.2 for paper capacitors and DM 3 for electrolytic capacitors.

high-voltage paper dielectric capacitors and electrolytic capacitors. Like VEB Gera, the 1949 and 1950 output was limited by material shortages. In 1949 the number of employees was reported as 160. Employment and plant output, however, is believed to have increased in 1951.

Table 26* outlines the annual volume of production for this factory for different periods.

c. RFT Kondensatorenwerk VEB Soemmerda, Stadtring 20, Soemmerda, Thuringia.

RFT Kondensatorenwerk VEB Soemmerda was formerly the independently owned firm, W. Ketski, and is now engaged exclusively in the manufacture of fixed paper dielectric capacitors. As of April 1951, this enterprise was consolidated under the administration of the RFT Kondensatorenwerk VEB Gera.

* Table 26 follows on p. 64.

Table 26

Fixed Electronic Capacitor Production of the East German Plant
RFT Kondensatorenwerk VEB Freiberg
1949-53

| | Paper Dielectric Capacitors | | | Electrolytic Capacitors | | |
|---|---|---|---|---|---|---|
| Year | Volume (Thousand Units) | Value (Thousand $ US) a/ | Value (Thousand EDM) b/ | Volume (Thousand Units) | Value (Thousand $ US) a/ | Value (Thousand EDM) b/ |
| 1949 | 550 | 55 | 660 | 50 | 15 | 150 |
| 1950 | 900 | 90 | N.A. | 100 | 30 | N.A. |
| 1951 | 1,650 | 165 | N.A. | 150 | 45 | N.A. |
| 1952-53 | 3,000 | 300 | N.A. | 200 | 60 | N.A. |

a. Dollar value data expressed in thousands, based upon current US f.o.b. prices for equivalent products: average of $0.10 per paper capacitor and $0.30 per electrolytic capacitor.
b. DM value data expressed in thousands of East Deutsche Mark, based upon an average unit price of DM 1.2 for paper capacitors and DM 3 for electrolytic capacitors.

The factory experienced a shortage of aluminum foil, and production was cut in mid-1949. Employment was reported at 200 in the fall of 1949.

Table 27* outlines the estimated annual volume of production for this factory.

d. <u>Keramisches Werk Hescho-Kahla, Hermsdorf, Thuringia</u>.

Keramisches Werk Hescho-Kahla consists of the main plant in Hermsdorf with other plants in Gera; Koenitz; Kahla; Koeppelsdorf, near Sonneberg; and Spergau. The five plants other than Hermsdorf are considered subsidiaries of Hescho-Kahla but are actually production workshops of and for the main plant at Hermsdorf, which itself is a subsidiary of the Soviet-owned electrotechnical enterprise SAG Kabel.

* Table 27 follows on p. 65.

Table 27

Fixed Electronic Capacitor Production of the East German Plant
RFT Kondensatorenwerk VEB Soemmerda
1949-53

| Year | Volume (Thousand Units) | Value (Thousand $ US) a/ | Value (Thousand EDM) b/ |
|---|---|---|---|
| 1949 | 1,200 | 110 | 1,200 |
| 1950 | 2,500 | 230 | |
| 1951 | 3,000 | 270 | |
| 1952-53 | 4,000 | 360 | |

a. Dollar value data expressed in thousands, based upon current US f.o.b. prices for equivalent products: average of $0.10 per paper capacitor and $0.30 per electrolytic capacitor.
b. DM value data expressed in thousands of East Deutsche Mark, based upon an average unit price of DM 1.2 for paper capacitors and DM 3 for electrolytic capacitors.

The Hermsdorf and Kahla plants of Hescho-Kahla became official Soviet property on 7 September 1946. The plant at Koeppelsdorf became official Soviet property in the spring of 1947.

Table 28* gives the number of persons employed by Hescho-Kahla in January of 1950 and 1951.

The plants at Hermsdorf, Gera, and Koenitz produce the following types of products: high-voltage porcelain; low-voltage porcelain; porcelain articles for chemical and technical purposes; and high-frequency porcelain parts, including capacitors, ceramic coil forms, ferromagnetic cores, and ceramic parts for high-frequency equipment. The plant at Kahla produces porcelain articles for households and restaurants. The plant at Koeppelsdorf produces small- and medium-sized radio sets and electrolytic capacitors.

The total production for 1950 at Hescho-Kahla included 8.6 million high-frequency capacitors and 344 metric tons of other high-frequency porcelain products, together amounting to 11.9 percent of the total company

* Table 28 follows on p. 66.

Table 28

Employment in the East German Hescho-Kahla Plants

| Plant | 1 Jan 1950 | 1 Jan 1951 |
|---|---|---|
| Hermsdorf Plant (Technical Porcelain) | 2,418 | 2,931 |
| Gera Plant (Technical Porcelain) | 549 | 560 |
| Koenitz Plant (Technical Porcelain) | 249 | 522 |
| Total | 3,216 | 4,013 |
| Kahla Plant (Household Porcelain) | 1,907 | 2,127 |
| Koeppelsdorf Plant (Radio Sets) | 918 | 1,037 |
| Spergau Plant (Kaolin Mining) | 34 | 27 |
| Total | 6,075 | 7,206 |

business for that year; 76,000 radios and 106,000 electrolytic capacitors, which together amounted to 44.1 percent of the company business.

Hescho-Kahla's main plant in Hermsdorf is the only factory in East Germany able to manufacture fixed ceramic capacitors, porcelain parts for high-voltage equipment, and chemical columns.

During 1950 the total output of all Hescho-Kahla's plants is closely estimated at DM 57 million; this was increased, reaching an estimated total of DM 68 million in 1951. Table 29* outlines the annual volume of production of fixed electronic capacitors for this factory for different periods.

e. RFT Dralowid-Werk VEB Teltow, Potsdamerstrasse 117-119, Teltow, near Berlin.

This plant, the former Dralowid-Werk of the Steatit-Magnesia AG, is the only quantity producer of fixed electronic deposited film resistors in East Germany. The facilities were rather completely dismantled and

* Table 29 follows on p. 67.

Table 29

Fixed Electronic Capacitor Production of the East German Plant
Keramisches Werk Hescho-Kahla
1950-53

| Year | Ceramic and Mica Capacitors | | | Trimmer Capacitors a/ | | | Electronic Capacitors | | |
|---|---|---|---|---|---|---|---|---|---|
| | Volume (Thousand Units) | Value (Thousand $ US) b/ | Value (Thousand EDM) c/ | Volume (Thousand Units) | Value (Thousand $ US) b/ | Value (Thousand EDM) c/ | Volume (Thousand Units) | Value (Thousand $ US) b/ | Value (Thousand EDM c/ |
| 1950 | 6,778 | 340 | 11,000 | 1,859 | 93 | 3,100 | 106 | 32 | 320 |
| 1951 | 11,400 | 520 | | 3,000 | 150 | | 150 | 45 | |
| 1952-53 | 15,000 | 750 | | 5,000 | 250 | | 200 | 60 | |

a. See footnote on p. 4, above.
b. Dollar value expressed in thousands, based upon current US f.o.b. prices for equivalent products: average of $0.05 per ceramic or trimmer capacitor and $0.30 per electrolytic capacitor.
c. DM value data expressed in thousands of East Deutsche Mark, based upon average unit price of DM 1.65 for ceramic and trimmer capacitors and DM 3 for electrolytic capacitors.

removed to the USSR in 1946, and the factory has been since reequipped. Although few details have been reported on actual plant operations, it is believed that most of the output consists of fixed deposited film resistors, based on the prewar Siemens-Halske development. In addition, the Dralowid-Werk manufactures presumably smaller quantities of precision resistors, both carbon film and wire-wound types. As of September 1950, it was decided that all fixed electronic resistors made by the VVB-RFT industry sector should be produced by the Dralowid-Werk. Since only a negligibly small quantity of electronic resistors are produced in East Germany outside of the VVB-RFT, in member plants of the SAG Kabel, this indicates the Dralowid-Werk to be the only East German manufacturer of electronic resistors.

The Dralowid-Werk is believed to have several hundred employees and is equipped with production quantities of the special bench lathes required for grinding carbon resistor spirals; the firm quoted prices on a Soviet inquiry totaling 16 million fixed electronic deposited film resistors. It is probable that the annual output of the Dralowid-Werk is on the order of 25 million to 35 million resistors per year.

f. Other Producers.

In the VVB-RFT, wire-wound variable potentiometers are manufactured by the RFT-Schalter and Widerstandbau, Berlin (Johannesthal); carbon film variable potentiometers are manufactured by the RFT Elektro Plant, Dorfheim/Salle. Other member firms of the SAG Kabel producing fixed electronic resistors and capacitors include the Werk fuer Fernmeldewesen HF, reported to be producing a small quantity of fixed deposited film resistors, possibly several hundred thousand per year; Siemens-Halske AG, Zwoenitz, reported to be manufacturing a very small quantity of high-precision resistors; and the Electro-Apparate Fabrik, Sonneberg, Thuringia, producing electrolytic capacitors at about 120,000 per year.

3. Hungary. 27/

The Remix Electrotechnical Works Company, Limited, an independent, nationalized concern which probably operates under, or in conjunction with, the Tungsram combine, is located at Tuzoloto-Utca 59, Budapest IX. This company specializes in the production of capacitors, resistors, voltage dividers, and volume controls. Before nationalization, Remix was owned jointly by the Hungarian Wolfram Co. (Orion) and Agrolux Limited, both subsidiaries of UILCO "Tungsram." After nationalization Remix was made an independent state enterprise. It is likely, however, that close cooperation continues to exist between Remix and UILCO "Tungsram."

In 1944 the labor force was 210 workers, and in 1947, before nationalization, the labor force consisted of 280 production workers and 40 nonproduction workers. The manager at that time was N.J. Fodor.

This plant made all the resistors manufactured in Hungary as of the end of 1947. Little other information of a positive nature is available except that in a 1947 report which gave the estimated production figures for 1947. It is known, however, that Remix was interested, in 1948, in the manufacture of deposited silver capacitors and that they hoped to make the equivalent of 6 million average-size capacitors of this type per year. It is not known if this level of output has been achieved. It is also known that Remix was interested in 1948 in the production of deposited resistance variable resistors.

4. Czechoslovakia. 28/

a. Lanskroun Electrical Equipment Works.

The Lanskroun plant was formed from the old Siemens-Halske AG plant in that city with the addition of several smaller plants taken over by the Czechoslovakian government after the coup, such as Ideal-Radio in Kolin, Gustav Klein in Krnov, and the former Blaupunkt plant, a subsidiary of Robert Bosch Company in Stuttgart.

The principal items produced by the Lanskroun plant are condensers, including fixed electronic electrolytic capacitors; resistors; and potentiometers. There is some indication that this plant formerly assisted the Hloubetin plant in the production of electron tubes, perhaps fabricating some of the parts for tubes, but it is now believed that with the emergence of the Hloubetin electron tube plant in Roznov pod Radhostem as the principal center for the production of tubes, the Lanskroun plant probably does not engage in this activity any longer. Batteries and telephone equipment are also made.

Resistors are produced in sizes of $\frac{1}{2}$, 1, and 2 watts. A $\frac{1}{4}$-watt size is being developed, but quantity production of miniature fixed electronic resistors has entailed very high costs to the Czechoslovak electronics assembly industry. Resistances have been standardized in values from 1 ohm to 1 million ohms.

Fixed electronic mica capacitors are manufactured in three voltages and are available in capacities from 1 to 1,000 micro-microfarads (mmfd). These mica capacitors consist of silver electrodes sprayed on the mica sheet. Difficulties encountered in their production include breakage of the mica with temperature changes, the peeling off of the silver coating, and changes in the capacity of the capacitor with changes in temperature and humidity. Tubular paper capacitors are available in capacities from 250 mmfd to 0.5 microfarads (mfd) in sizes of 750 and 1,000 volts. Paper capacitors of 0.01 mfd are made with a 3,000-volt rating. The principal difficulty in the manufacture of these capacitors is insecure leads.

No fixed ceramic capacitors were made in Czechoslovakia in 1949.

The Lanskroun Electrical Equipment Works manufactures wet electrolytic capacitors in sizes of 4, 8, 16, and 32 mfd, rated at 450 volts. Low-voltage fixed electronic dry electrolytic capacitors are made in capacities of 10, 25, 50, and 100 mfd. Fixed electronic electrolytic capacitors have proved unsatisfactory because of excessive size, they have tended to short easily, and the wet electrolytic capacitors have tended to dry up.

All the difficulties enumerated above in the manufacture of the various classes of capacitors can be attributed to an unsatisfactory level of engineering and technical skill. The result of this condition is that the electronics industry in Czechoslovakia tries wherever possible to use foreign capacitors. Captured German stocks were in common use, especially in the ceramic types.

The labor force at the Lanskroun plant was given as 1,700 in 1948, and it was expected that it would be 2,400 by the end of 1949 and 3,500 by the end of 1950. The plant works in two shifts. A third shift would increase production significantly. It is believed that at the time of the report telling of two-shift operation an unfavorable market situation was responsible for the plant's not operating the third shift.

The capacitor section included five production lines in 1949. Capacity for resistor production was 26 million per year in 1948, but this was only 50 percent utilized, because of the unfavorable market situation alluded to above. It is believed that an expansion of facilities amounting to approximately 25 percent had taken place by the beginning of 1951 as the result of building scheduled to be completed by that time. This is consistent with the proposed increase in the size of the labor force mentioned above. New machinery is being continually added, and these facilities are considered relatively up to date.

The inputs of Lanskroun come from a variety of sources. Paper for capacitors comes from the Vrany paper mill; plastics, from Plastimat in Jablonec and Ruetgers in Moravska Ostrava; and sheet metal, from the

Rymarov rolling mill. From sources outside of Czechoslovakia the Lanskroun plant obtains the following commodities: boric acid from the UK, carbon contacts from France, glycol from Switzerland and in 1949 from the US, and metal foil shipped through Switzerland.

Seventy percent of the output of this plant is believed to go to the USSR and the Satellites, principally Poland and Bulgaria, and the remainder to the other plants of the Tesla combine. There is a significant effort devoted to the production of fixed electronic metallized paper capacitors. These are shipped only on the approval of the military department of the plant. Foreign deliveries of these capacitors have been made only to the USSR, Poland, and Bulgaria.

There are no machinery or materials shortages facing the Lanskroun plant. Its principal problem is the procurement of skilled technicians, engineers, and workmen.

b. Hloubetin Electrical Equipment Plant.

This plant, formerly the German-owned Always, is located in Prague (Hloubetin), close to the other Tesla plants in that city.

Unfortunately, little or no information exists on which to base a description of this plant specifically. It is believed, however, that much of the information on production and production problems at the Lanskroun plant also applies to this plant. It is definitely known that fixed electronic capacitors are produced there, but magnitudes are not known, nor is there any specific information on resistor production.

APPENDIX C

# METHODOLOGY

## 1. Methodology for Development of Input Factors.

### a. Estimating Output by Means of Input Coefficients.

The volume of production of an economic unit is a function of, or depends upon, the quantities of the various inputs used in the production process. An input coefficient is defined as the quantity of that input necessary to produce one unit of product. If A produces a product P, then $\frac{A}{P} = a$ is the input coefficient of A in the production of P. If B is also required to produce P, then $\frac{B}{P} = b$ is the input coefficient of B in the production of P.

Input coefficients are calculated from the input-output relations existing in economic units for which this information is available. By means of these coefficients the outputs of other economic units may be estimated from the quantities of inputs used by them.

For example, if it is known that 50 units of input A are required to produce one unit of product P, and then if it is known that 500 units of A are used by a given economic unit, the estimate of the output of this unit will be 10 units of P. If it is also known that this unit uses 40 units of input B, and if 4 units of B are required to produce one unit of P, then it is possible to make a second, independent estimate of the output of the economic unit.

Two basic conditions must be satisfied in order that input coefficients may be employed in this fashion. Input coefficients must be (a) stable through time (intertemporal stability) and (b) they must be stable from one economic unit to another or from one geographic region to another (interspatial stability). The likelihood that these two conditions are satisfied will be considered in this section.

In the production of any given product the values taken by the input coefficients depend upon the particular production methods employed. The criterion used as a guide by an economic unit in the choice of a production method is, in general, related to the relative costs of alternative methods. An economic unit desires to minimize cost for a given level of output and will choose accordingly the method requiring the least-cost combination of inputs. The enterprise, of course, does not have complete freedom in its choice of method, for the area of its choice is bounded by technical conditions unique to the particular product produced.

Any change in the price of one input relative to that of another introduces an important incentive for the economic unit to substitute more of the cheaper input for the dearer input, subject, of course, to technical restrictions. Thus intertemporal stability of input coefficients will depend in part upon the stability of the relative prices of the various types of inputs used, relative to their technical substitutability in the production process.*

Further variations arise from the differential time periods required for adjustments arising from changes in resource supplies and in levels of output. These differentials are so pronounced that inputs are frequently classified as fixed and variable inputs, according to the length of the time periods required for adjustments to be made. It is implied in this distinction that at least some of the coefficients will tend to vary with the level of output.

There is also a considerable amount of variation in input coefficients among economic units producing similar products in different geographical locations. The chief cause for this variation is that different regions, both international and intranational, possess

* In a free market decentralized economy where prices are flexible, price changes result from two possible sources: (1) given the total amount of the resource available, changes occur in the amounts of the resource desired for employment in alternative uses; or (2) given the types of alternative uses and the respective quantities used, a change in the over-all quantity of the resource available occurs. The solution of this resource allocation problem in a decentralized economy is achieved through adjustments in the proportions in which the inputs are employed, on the level of the individual enterprise. In a planned economy, where the allocation of resources is determined by a central planning board, a similar result is accomplished by an entirely different means. Both types of economy are subject, of course, to the same constraints: that it is not possible to use more of a resource than is available, and that it is undesirable for resources to be unemployed.

resources in varying proportions. Given this unequal distribution of resources, the least-cost combinations of inputs, or production methods, will vary with respect to geographical areas. It follows that substantial error may result from incautious application of input coefficients calculated in the US as a basis for estimating input coefficients for other areas of the world. However, these variations will be smaller as the degree of technical substitutability of processes and inputs is more limited. The making of electrolytic copper, for example, requires a fixed amount of electricity per unit of copper wherever it may be produced.

Methods of collecting input coefficients so as to avoid most of these potential difficulties are suggested below. It is clear, however, that all input coefficients will not be equally stable. When applying them it is important, where choice is possible, to place the greatest reliance upon those input coefficients that are the more stable.

(1) Choice of the Economic Unit to Be Studied.

The choice of the economic unit to be studied depends upon the nature of the problem to be solved. The desirable economic unit is an operation or a department within a plant performing a single operation. The focus on such a narrow category facilitates the comparison of input coefficients among economic units. However, inasmuch as information on inputs sufficiently detailed to permit a departmental breakdown is seldom available, a workable compromise is to concentrate on the plant level. Extreme care must be taken in a study made at this level that the input coefficient used to estimate output be obtained from an economic unit performing a comparable number of operations. For example, if a labor input coefficient is used to estimate the volume of output of a plant which makes all of its own parts, the input coefficient must not be taken from a plant which purchases all of its parts and performs an assembling operation only.

(2) Information Required.

The use of input coefficients to estimate output requires two types of information in addition to the values of the coefficients. This additional information may be classified as (a) information concerning the quantities of inputs used and (b) information concerning the product mixes.

Frequently, when study is focused on the departmental level, and almost always, when focused on the level of an entire plant, it will be found that many different products have common inputs but differing requirements per unit. In this case, given the quantities of the inputs used, the absolute volume of output will be a function of the proportions in which the various products are produced, or the product mix. Where information is known concerning inputs which are not common to more than one product, this problem will not occur. Otherwise, it will be necessary to have independent information on the proportions in which the products are produced in order to estimate the volume of output by the application of input coefficients to input quantity data.

(3) Conclusions.

An important feature of estimating output by means of input coefficients is the mechanical and explicit manner in which the estimates are derived. It may appear that at times intuition would be a more useful, or more reliable, method, producing more reasonable results. This, however, is not the case. Intuition and judgment enter into the construction and choice of the mechanical devices employed. But once these devices have been selected, use of them should be made in a completely explicit manner. Such explicit use makes possible a check of the estimate by other persons and will facilitate a reestimation at a later date by the same analyst in the light of additional or improved information.

b. Calculation of Input Coefficients.

(1) Choice of a Product Definition.

Two procedures of defining products for purposes of calculating input coefficients have frequently been followed. They outline two possible extremes. In one, input coefficients have been calculated for single narrowly defined products. In the other procedure, products have been aggregated into commodity classifications, dividing an entire economy into from 50 to 450 commodity categories.

For most purposes related to intelligence research, a compromise between these two procedures is indicated. Many of the products of interest to intelligence research would be completely buried in the 450 industry approach. On the other hand, inasmuch as there are thousands of individual products -- and the possibilities of further narrowing the definitions are almost infinite -- it is necessary to combine products to some extent.

The appropriate method for combining groups of products for the purpose of calculating input coefficients is based on some one element, or unit of measure, common to all. This common element may be an exterior characteristic, a principal input, or, in cases where the products are exceedingly heterogenous, money values. It is desirable that this common element, if not an input itself, be proportional in amount to the amounts of the principal raw materials inputs. For example, the combination of many types of electric motors by kilowatt capacities is useful when, as one moves from motors of lesser kilowatt capacities to motors of greater kilowatt capacities, the amounts of the inputs required to produce them increase proportionately. In this fashion, one may speak unambiguously of the amount of copper, for instance, required to produce electric motors per kilowatt. If the relation is not proportional or does not even approach proportionality, it is always necessary to specify the composition of the particular product category (or product mix) on which such a figure is based, in terms of the types and quantities included. The resultant input coefficients will be applicable only in cases where the composition of product is identical.

Because of the necessity of making international comparisons, it is more useful to use physical units rather than value as a unit of measure. The calculation of "purchasing power parity" conversion factors for detailed product types is difficult and time consuming. In many cases, where proportionality does not hold because of the heterogeneity of the product mix, it is possible to break down the definition of the product only slightly in order to approximate this proportionality.

(2) Dealing with Interspatial Instability.

Because of the possibility of substantial variations in input coefficients as a result of differing production methods, little reliance should be placed upon coefficients calculated on the basis of the production method employed in a single plant. It is highly desirable that as many separate calculations as possible be made of the same input coefficient in order to check the spread of the coefficients. It is likely that the spreads of the coefficients will not be the same for different types of inputs. There will be little or no spread between enterprises of some coefficients, because of the limited technical possibilities for substitution. On the other hand, for some coefficients the spread is likely to be great. Because these variations will not be due significantly to errors of measurement but to variations of circumstance, the taking of an arithmetic mean of the coefficients is meaningless. These variations can serve to indicate the degree of reliance which may be placed upon their application to other plants.

In general, it is to be expected that the coefficients relating to raw materials and semifabricated products will show the smallest amount of spread, whereas the coefficients related to energy, "capital," and especially labor, will show the greatest amount of spread because of the greater technical freedom for substitutions.

(3) Dealing with Intertemporal Instability.

This class of problems is probably the most difficult to be encountered. Again the coefficients derived from raw materials and semifabricated inputs will show the greatest stability. Significant shifts in the proportions in which these inputs are employed usually are accomplished only very slowly and painfully. On the other hand, coefficients of energy, "capital," and labor are likely to prove highly unstable. In response to changes in the over-all availability of the inputs, rather large substitutions can frequently be made.

Capital, energy, and labor input coefficients will also vary importantly with the level of output. Capital, defined here as buildings, moving and fixed machinery, and such, measured in terms of either value or of physical units such as number of machines, horsepower of prime movers, or square feet of floor space, is ordinarily not variable with respect to short-run fluctuations in output. The greater the capacity utilization at the time of the calculation of the input coefficient, the smaller the value of the coefficient will be. The same is true of energy, although to a lesser extent, because a certain proportion of energy purchased will fluctuate with the volume of output. On the other hand, the labor coefficient will decline up to a certain point as capacity utilization is increased.

It is desirable that the calculations of input coefficients for a given product at a given plant be made for varying levels of output, with an explicit effort made to obtain the measures at or near the level of designed or "normal" capacity utilization. The spreads of the values of the coefficients between differing levels of output will again suggest the reliability of the coefficients between differing levels of output and will indicate the reliability of the coefficients for application to other plants.

In the absence of fairly detailed information on such matters as the history of resource supplies and technological change, there is no criterion which may be applied to limit the length of time period which may be permitted to elapse between the calculation of the input coefficients and their employment for estimating output in other plants.

2. Collected Input Coefficients.

The input coefficients as used in this report do not fulfill in all cases the requirements outlined above. The following is an attempt to evaluate them in the light of the criteria presented above and to indicate those which are believed to be the most useful.

a. Capacitors.

Those input coefficients believed to be the most useful are as given in Tables 30 and 31.*

Table 30

Input Coefficients for Power-Factor Capacitors

| | Input per Kva |
|---|---|
| Capacitor Paper<br>Mostly 0.0005 Inch Thick,<br>Using Chlorinated Diphenyl<br>Impregnant (Pounds) | 0.9 |
| Capacitor Paper<br>Using Mineral Oil<br>Impregnant (Pounds) | 1.6 to 2.0 |
| Aluminum Foil<br>Mostly 0.00025 Inch or 6 to<br>7 Microns Thick, Using<br>Chlorinated Diphenyl<br>Impregnant (Pounds) | 0.3 |
| Aluminum Foil<br>Using Mineral Oil<br>Impregnant (Pounds) | 0.5 |
| Winding Machines<br>(Hours per Machine) | 0.0128 |

* Table 31 follows on p. 80.

Table 31

Input Coefficients for Fixed Electronic Paper Capacitors

| | Input per Thousand Units |
|---|---|
| Capacitor Paper Mostly 0.0003 to 0.0004 Inch Thick, Using Chlorinated Diphenyl Impregnant (Pounds) | 3.5 |
| Capacitor Paper Mostly 0.0003 to 0.0004 Inch Thick, Using Mineral Oil Impregnant (Pounds) | 5.5 |
| Aluminum Foil Mostly 0.00025 Inch Thick, Using Chlorinated Diphenyl Impregnant (Pounds) | 2.5 |
| Aluminum Foil Using Mineral Oil Impregnant (Pounds) | 4.0 |
| Winding Machines (Hours per Machine) | 5.33 |

Other input coefficients which may be of occasional use but are generally subject to a wider variation are as follows: the minimum coefficient of man-hours per 1,000 units of all capacitors* in the US is 0.033 to 0.04 man-hour, and in the UK is 0.099 to 0.12 man-hour. The input coefficient of mica is 11.5 pounds per 1,000 mica capacitors.

Table 32** provides data on specific input coefficients for various categories of capacitors, as available from the indicated sources. This table served as the basis for estimating the collected input coefficients in Tables 30 and 31.

* Of all types of capacitors produced, fixed paper dielectric capacitors amount to about 50 percent.
** Table 32 follows on p. 81.

Table 32

Input Coefficients for Various Categories of Capacitors

| Item | Unit | Total Man-hours | Capacitor Paper (Pounds) | Aluminum Foil (Pounds) | Motor-Driven Hand-Winder Machines (Units per Hour) | Mica (Pounds) |
|---|---|---|---|---|---|---|
| Capacitors, All Types, US, 1947 a/ | 1,000 | 37.2 | N.A. | N.A. | N.A. | N.A. |
| Capacitors, All Types, US, 1951 30/ | 1,000 | 28.6 | N.A. | N.A. | N.A. | N.A. |
| Capacitors, Fixed Paper Dielectric, US, 1951, Using Chlorinated Diphenyl Impregnant b/ | 1,000 | N.A. | 3.5 | 3.0 | 5.33 | N.A. |
| Capacitors, Fixed Paper Dielectric, US, 1951, Using Oil Impregnant c/ | 1,000 | N.A. | 5.25 | 4.5 | 5.33 | N.A. |
| Capacitors, Mica, US, 1951 d/ | 1,000 | N.A. | N.A. | N.A. | N.A. | 11.5 |
| Capacitors, Power-Factor, US, 1951 e/ | | | | | | |
| 60 Cycles per Second, Using Chlorinated Diphenyl Impregnant | Kva | N.A. | 0.8 | 0.17 | N.A. | N.A. |
| 50 Cycles per Second (360 to 480 Volts, AC) | Kva | N.A. | 1.2 | 0.5 | 0.0128 | N.A. |

a. 29/ US shipments of fixed electronic capacitors were 440 million units, at $49.2 million. Estimated payroll for all electronic components was $156 million, or 60,000 employees. Man-hours were allocated to fixed capacitors on the basis of the ratio of labor cost to total value of shipments.
b. 31/ Capacitor paper varies from 0.0003 to 0.0004 inch in thickness.
c. 32/ Use of mineral oil impregnation requires 1.5 times as much paper and foil per 1,000 capacitors.
d. These data are for an average mix of both transmitting and molded-mica types. Transmitting types require best-quality mica, molded-mica types use fair-to-good stained mica, and in many applications green mica is just as good.
e. Seventy-five percent of the capacitor paper requirement for power capacitors is for paper of 0.0005-inch thickness, and the remainder for paper thicknesses of from 0.00025 to 0.0004 inch. For paper impregnated with chlorinated diphenyl, the dielectric constant is 5; for paper impregnated with mineral oil, the dielectric constant is 3. Mineral oil requires about 1.7 times the amount of paper and aluminum foil required for other impregnants.

b. Fixed Electronic Resistors.

No specific input coefficients are recommended for fixed electronic resistors. Man-hour and copper wire input requirements, however, are available and will furnish rough approximations for a few types. The man-hour coefficient per 1,000 resistors is as follows: US minimum coefficient per 1,000 resistors, 10 man-hours; US coefficient for fixed composition resistors, 5 man-hours; and European coefficient for fixed deposited film resistors, 25 man-hours. The copper wire input coefficient for pigtail leads on all types of resistors is 1 pound.

Page Denied

Next 3 Page(s) In Document Denied

Declassified in Part - Sanitized Copy Approved for Release 2013/08/12 : CIA-RDP79R01141A000100170002-9

SECRET