15925

CIA/RR 35
(ORR Project 33.226)

~~S-E-C-R-E-T~~

CIA HISTORICAL REVIEW PROG
RELEASE IN FULL

INPUT REQUIREMENTS OF THE AIRCRAFT INDUSTRY OF THE USSR*

Summary and Conclusions

The inputs discussed in this report are confined to the categories of materials, labor, energy, and services required to support both current and capacity production of the aircraft industry of the USSR. The inputs for capacity have been projected 3 years in advance of January 1954 and are based upon the assumption that capacity effort would be initiated on or about 1 January 1954.

This report consists primarily of discussions of the methods used to determine the input coefficients for each of the critical categories and the method of calculating total inputs by the application of input coefficients to the 1953 and capacity production estimates of the Soviet aircraft industry.** These production estimates are based upon an analysis of 27 Soviet airframe plants with a total floor area of 30,114,645 square feet and 14 Soviet aircraft engine plants with a total floor area of 17,789,637 square feet. The 1953 annual production in these plants amounted to 9,337 aircraft and 27,698 aircraft engines and included 20 different types of aircraft and 7 different types of aircraft engines. The requirements necessary to support this production are listed by categories in this report. These inputs are summarized in Table 1.***

The conclusions drawn from this report on the input requirements of the aircraft industry of the USSR are as follows:

1. The USSR uses less critical materials per pound of airframe and engine weight than does the US.

2. The Russians will try to conserve critical elements such as nickel, columbium, cobalt, zinc, molybdenum, and copper in the

---

* The estimates and conclusions contained in this report represent the best judgment of the responsible analyst as of 15 April 1954.
** Production estimates are taken from a forthcoming CIA report, ORR Project 33.235, Analysis of the Aircraft Industry of the USSR, TS.
*** Table 1 follows on p. 2.

Table 1

Summary of Requirements of the Soviet Airframe and Aircraft Engine Industries 1953 Production and 1956 Capacity

		Amount	
Input	Unit	1953 Production	1956 Capacity
Material			
Ferrous Metals	Metric Tons	73,400	331,000
Nonferrous Metals	Metric Tons	60,300	275,000
Rubber	Metric Tons	1,330	6,240
Glass and Plastics	Metric Tons	589	2,690
Cobalt	Metric Tons	396	1,790
Labor			
Direct	Number of Employees	112,500	262,500
Indirect	Number of Employees	112,500	262,500
Total a/		225,000	525,000
Skilled	Number of Employees	79,000	184,000
Unskilled	Number of Employees	146,000	341,000
Total a/		225,000	525,000
Managerial b/	Number of Employees	45,000	105,000
Technical b/	Number of Employees	41,000	94,000
Energy			
Electrical Power	Million Kilowatt-Hours	419	1,310
Coal	Thousand Metric Tons	696	1,280
Services			
Transportation c/	Thousand Metric Tons	960	2,480

---

a. The categories direct and indirect and the categories skilled and unskilled represent different breakdowns of the same total.

b. For the explanation of these headings, see pp. 32-33.

c. The category of transportation includes all transportation into both airframe and aircraft engine plants and most of the transportation out of these plants.

manufacture of airframes and engines. In conserving these elements, the Russians will not lower the quality of any material that can exert a significant bearing on the operational performance of the aircraft.

3. There has been very limited use of magnesium in Soviet aircraft as compared with equivalent US types.

4. The ratio of steel to aluminum in Soviet aircraft can be expected to remain high in comparison to US aircraft.

5. The ratios of unskilled to skilled workers and managerial to production workers are higher in the Soviet aircraft industry than in the US aircraft industry.

6. The Soviet labor productivity is lower than that of the US; therefore, the Russians require more labor than the US to produce a given number of aircraft in a stated floor area.

7. Soviet aircraft plants have a higher density of workers per square foot of floor area than US aircraft plants.

I. Introduction.

A. Purpose and Scope.

The purpose of this report is to determine the input requirements of the aircraft industry of the USSR in terms of the categories of materials, manpower, energy, and services. These inputs have been consolidated into one report separate from the report on the production of aircraft and aircraft engines in the USSR in order to give a more complete coverage of the input requirements of the industry and in order to make the material more readily accessible to the users of input information. Only the principal inputs required for the production of airframe and aircraft engines in the USSR have been studied. The inputs for associated products such as components, parts, and guided missiles are not covered in this report.

B. Description of Inputs.

The inputs considered in this report are materials, labor, electrical energy, fuels and lubricants, and transportation. Since many possible subdivisions of these inputs exist, a brief description of the items covered under each of the major categories is indicated so that the limitations and significance of the figures can be properly evaluated in terms of over-all significance to the Soviet economy.

1. Materials.

The materials inputs to the Soviet aircraft industry discussed in this report are as follows:

a. Ferrous Metals.

(1) Low-Carbon Steel.
(2) Alloy Steel.
(3) Stainless Steel.

b. Nonferrous Metals.

(1) Aluminum.
(2) Copper and Copper Base Alloys.
(3) Magnesium.
(4) Lead.

c. Rubber.

d. Glass and Plastics.

e. Cobalt (Alloying Element).

The list presents a general breakdown of the important materials utilized in the Soviet aircraft industry. It includes materials used in airframes, aircraft engines, and landing gear but excludes wheels, engine accessories, installed electric and electronic equipment, instruments, and similar equipment. The breakdown makes possible the computation of base metal inputs but does not permit other than qualitative order-of-magnitude estimates of alloying element inputs. With the exception of cobalt, the critical alloying elements have not been included in this report, because the determination of the exact amounts of elements in each material is too complex for exact estimates, the amounts are relatively small, and a wide range of substitutability of alloying elements is possible. Cobalt has been included because it is an extremely critical material and is one of the few elements used to obtain high-temperature properties.

2. Labor.

The labor inputs are listed in terms of the total labor required in airframe and aircraft engine plants together with a breakdown of the requirements by type of labor normally required in aircraft manufacture. Labor inputs include the categories of total labor, direct and indirect labor,* skilled and unskilled labor, managerial employees, and technical employees. The managerial and technical categories are considered extremely critical to the industry and to the Soviet economy as a whole. From the information presently available it is not feasible to attempt labor requirements analysis in terms of specific skills or positions.

3. Electrical Energy.

The input of electrical energy has also been determined in terms of total quantity required under present production conditions and under capacity conditions. Electrical energy is presented in terms of the total kilowatt-hours required per plant.

4. Fuel and Lubricants.

Fuel and lubricants are important inputs to the aircraft industry in terms of the total demands of the industry upon the economy as a whole and also as a guide for judging the level of output in a plant. In this report, coal is the only fuel considered, as it

---

* Direct labor refers to those laborers whose work is expended on the manufacturing process, which includes machining, processing, fabricating, assembling, installing, testing in the manufacturing area, and rework prior to acceptance. Indirect labor refers to all other personnel such as the supervisory employees (above the working foreman level) and their clerical staffs and the employees engaged in inspection, receiving, storage, shipping, maintenance, janitorial duties, finance, accounting, and similar duties.

is the only fuel used for the maintenance of plant facilities. Lubricants considered are oil and grease. The requirements for fuel and lubricants are based upon analysis of the fuel requirements for each individual plant. Fuel for testing purposes, however, has not been included, because of insufficient evidence as to Soviet testing procedures and a lack of accurate US input coefficients.

5. Transportation.

Transportation, as a service input, is the most difficult input to analyze, since it is extremely difficult to measure objectively. It is not feasible to discuss transportation in terms of the normal measure of ton-miles because of the complexity of determining the source of every input into the industry. Transportation inputs are therefore covered in terms of the total tons of transportation required to support the production of each individual plant and to distribute the final product to its ultimate destination and through an analysis of the scope of interindustry shipments of materials, components, parts, and completed products.

C. Method and Scope of Research.

A complete discussion of the methodology used in estimating the inputs of the Soviet airframe and aircraft engine industry is presented in this report. It must be stressed, however, that although these estimates of input requirements are based upon a complete analysis of all available information on each plant, the estimates are subject to several areas of error and must not be considered as absolute figures. The quantity and quality of intelligence on inputs is very poor and sketchy for each individual plant. As a result of such poor basic information, heavy reliance has been placed upon determining total input requirements from the total estimated production by applying coefficients of inputs required per pound or other units of measurement of finished product. These coefficients have been determined either from US experience or from analysis of captured Soviet equipment and are subject to small ranges of error, whereas the over-all production estimates are subject to an estimated error of plus or minus 30 percent. The estimates have been presented in this report in terms of the total inputs required by type of aircraft and by each plant with the same approximate range of error for both.

II. Materials.

A. Materials Technology.

The types of materials used in Soviet airframe and aircraft engine manufacture are basically a function of the technology of the Soviet aircraft industry. The two factors of Soviet technology which have the greatest effect upon the type of materials inputs are the level of Soviet aircraft metallurgy and the fabrication techniques used in the manufacture of airframes and aircraft engines.

1. Level of Soviet Aircraft Metallurgy.

The level of Soviet aircraft metallurgy is comparable to that of the US and the UK at the present time. The Russians undoubtedly possess very fine metallurgical scientists and research facilities, and their level of aircraft metallurgy is limited only by the availability of raw materials. There is every indication that the Russians are well endowed with basic raw materials with the exception of certain alloying elements but are somewhat deficient in the processing and production of the desired materials. To overcome these deficiencies the Russians use substitute materials and carefully economize in the use of critical materials. The Russians have copied many materials from the US, the UK, and Germany in addition to producing materials to their own specifications. In copying such materials, the Russians have rarely improved the quality of material selected for a particular part but have often selected a material of lower quality. In any part where quality was required, however, they have consistently demonstrated the ability to provide it. 1/* In general, the material best suited to their production facilities and to their labor skill has been selected and quality provided where quality is required. Sometimes the choice of materials is clearly motivated by a requirement to conserve critical alloying elements, while at other times the choice is motivated by fabrication methods and labor skills. In addition there is evidence that the availability of semifinished products such as bar stock, plate, sheets, extrusions, and tubing is the determining factor in the choice of materials. In general the use of materials in the Soviet aircraft industry does differ considerably from US practice and probably would result in a slightly smaller requirement for critical materials per pound of finished product than that of the US.

---

* Footnote references in arabic numerals are to sources listed in Appendix D.

2. Fabrication Techniques.

The fabrication techniques of the Soviet aircraft industry are vastly different from current US techniques and, in general, can be said to be equivalent to US techniques in World War II. This has a great bearing on the types of materials used since the ability to handle certain materials is dependent upon modern tooling and a large skilled labor supply. There is a great difference between the fabricating techniques of airframe production and aircraft engine production in the USSR. The analysis of a MIG-15 aircraft which crashed off the coast of Korea revealed that extensive hand work and hand fitting was employed in the manufacture of the airframe. The RD-45 engine in this aircraft, however, indicated the utilization of extensive tooling, highly skilled labor, and critical casting and forging techniques in its manufacture. 2/ Examination of later MIG-15's indicates the same differences in manufacturing techniques. This can be explained by the fact that aircraft engine manufacture is largely done by standard machine tools, whereas airframe manufacturing requires many large, special-purpose machine tools under present US production technique. The Russians have apparently been unable to reequip airframe plants with modern machine tools and, until the plants are so equipped, they cannot efficiently employ new materials such as magnesium sheet and 75 ST aluminum.

B. Materials Usage.

1. Major Materials.

The Soviet aircraft industry employs aluminum alloy sheet, castings, and forgings in the manufacture of airframes and aircraft engines. The industry uses large quantities of 24 ST type sheet and only limited quantities of the 75 ST type. 3/ Aluminum castings and forgings rather than magnesium castings are used most frequently for the manufacture of aircraft engines. 4/ Reports indicate that the Soviet rejection rate of raw castings is 2 to 4 times that of US industry. 5/ Aluminum alloy forgings are used to the largest extent in the manufacture of reciprocating aircraft engines for such parts as crankcases and pistons. 6/

Steel is used extensively in both airframes and aircraft engines by the Russians. A standard structural steel, Cromansil, is employed almost exclusively for the construction of airframes. 7/ In fabricating this steel for airframe components, a great preference is shown for building up the desired shape using weldments. 8/ For the steel parts of reciprocating aircraft engines the Russians use the Wright Aeronautical Corporation pre-World War II Bill of Materials for the respective aircraft engines. 9/ The selection of steels for the Soviet jet engines indicates the maturity of Soviet aircraft metallurgy. Materials have been used in conformance with US, UK, German, or native practices, depending always on the most economic material. 10/ In general, the Russians use more steel in airframes than do US manufacturers.

In addition to use in electrical wiring and as an alloying element, copper is used by the Russians in a lead-bronze, antifriction alloy extensively used as a bearing material. 11/

Magnesium is employed much less for airframe and aircraft engine components in the USSR than in the US. It is used in a cast form only in low-strength applications. There is no evidence of the employment of magnesium sheet in the Soviet aircraft industry. 12/ Little significance can be attributed to the limited application of magnesium in the aircraft material examined to date, since these examinations have been confined to Soviet fighter aircraft. The weight savings gained by the use of magnesium are more critical in the construction of heavy-bomber aircraft, and in the US, magnesium alloys are assuming increased importance principally in this field. Thus it is anticipated that examination of Soviet heavy-bomber aircraft should reveal a more extensive application of magnesium.

The principal use of lead, other than as an alloying element, in the Soviet aircraft industry is in the fabrication of mass-balances that are inserted in the airframe for static and dynamic stability purposes. 13/

Natural rubber and synthetic types, namely, polybutadiene nitrile and polychloroprene, are employed by the Russians for various parts of their aircraft such as tires, flexible hoses, O-rings, and fuel-tank sealants. The Russians have had the capability of producing satisfactory synthetic rubber aircraft products since the outbreak of World War II. 14/

Glass is used by the Russians in the manufacture of bullet-resistant windshields. Examination of captured material indicates that the Soviet bullet-resistant plate is manufactured by laminating 1.25-inch acrylic sheet to 1-inch plate glass. 15/ The major use of plastics by the Soviet aircraft industry is in the manufacture of clear acrylic canopies. 16/

2. Substitute Materials.

Substitution of raw materials in the Soviet aircraft industry involves substituting one element for another when alloying or compounding a material to meet a given specification. There are many instances of this metallurgical substitution in the USSR, and the resultant quality has been varied as judged from analyzed captured Soviet equipment. In all cases examined, the quality of substituted materials has been sufficient for the application intended and in isolated cases has yielded a material with superior characteristics to anything known in the West.

The assumption can safely be made that the Russians will try to conserve nickel, columbium, cobalt, zinc, molybdenum, and copper. Specific instances where savings might be effected are difficult to point out. The question of what substitutions are foreseen can best be answered by reviewing what has been found in Soviet airframes and aircraft engines. The following examples are cited:

a. In 1949 the Russians used an alloy very similar to G-18-B in the manufacture of the turbine rotor disc for the RD-45 engine. They used 66 percent less columbium and 25 percent less nickel, however, than was used by the UK and the US. Creep and stress rupture tests of this alloy reveal that the Soviet composition was 600 psi superior at actual operating conditions. If the US had made approximately the same reductions, 19,000 pounds of columbium and 28,000 pounds of nickel would have been saved during 1953 on the J-48 program alone. 17/ In later models of Soviet jet engines, the G-18-B type alloy was changed to a ferritic composition resulting in further savings of these critical elements. 18/

b. The Russians have successfully employed aluminized carbon steels in place of stainless steel in the outer combustion chambers of the RD-45 and VK-1 jet engines. This substitution is now being adopted by the US industry, and the elimination of type 321 stainless steel in such application is estimated to conserve approximately 150,000 pounds of chromium and 66,000 pounds of nickel per year. 19/

c. The Russians used Type 321 stainless steel in the turbine exhaust flange, the turbine nozzle-vane inner-shroud support, and the turbine case of the RD-45 jet engine instead of H.R. Crown Max which contains a much higher percentage of chromium and nickel and about 3 percent tungsten. This substitution was made without apparently impairing efficiency or operating life. The Russians retained H.R. Crown Max in hotter parts of the engine. 20/

d. Soviet studies and actual application of boron-treated steels to increase hardenability indicates that the USSR can conserve nickel, molybdenum, and vanadium by this technique. This trend is confirmed by the wide usage of boron-treated Cromansil types of steel that have been found in every airframe and aircraft engine examined to date. 21/

The only known use of cobalt in the Soviet aircraft industry is in turbine guide vanes and turbine blades of the VK-1 jet engine. The main use of cobalt in US reciprocating engines is in the alloy used for facing valve seats and in the alloy used in the valve tips. Materials analysis of the valves from a Soviet ASH-62 aircraft engine indicated an absence of cobalt. 22/ The valve tip alloy used by the Wright Aeronautical Corporation contains from 2.7 to 3.3 percent cobalt; the Soviet materials contain none. The World War II US specifications for valve seat alloys required a cobalt-chromium alloy containing from 50 to 55 percent nickel. 23/ Current US practice utilizes an 80 nickel-20 chromium-type alloy. 24/ The absence of cobalt from the seat alloy and the use of an alloy containing only about 50 percent nickel indicate that the course of Soviet development work in the valve material field may have been guided by a need to conserve both cobalt and nickel. Since the analysis of the captured reciprocating engine parts have revealed the absence of cobalt, the assumption is made that the Russians do not use cobalt alloys in their reciprocating engines.

Based on the examples cited above, the conclusion is reached that the Russians will make aggressive efforts to downgrade the critical-element content of their aircraft alloys. The Russians acted to save critical materials in their jet engines before the US did in similar engines. The critical elements that the Russians will attempt to conserve are nickel, columbium, cobalt, zinc, molybdenum, and copper.

C. Method of Computing Materials Inputs.

1. Airframes.

The materials input requirements for Soviet airframes and aircraft engines have been estimated principally by analogy with comparable US types. Wherever possible, however, estimates of materials inputs have been based on the study of captured Soviet aircraft. Results of analysis of captured Soviet equipment have been obtained from the Air Technical Intelligence Center, Wright-Patterson Air Force Base, Ohio (ATIC), as were estimates of weights and bills of materials for individual Soviet airframes and aircraft engines.

The only Soviet aircraft of which the US has made a thorough materials applications study is the MIG-15. The Soviet MIG-15 airplane serial number 120147, which crash landed into the bay off the Korean mainland in early July 1951, was salvaged and transported to the US to be analyzed and studied by the ATIC and the Cornell Aeronautical Laboratory, Inc., at Buffalo, New York. From a study of this aircraft, a compilation of the rough stock required to produce one MIG-15 airframe was assembled. 25/ Estimates were made of the wing group, empennage, and main landing gear, which were in poor condition. In the final summarization, where the weights of some materials were low in comparison with US fighters, these rates were adjusted upward to produce a more realistic figure.

Cornell did not include scrap losses in the rough stock bill of materials for the MIG-15. Soviet scrap losses, however, are not assumed to be any greater than those experienced in the US for the following reasons:

a. The standards of Soviet workmanship in non-critical areas are lower than the standards accepted in US practice.

b. Hand labor is used, making possible reworking of rejected parts and usage of trim-off materials.

c. Regulations of the People's Commissariat for Trade impose heavy fines on the worker for materials spoilage. 26/

The first discrepancy to be noted in the MIG-15 bill of materials as calculated by Cornell was the wide proportionate difference between the materials input requirements to produce the MIG-15 and the F86E airframe. Materials weighing 7,117 pounds are required to produce 1 MIG-15 with an Aeronautical Monthly Progress Report (AMPR) airframe weight* of 5,130 pounds; but 14,021 pounds of materials are required for 1 F86E with an AMPR airframe weight of 7,216 pounds. According to US aircraft industry practice, 10 to 30 percent of the quantities shown in bills of materials are added for contingencies. 27/ Assuming that these same contingencies exist in Soviet practice, ATIC adjusted the Cornell value upward by 15 percent. Since the US bills of materials include approximately 10 percent scrap, ATIC further increased the MIG-15 gross input value by this amount. These adjustments brought the MIG-15 input quantities to a total of 8,890 pounds, which is more in line with US values.

---

* AMPR airframe weight is defined as follows:

Weight empty (weight of aircraft minus crew, fuel, oil, armament, cargo, bombs, and disposable or special equipment) minus the total weight of the items listed below:

1. Engine (dry weight).
2. Propeller hubs, blades, power control, and governor.
3. Wheels, brakes, tires, and tubes.
4. Auxiliary power plant.
5. Turbosupercharger (not including controls, intercoolers, lubricating system, and similar equipment).
6. Radio receivers, transmitters, radar and removable units (but not installation parts and wiring).
7. Starter (not including shafts, gear boxes, wiring, and similar equipment).
8. Battery (not including containers or other items).
9. Generator (not including control boxes, regulator, and similar equipment).
10. Turrets, and power operated gun mounts. If the plant manufactures its own turrets, the weight of the turret is not included in this item.

AMPR airframe weight of a helicopter is the same as defined above except that item 2 is omitted from the list of items to be deducted from airframe weight empty. In effect, this means that rotors, as well as the rotor-driving mechanism (includes transmissions, clutches, shafting, and free wheeling units for main and tail rotors), should be included in the airframe weight of helicopters.

In the case of the Type 39 (latest variation of the MIG-15), gross materials inputs were derived by multiplying the materials requirements for the MIG-15 by the ratio of AMPR airframe weights of the Type 38 to the MIG-15.

Gross materials input values for Soviet aircraft (Il-28, Type 35, Tu-4, Il-12, Li-2, Yak-6, Yak-8, Yak-16, Yak-11, Type 33, Type 34, Omega I, Type 32, and Type 36) were derived by multiplying the ratio of USSR airframe weights to US AMPR airframe weights times the gross materials input required for the US aircraft equivalent. Quantities of aluminum, steel, copper, and other materials for Soviet aircraft were derived by using this same ratio, with the exception of the Il-28 and the Type 35.

In the cases of the Il-28 and the Type 35, ATIC substituted adjusted percentages of aluminum, steel, copper, and other materials for the B-57 (the comparable US aircraft) percentages. 28/ The adjusted values were considered more realistic in view of the relatively high percentage of steel used in the MIG-15 compared with the average US percentages of steel used.

The US bills of materials do not include materials for landing gears. The Air Materiel Command, Wright-Patterson Air Force Base, Ohio, could only furnish the gross materials input requirements for the landing gear of two US counterparts. These gross inputs were proportional to the gross requirements for the landing gear of the MIG-15. Hence, the gross requirements for the other aircraft were increased by the following amount:

$$\frac{\text{MIG-15 landing gear material input}}{\text{MIG-15 AMPR airframe weight}} \times \begin{array}{c}\text{AMPR airframe weight}\\ \text{of aircraft noted}\end{array}$$

Complete bills of materials were not available on US aircraft comparable to the An-2, Yak-12, Yak-18, and Type 25. In these instances the gross materials input value was derived as follows:

$$\frac{\text{MIG-15 gross input}}{\text{MIG-15 AMPR airframe weight}} \times \begin{array}{c}\text{AMPR airframe weight}\\ \text{of aircraft noted}\end{array}$$

ATIC assigned arbitrary percentages of aluminum, steel, and other materials to these gross materials inputs to derive an estimate, since these percentages were approximately in line with US values for comparable aircraft.

The Russians use almost exclusively a standard structural steel, Cromansil, for airframes. Hence, the percentages of low-carbon steel and stainless steel are very low. 29/ The US bills of materials contained relatively larger percentages of low-carbon steel and stainless steel than are contained in the MIG-15 bill of materials. The ratios of low-carbon steel and stainless steel to the gross amount of steel of the MIG-15 were used to estimate the amount of these alloys in the bills of materials for the other Soviet aircraft.

The design decision made with regard to the use of steel or aluminum is a function of a complex set of interdependent variables. These variables include design traditions, aerodynamic considerations, economic factors such as materials availability, and manufacturing problems such as machine tools, equipment, and labor skills available. Each of these variables influences the design decisions made. In the US, design traditions and aircraft performance specifications would probably have the major influence on design decision. In the USSR the availability of materials, machine tools, equipment, and labor skills would probably have a greater influence than in the US. In general, US data indicate a tendency to minimize the ratio of steel to aluminum whereas Soviet designers would probably tend to maximize the ratio.

Although the use of a relatively high percentage of steel may be favored in larger Soviet aircraft such as the Tu-4, practical considerations of performance efficiencies of larger aircraft and factors such as rigidity and aerodynamic loads would limit the amount of steel which would be used. The ratio of steel to aluminum with regard to Soviet aircraft might be expected to remain higher than in US aircraft; therefore, derived Soviet gross materials input requirements listed in Table 2* could be considered as representing the minimum requirements for steel. There are insufficient Soviet data at present to adjust Soviet percentages of steel, aluminum, and other materials above those listed. Closer examination by ATIC of materials applications in the Yak-11 will provide some clue as to the Soviet pattern.

---

* Table 2 follows on p. 16.

Table 2

Bills of Materials for Soviet Airframes
1953

Pounds

	Type of Aircraft																		
	Fighter		Bomber			Transport							Trainer		Recon-naissance		Rotary Wing			Glider
Input	Type 38	MIG-15	Il-28	Type 35	Tu-4	An-2	Il-12	Li-2	Yak-6	Yak-8	Yak-12	Yak-16	Yak-11	Yak-18	Type 33	Type 34	Omega I	Type 32	Type 36	Type 24
Airframe Weight	7,000	5,130	16,840	17,000	48,114	3,500	16,000	13,370	1,754	2,394	807	5,946	2,500	850	5,040	20,500	1,500	2,300	4,710	6,300
Low-Carbon Steel	336	245	707	714	1,300	119	400	361	96	126	27	137	63	29	66	267	152	232	476	170
Alloy Steel (Not including Stainless Steel)	5,820	4,270	12,160	12,280	22,870	2,098	6,780	6,280	1,666	2,180	483	2,420	1,063	492	2,027	4,450	2,612	4,005	8,200	2,887
Stainless Steel	55	40	115	116	212	20	64	59	16	20	5	23	10	5	10	41	24	37	75	27
Aluminum	5,170	3,790	21,210	21,420	54,400	3,540	21,760	11,740	1,144	1,561	815	6,480	3,575	900	6,300	24,400	1,575	2,415	4,950	7,250
Copper and Copper Base Alloys	392	289	741	748	1,588	130	592	308	121	158	30	244	75	35	96	349	110	168	344	183
Magnesium	23	17	66	66	149	0	352	160	0	0	0	71	45	0	00	0	475	729	1,490	0
Lead	48	35	34	34	481	16	400	40	5	7	4	18	0	4	25	103	0	0	0	21
Rubber	94	69	1,044	1,054	1,636	30	784	388	51	67	7	172	63	7	202	820	18	28	57	41
Glass and Plastics	136	100	118	119	914	46	208	173	23	30	10	77	40	11	116	471	36	55	133	62

The materials input coefficients for the Soviet airframes were derived by dividing the input requirement in Table 2 by the AMPR airframe weights. The coefficient may be expressed as the following ratio:

$$\frac{\text{Pounds of material per unit airframe}}{\text{Pounds of AMPR airframe weight}}$$

The materials input coefficients for the Soviet airframes are presented in Table 3.*

2. Aircraft Engines.**

ATIC examinations of Soviet aircraft engines have not revealed any significant quantitative differences in materials applications compared to their US counterparts. The bills of materials for equivalent US aircraft engines were used for the Soviet aircraft

---

* Table 3 follows on p. 19.

** The integral parts of an aircraft engine are as follows:

a. Reciprocating Engines.

The integral parts of reciprocating engines include: integral supercharger, propeller reduction gears, integral engine lubrication system, oil pumps, starter connection including starter dog, gun synchronizer, impulse generator drive, generator or power take-off drive, vacuum and hydraulic pump drives, propeller governor drive, and all piping and controls between engine parts. The integral parts do not include: ignition system (complete), carburetor, aftercoolers and intercoolers, fuel injection system, starter, generator, and fuel pumps.

b. Jet Engines.

The integral parts of jet engines include: accessories gear case assembly, all accessories except those designed and manufactured by vendors, compressor assembly, turbine stator assembly, exhaust cone assembly, and, where applicable, propeller gear box, as well as all piping required in the engines themselves as inherent power plant carriers to the point of quick disconnects located in the airframe.

engines without adjustment with the exception of the R1300-1, the US equivalent of the Soviet ASH-21. No magnesium is used in the ASH-21. 30/ Therefore, the amount of aluminum required for the R1300-1 was increased by the amount of magnesium required. The gross inputs for the Soviet aircraft engines were derived by multiplying the ratio of Soviet to US aircraft engine dry weights* times the materials input values for the equivalent US aircraft engine. The gross materials input requirement for each Soviet aircraft engine is listed in Table 4.**

The materials input coefficients for Soviet aircraft engines were computed from the following relationship:

$$\frac{\text{Pounds of material per unit engine}}{\text{Pounds of engine dry weight}}$$

The materials input coefficients for the Soviet aircraft engines are given in Table 5.***

D. Materials Requirements.

1. Airframes.

The materials requirements for airframes were estimated by multiplying the coefficients of Table 3 by the total pounds produced. The materials inputs required by type of aircraft are shown in Table 6.**** The materials requirements to meet current production and assumed capacity production in 1954, 1955, and 1956 are presented in Appendix A for each airframe plant. In case the Russians tried to produce at capacity, the assumption was made that they would not continue to produce the models being produced in Plants 1, 23, 49/86, 82, 168, 272, 293/456, 381, 448, 464, and 472. 31/ Since the models that would be produced in these plants under capacity conditions are unknown, the number of aircraft being produced was determined from the weighted average airframe weight of the known aircraft in production. In estimating the materials inputs for the above plants, the Tu-4 coefficients were used for Plant 23 and an average of the MIG-15, Il-28, Il-12, and Li-2 coefficients was used for the other plants. The gross materials requirements of the Soviet airframe industry are summarized in Table 7.*****

---

* Engine dry weight is defined as the weight of the assembled integral parts of an aircraft engine minus lubricants.

** Table 4 follows on p. 20.

*** Table 5 follows on p. 20.

**** Table 6 follows on p. 21.

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

Table 3

Materials Input Coefficients for Soviet Airframes a/
1953

Input	Type of Aircraft																			
	Fighter		Bomber			Transport							Trainer		Reconnaissance		Rotary Wing			Glider
	Type 38	MIG-15	Il-28	Type 35	Tu-4	An-2	Il-12	Li-2	Yak-6	Yak-8	Yak-12	Yak-16	Yak-11	Yak-18	Type 33	Type 34	Omega I	Type 32	Type 36	Type 24
Low-Carbon Steel	0.048	0.048	0.042	0.042	0.027	0.034	0.025	0.027	0.055	0.055	0.034	0.023	0.025	0.034	0.013	0.013	0.101	0.101	0.101	0.027
Alloy Steel (Not including Stainless Steel)	0.832	0.832	0.722	0.722	0.475	0.599	0.424	0.470	0.950	0.950	0.599	0.407	0.425	0.579	0.402	0.217	1.741	1.741	1.741	0.458
Stainless Steel	0.0078	0.0078	0.0068	0.0068	0.044	0.0056	0.0040	0.0044	0.0089	0.0089	0.0056	0.0038	0.0040	0.0054	0.0020	0.0020	0.016	0.016	0.016	0.0043
Aluminum	0.739	0.739	1.26	1.26	1.13	1.01	1.36	0.878	0.652	0.652	1.01	1.09	1.43	1.06	1.25	1.19	1.05	1.05	1.05	1.17
Copper and Copper Base Alloys	0.056	0.056	0.044	0.044	0.033	0.037	0.037	0.023	0.069	0.069	0.037	0.041	0.030	0.041	0.019	0.017	0.073	0.073	0.073	0.029
Magnesium	0.0033	0.0033	0.0039	0.0039	0.0031	0.0	0.022	0.012	0.0	0.0	0.0	0.012	0.018	0.0	0.0	0.0	0.317	0.317	0.317	0.0
Lead	0.0068	0.0068	0.002	0.002	0.001	0.0046	0.025	0.003	0.003	0.003	0.0046	0.003	0.0	0.0046	0.005	0.005	0.0	0.0	0.0	0.034
Rubber	0.0135	0.0135	0.062	0.062	0.034	0.0087	0.049	0.029	0.029	0.029	0.0087	0.029	0.025	0.0087	0.040	0.040	0.012	0.012	0.012	0.0065
Glass and Plastics	0.0195	0.0195	0.007	0.007	0.019	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.016	0.013	0.023	0.023	0.024	0.024	0.024	0.0098

---

a. Materials input coefficient = $\frac{\text{Pounds of material per unit airframe}}{\text{Pounds of AMPR airframe weight}}$

Table 4

Bills of Materials for Soviet Aircraft Engines a/ 1953

Pounds

	Type of Aircraft Engine						
	Jet		Reciprocating				
Input	VK-1 (Improved)	VK-1	ASH-90	ASH-82	ASH-62	ASH-21	M-11
Dry Weight	2,010	1,980	2,960	1,980	1,189	1,077	429
Low-Carbon Steel	422	416	459	194	1,617	227	931
Alloy Steel (Not including Stainless Steel)	923	909	7,580	5,980	2,222	2,520	592
Stainless Steel	2,030	2,000	1,009	0	0	168	0
Aluminum	1,646	1,622	2,410	1,339	503	1,088	280
Copper and Copper Base Alloys	12	12	358	190	87	60	61
Magnesium	0	0	0	48	0	0	0
Cobalt	58	57	0	0	0	0	0

a. The above bills of materials include scrap and reject losses but do not include spares.

Table 5

Materials Input Coefficients for Soviet Aircraft Engines a/ 1953

	Type of Aircraft Engine						
	Jet		Reciprocating				
Input	VK-1 (Improved)	VK-1	ASH-90	ASH-82	ASH-62	ASH-21	M-11
Low-Carbon Steel	0.210	0.210	0.155	0.098	1.36	0.211	2.17
Alloy Steel (Not including Stainless Steel)	0.459	0.459	2.56	3.02	1.87	2.34	1.38
Stainless Steel	1.01	1.01	0.341	0.0	0.0	0.156	0.0
Aluminum	0.819	0.819	0.814	0.676	0.423	0.01	0.652
Copper and Copper Base Alloys	0.0059	0.0059	0.121	0.096	0.073	0.056	0.142
Magnesium	0.0	0.0	0.0	0.024	0.0	0.0	0.0
Cobalt	0.029	0.029	0.0	0.0	0.0	0.0	0.0

a. Materials input coefficient = $\frac{\text{Pounds of material per unit engine}}{\text{Pounds of engine dry weight}}$.

Table 6

Gross Materials Requirements for Production of Soviet Airframes
1953

Model	Airframes Produced (Units)	Airframes Produced including Spares (Pounds)	Low-Carbon Steel (Metric Tons)	Alloy Steel, Not including Stainless Steel (Metric Tons)	Stainless Steel (Metric Tons)	Aluminum (Metric Tons)	Copper and Copper Base Alloys (Metric Tons)	Magnesium (Metric Tons)	Lead (Metric Tons)	Rubber (Metric Tons)	Glass and Plastics (Metric Tons)
Fighter											
MIG-15 or Variant	3,980	30,580,000	666	11,500	108	10,300	777	45.8	94.3	187	270
Bomber											
Il-28	1,008	18,600,000	354	6,090	57.4	10,600	371	32.9	16.9	523	59.0
Type 35	384	7,200,000	137	2,360	22.2	4,120	144	12.7	6.5	202	22.9
Tu-4	312	16,234,000	199	3,500	32.4	8,320	243	22.8	7.4	250	140
Transport											
An-2	132	558,000	8.6	152	1.4	256	9.4	0.0	1.2	2.2	3.3
Il-12	70	1,406,000	16.0	271	2.6	863	23.6	14.0	16.0	31.3	8.3
Li-2	135	2,318,000	28.4	494	4.6	923	24.2	12.6	3.2	30.5	13.7
Yak-6	324	723,000	18.0	312	2.9	214	22.6	0.0	1.0	9.5	4.3
Yak-8	240	723,000	18.0	312	2.9	214	22.6	0.0	1.0	9.5	4.3
Yak-12	240	240,000	3.7	65.2	0.6	110	4.0	0.0	0.5	0.9	1.4
Yak-16	192	1,446,000	15.1	267	2.5	715	26.9	7.9	2.0	19.0	8.5
Trainer											
Yak-11	312	987,000	11.2	190	1.8	640	13.4	8.1	0.0	11.2	7.2
Yak-18	1,416	1,499,000	23.1	394	3.6	721	27.9	0.0	3.2	6.0	8.8
Reconnaissance											
Type 33	133	843,000	5.0	154	0.8	478	7.3	0.0	1.9	15.3	8.8
Type 34	44	1,127,000	6.6	111	1.0	608	8.7	0.0	2.6	20.4	11.8
Rotary Wing											
Type 36	55	324,000	14.8	256	2.4	154	10.7	46.6	0.0	1.8	3.5
Glider											
Type 24	360	2,886,000	35.3	600	5.6	1,530	38.0	0.0	4.4	8.5	12.8
Total	9,337	87,694,000	1,560	27,000	253	40,800	1,770	203	162	1,330	589

Table 7

Gross Materials Requirements of the Soviet Airframe Industry
1953 Production and 1954-56 Capacity

Metric Tons

Input	1953 Production	Capacity Production 1954	1955	1956
Low-Carbon Steel	1,560	3,280	5,900	7,020
Alloy Steel (Not including Stainless Steel)	27,000	56,600	102,000	121,000
Stainless Steel	253	532	955	1,140
Aluminum	40,800	87,900	155,000	186,000
Copper and Copper Base Alloys	1,770	3,700	6,650	7,960
Magnesium	203	469	863	1,090
Lead	162	444	823	1,060
Rubber	1,330	2,980	5,200	6,240
Glass and Plastics	589	1,250	2,250	2,690

2. Aircraft Engines.

The estimate of gross material inputs given in Table 8* for each type of aircraft engine was obtained by multiplying the coefficients of Table 5** by the pounds of engines produced. The estimate of aircraft engine production 32/ was based on the number of engines required to support the current production of aircraft, the assumption being that 125 percent spare engines are required for each engine installed in an aircraft. Since the production of aircraft engines was estimated by this method and not by an estimate of the production of each engine plant, no estimate of the materials required by individual plants was made.

---

* Table 8 follows on p. 24.
** P. 20, above.

[p. 22 blank]

Table 8

Gross Materials Requirements for Production of Soviet Aircraft Engines
1953

		Type of Aircraft Engine							
		Jet		Reciprocating					
Input	Unit	VK-1 (Improved)	VK-1	ASH-90	ASH-82	ASH-62	ASH-21	M-11	Total
Engines Produced	Units	601	15,219	2,808	513	1,031	1,863	6,264	27,698
Dry Weight Engines Produced	Pounds	1,208,000	30,100,000	8,310,000	1,020,000	1,230,000	2,010,000	2,690,000	45,400,000
Low-Carbon Steel	Metric Tons	115	2,880	584	45.4	759	192	2,650	7,110
Alloy Steel (Not including Stainless Steel)	Metric Tons	251	6,290	9,650	1,040	1,040	2,130	1,680	22,200
Stainless Steel	Metric Tons	554	13,800	1,290	0	0	142	0	15,200
Aluminum	Metric Tons	449	11,200	3,070	313	236	921	795	16,500
Copper and Copper Base Alloys	Metric Tons	3.2	80.8	456	44.4	40.7	51.1	173	846
Magnesium	Metric Tons	0	0	0	11.1	0	0	0	11.1
Cobalt	Metric Tons	1.6	396	0	0	0	0	0	396

As the production of aircraft engines has been estimated from the number of aircraft, the number of engines at capacity production will increase over the number at 1953 production by the same percentage that the aircraft increase, assuming that the product mix of aircraft remains constant. If the further assumption is made that the product mix of engines will remain the same, the materials requirements for capacity production may be estimated by multiplying the materials inputs for 1953 production by the percentage increase in number of aircraft; that is, increasing the current materials inputs by 2.12, 3.78, and 4.53 gives the materials requirements at capacity production for 1954, 1955, and 1956, respectively. The gross materials requirements for the number of aircraft engines to support 1953 production and 1954-56 capacity production of aircraft are given in Table 9.

Table 9

Gross Materials Requirements of the Soviet Aircraft Engine Industry
1953 Production and 1954-56 Capacity

Metric Tons

Input	1953 Production	Capacity Production 1954	1955	1956
Low-Carbon Steel	7,110	15,100	26,900	32,200
Alloy Steel (Not including Stainless Steel)	22,200	47,100	84,000	101,000
Stainless Steel	15,200	32,200	57,400	68,900
Aluminum	16,500	35,000	62,400	74,800
Copper and Copper Base Alloys	846	1,790	3,200	3,830
Magnesium	11.1	23.5	41.2	50.3
Cobalt	396	840	1,500	1,790

3. Summary.

The gross materials requirements for both Soviet airframe and aircraft engine production are summarized in Table 10.

Table 10

Gross Materials Requirements of the Soviet Airframe and Aircraft Engine Industries
1953 Production and 1954-56 Capacity

Metric Tons

Input	1953 Production	Capacity Production 1954	Capacity Production 1955	Capacity Production 1956
Low-Carbon Steel	8,670	18,400	32,800	39,200
Alloy Steel (Not including Stainless Steel)	49,200	103,000	186,000	222,000
Stainless Steel	15,500	32,700	58,400	70,000
Aluminum	57,300	123,000	217,000	261,000
Copper and Copper Base Alloys	2,620	5,690	9,850	11,800
Magnesium	214	493	904	1,140
Lead	162	444	823	1,060
Rubber	1,330	2,980	5,200	6,240
Glass and Plastics	589	1,250	2,250	2,690
Cobalt	396	840	1,500	1,790

III. Labor.*

A. Characteristics of Soviet Plants.

Essential to any analysis of the capabilities of a production facility is a thorough understanding of the efficiency of the labor employed and the scale of effort currently being expended on the production effort. The efficiency of labor normally means the productivity of a unit of labor in terms of the pounds of finished product produced as compared to some standard productivity to be expected. This efficiency as normally measured in terms of the pounds per

---

* The discussion of the labor force in the Soviet aircraft industry is based primarily upon a study of the airframe plants although some of the general conclusions doubtless apply to the aircraft engine plants as well.

man-hour produced can be compared either to recognized "standard" hours established for each type of operation or can be compared to the average pounds per man-hour of an equivalent industry. The measure of labor efficiency in this report is taken to be the average pounds produced per man-hour in the US aircraft industry in 1944. This standard has been accepted, since such an average can be computed from available statistics on US aircraft production during World War II.

The over-all efficiency of labor in an aircraft industry is affected by many different factors, which should be noted for the purpose of full comprehension of the significance of the labor input requirements of the Soviet aircraft industry. These factors can be summarized as follows:

1. The size of plants.
2. The number and types of machine tools.
3. The fabrication techniques.
4. The organization and management.
5. The quality of aircraft design.
6. The number and quality of available workers.
7. The density of labor in the plant.
8. The hours per week worked by each employee.

To summarize briefly the conditions in the Soviet aircraft plants pertaining to these factors, it can be said that Soviet plants are generally considerably smaller than US plants, ranging in size from 0.5 million square feet to 2 million square feet, whereas many US plants comprise as much as 5 million square feet. In like manner, analysis of Soviet aircraft reveals that Soviet industry does not utilize equivalent modern special-purpose machine tools found in US plants and depends more upon hand fabrication and standard machine tools. There is evidence, however, that Soviet airframe and aircraft engine designs are comparable to US standards. The design philosophy in the USSR differs from that of the US. Soviet aircraft design is determined by the functional requirements, the size and type of production facilities, the availability of materials, the desire for a high production rate, and the availability of a large supply of unskilled labor, whereas in the US design would be primarily a consideration of the functional requirements. The management of Soviet plants is considered excellent. Soviet plants have been producing for at least 15 years and are characterized as self-sufficient, self-contained units comparatively isolated from other plants because of inadequate transportation facilities. The organization of all plants is a standard organization established by the Ministry of Aviation Industry, which also established standard worker norms for the man-hours required to produce a given part. 33/

B. Types of Labor Required.

1. Skilled.

The labor force of the Soviet aircraft industry consists of a large supply of unskilled labor, which leads to the practice of greater reliance on hand fabrication than would be found in US plants. Since all Soviet aircraft plants are classed as defense plants, very few transfers of personnel are permitted from one plant to another. The inexperienced laborer thus becomes the only source of labor supply. Only 20 percent of the foremen in a plant are graduates of technical schools sponsored by the Ministry of Aviation Industry. At least 90 percent of the workers work on a piecework system and are categorized as follows:

Category 1.	Unskilled.
Category 2.	Laborers.
Category 3.	Laborers with some experience.
Category 4.	Persons who can maintain work without continuous supervision but not completely qualified.
Category 5.	Persons completely qualified.
Category 6.	Qualified persons with outstanding ability.
Category 7.	Specialized, highly qualified.
Category 8.	Specialized, requiring high degree of training. Usually inspectors and machine set-up men. 34/

The largest percent of direct workers belong to Categories 2 through 6, with a very small percentage in Categories 7 and 8. The percentage distribution of direct workers by principal categories in the shops is as follows:

Percent

Shop	Category 2	Category 3	Category 4	Category 5	Category 6	Category 7
Flight Test	0	0	25	25	35	15
Assembly	20	20	20	30	10	0
Riveting Assembly	25	30	20	15	5	0
Fitting and Welding	10	23	35	20	10	2
Sheet Metal	15	20	20	30	10	0
Machine	10	30	30	18	10	2.5 to 5

Workers in Categories 2 and 3 are primarily apprentices in machine shops or in simple assemblies and comprise 35 percent of the direct workers. Categories 4 and 5 comprise workers who have apprentices working for them in the riveting assembly, sheet metal, and assembly shops or who perform simple operations in the machine shop. This group comprises about 48 percent of the direct labor. Thus from 80 to 90 percent of all direct workers belong to Categories 2 through 5. Category 1 normally includes common laborers who are not working directly on aircraft production.

By US standards, the difference between skilled and unskilled labor is primarily determined by the prevailing wage each laborer receives and in turn is normally determined by the experience of the laborer on the job. In effect, the required experience to permit a laborer to draw a skilled laborer's wage is equivalent to successful completion of apprenticeship on the job. If this definition of skilled and unskilled labor is applied to the categories given above, the unskilled laborers would comprise Categories 1 through 4. Taking Categories 5 through 8 as skilled, the percentage of skilled laborers in the 6 shops listed above is 40 percent. The conclusion is that, in Soviet airframe plants, the skilled labor force comprises 40 percent of the total direct labor force.

The skilled labor force of a representative US aircraft plant comprised 87 percent of the direct labor, 68 percent of the indirect labor, and 80 percent of the total labor force. 35/ Assuming that the same relationship of skilled indirect labor to skilled direct labor exists in Soviet aircraft plants as existed in the US plant, the Soviet skilled indirect labor comprises 31 percent of the total indirect labor force.

Assuming that 50 percent of the total labor in Soviet aircraft plants is direct labor, the skilled labor force comprises 35 percent of the total labor force in Soviet plants.

2. Direct.

Soviet airframe plants are roughly comparable to US airframe branch plants, since many functions performed by the parent plant in the US are normally performed in Moscow for the entire Soviet serial production airframe industry. Such functions include engineering, contract administration, procurement, tool design, research and technological development, and experimental production. 36/ Since these functions are performed by indirect labor, the ratio of direct labor to total labor in Soviet airframe plants would tend to be higher than in the US airframe industry. The ratio of direct workers in US airframe branch plants, however, should be comparable to that of Soviet plants. During World War II, in US airframe branch plants subcontracting less than 50 percent, 53 percent of the total labor was direct labor. 37/ (See Table 11.*)

Other factors, however, suggest that a more complex organizational structure exists in Soviet plants than in US airframe branch plants. Indications of this complexity are that each department has its group devoted to timekeeping, bookkeeping, technical control, inspection, time study, production control, and other groups in addition to a centralized department devoted to these functions. In addition, the following sections appear to have a more complex organization than would be found in a US airframe branch plant:

---

* Table 11 follows on p. 31.

Table 11

Ratio of Direct Labor to Total Labor in US Airframe Branch Plants during World War II

US Airframe Branch Plants	Direct Labor as an Average Percent of Total Labor
Bell Aircraft Corporation, Marietta, Georgia	42.9
Boeing Airplane Company, Inc., Wichita, Kansas	52.6
Consolidated Vultee Aircraft Corporation, Downey, California	62.7
Consolidated Vultee Aircraft Corporation, Fort Worth, Texas	57.6
Consolidated Vultee Aircraft Corporation, Nashville, Tennessee	44.4
Consolidated Vultee Aircraft Corporation, Wayne, Michigan	44.4
Curtiss-Wright Corporation, Buffalo, New York	52.6
Curtiss-Wright Corporation, St. Louis, Missouri	56.0
Douglas Aircraft Company, Inc., Chicago, Illinois	52.1
Douglas Aircraft Company, Inc., Long Beach, California	59.0
Douglas Aircraft Company, Inc., Oklahoma City, Oklahoma	51.4
North American Aviation, Inc., Dallas, Texas	59.4
North American Aviation, Inc., Kansas City, Kansas	52.4
Average	52.9

a. Air and Chemical Attack Defense Section.
b. Plant Secret Section.
c. Plant Internal Security Section.
d. Workers Training Section.
e. Workers Supply Section.
f. Workers Housing Section.
g. Transport Section.
h. Storage Section.

The Soviet plant organization also includes political functions which have no counterpart in US plants. These functions include the Plant Komsomol Committee and the Communist Party Committee.

If Soviet plants are considered roughly comparable to US airframe branch plants, and a ratio of 0.53 for direct to total workers therefore will apply, then the other considerations given above would tend to lower this ratio. For the purpose of this report, a ratio of 0.50 for direct to total workers in Soviet airframe plants is assumed.

No constant ratio of direct to total employees existed, however, in the US airframe branch plants listed in Table 11. The ratio of direct to total employees varied from month to month. Eight of the 13 plants started with a ratio higher than the average of 0.53, and 9 of the plants ended with a ratio higher than the average. In these 13 US plants, the average range of the ratio of direct to total employees was 0.39 to 0.67. For a period of 12 months, however, an average figure should give fair results.

3. Managerial.

In an effort to determine what percentage of the total labor force is engaged in management and administration, a study of organization charts 38/ which are understood to apply to the airframe industry rather than to a particular plant was undertaken. Using the departments on which the source gave employment figures, the conclusion was reached that management personnel comprised 20 percent of the total labor force. The term "management personnel" as used in this report is synonymous with administrative personnel and includes all personnel whose activities are concerned with the initiation of an enterprise; the establishment of major policies; the provision of necessary equipment; the actual work of executing the objectives for which the plant has been organized; the issuance of orders concerning the work to be done; seeing that the personnel are fitted for the work and trained to operate efficiently; and caring in general for the everyday routine necessary to insure that men, materials, and equipment are working toward the desired end. A management force comprising 20 percent of the total labor force is high in comparison to US airframe branch plants, but this figure is considered reasonable for Soviet plants because of the more complex organization structure, the duplication of effort, and the fear psychology which pervades the industry.

4. Technical.

Further examination of the organization charts 39/ revealed that 18 percent of the total labor force was technical personnel. The term "technical personnel" as used in this report comprises professional men, designers, and draftsmen. The percentage of technical personnel in Soviet aircraft plants is about twice that of US aircraft plants which may result from the following factors:

a. The Soviet classification of technologists may include laboratory technicians.
b. Soviet plants do their own foundry and forge work; hence, they require more metallurgists than US plants.
c. Soviet plants do their own construction requiring the use of civil engineers.
d. Greater duplication of technical functions exists in Soviet plants than in US plants.

C. Worker Density.

Examination of a captured MIG-15 indicates that shop methods in Soviet aircraft plants making the MIG-15 closely parallel the methods used during World War II in US fighter plants. 40/ If the Soviet shop methods are similar to those of the US during World War II, then average floor space per worker should be equal in both countries. A short supply of machine tools in Soviet airframe plants, however, is assumed. 41/ The assumption therefore is made that because of the shortage of machine tools and the evidence of more hand work, the average floor space per worker would be less in the Soviet airframe industry than in that of the US.

A study was made of the relationship between floor space per worker and airframe weight of the aircraft being produced in US plants during World War II. No consistent relationship could be determined, although there was a slight indication of larger floor space per worker for heavier airframes.

Because no consistent relationship between worker density and airframe weight could be determined and the shop methods used in the fabrication and assembly of the MIG-15 are similar to those used in the manufacture of the P-51, it was assumed that the floor space per worker in a US branch plant making the P-51 would approximate Soviet worker density. A study was made of the North American Aviation, Inc. branch plant in Dallas, Texas. The average density over a period of 43 months was 135.6 square feet per total worker, whereas the average density was 72.4 square feet per total worker for the 18 most dense months. 42/ This density of 72.4 square feet is considered to be representative of Soviet plants. Storage facilities in Soviet airframe plants are estimated to occupy 3 percent more area than in US branch plants. 43/ Therefore, the value of 72.4 square feet per total worker was increased by 3 percent to account for the larger storage area of the Soviet plants. The adjusted value of 75.0 square feet per total worker is assumed to be the worker density for Soviet airframe plants.

Applying the shift factors of 100:70:50 44/ the following densities are obtained:

Number of Shifts	Density (Square Feet of Floor Area per Total Worker)
1	165.0
2	127.5
3	75.0

No constant worker density, however, exists in US airframe plants. At the beginning of production of a new model, the floor space per worker is large. As production accelerates and more people are employed, the floor space per worker decreases until a peak-employment is reached, generally around the 18th month. If production is held constant, labor requirements will decline in direct proportion to the learning process, and the floor area per worker will begin to increase. It is believed that in Soviet airframe plants, the workers would not be laid off as the labor requirements decline; instead, the workers would be used to manufacture consumer goods.

D. Labor Requirements.

1. Airframes.

Using the factors developed above, the labor requirements of each Soviet airframe plant were estimated. These labor requirements are presented in Appendix A. The labor requirements for the Soviet airframe industry are summarized in Table 12.

Table 12

Labor Requirements of the Soviet Airframe Industry
1953 Production and 1956 Capacity

Thousands of Workers

Type of Labor	1953 Production	1956 Capacity
Direct	86	201
Indirect	86	201
Total a/	172	402
Skilled	60	141
Unskilled	112	261
Total a/	172	402
Managerial b/	34	80
Technical b/	31	72

a. The categories direct and indirect and the categories skilled and unskilled represent different breakdowns of the same total.

b. For the explanations of these headings see pp. 32-33, above.

2. Aircraft Engines.

No employment study has been made of the Soviet aircraft engine industry. However, if the assumption is made that the ratio of total employment in the aircraft engine industry to total employment in the airframe industry is the same in the USSR as in the US, a total employment figure for the Soviet aircraft engine industry may be estimated. The US aircraft engine industry has employed an average of 30.6 percent as many workers as the airframe industry during 1947-52. 45/ Using this ratio and the same factors for direct, indirect, skilled, unskilled, technical, and management categories for the aircraft engine industry as were used for the airframe industry, the labor figures for the aircraft engine industry presented in Table 13 were estimated.

Table 13

Labor Requirements of the Soviet Aircraft Engine Industry
1953 Production and 1956 Capacity

Thousands of Workers

Type of Labor	1953 Production	1956 Capacity
Direct	26.5	61.5
Indirect	26.5	61.5
Total a/	53.0	123.0
Skilled	19.0	43.0
Unskilled	34.0	80.0
Total a/	53.0	123.0
Managerial b/	11.0	25.0
Technical b/	10.0	22.0

---

a. The categories direct and indirect and the categories skilled and unskilled represent different breakdowns of the same total.

b. For the explanation of these headings, see pp. 32-33, above.

3. Summary.

The labor requirements for the Soviet airframe and aircraft engine industries are summarized in Table 14.

Table 14

Labor Requirements of the Soviet Airframe
and Aircraft Engine Industries
1953 Production and 1956 Capacity

Thousands of Workers

Type of Labor	1953 Production	1956 Capacity
Direct	112.5	262.5
Indirect	112.5	262.5
Total a/	225.0	525.0
Skilled	79.0	184.0
Unskilled	146.0	341.0
Total a/	225.0	525.0
Managerial b/	45.0	105.0
Technical b/	41.0	94.0

a. The categories direct and indirect and the categories skilled and unskilled represent different breakdowns of the same total.
b. For the expanation of these headings, see pp. 32-33, above.

An indication of labor efficiency in the Soviet aircraft industry may be obtained by using the current direct labor figure of 86,000 workers estimated above and the current on-site production estimate of 6,380,000 pounds of airframe per month. 46/ Using the factor of 48 work-hours per Soviet worker per week, 47/ a Soviet labor productivity of 0.361 pounds per direct man-hour is obtained. In May 1944, the US peak labor productivity month, the employment in the US airframe industry was 368,858 direct workers who worked an average of 45.8 hours per week, and the on-site production was 68,450,000 pounds of airframe. 48/ Thus the US produced 0.943 pounds per direct man-hour during the month of peak labor productivity. Using these labor productivity factors, the current Soviet labor productivity is 38 percent of the 1944 US labor productivity in airframe plants.

The US, however, produced 80 airframes per million square feet of floor area in May 1944, and the current Soviet monthly production is 25.9 airframes per million square feet of floor area. It is obviously unfair to establish an efficiency that does not account for the variation in the scale of production undertaken. In the production of aircraft the cost of labor in man-hours per pound of product decreases as production increases. In the US this variation in man-hours per pound with quantity usually followed very closely an 80-percent learning curve. In simple terms, the 80-percent learning curve means that each time the quantity produced is doubled, the unit of labor involved in production will drop to 80 percent of the amount required in the original quantity. Using the 80-percent curve with rate of output as a base, the Soviet labor productivity is found to be 0.524 direct man-hours per pound at the rate of 80 airframes per month. Hence, the Soviet labor productivity is 56 percent of the 1944 US labor productivity.

In conclusion, it may be said that the labor force of the Soviet aircraft industry is less efficient and less skilled than the labor force of the US aircraft industry.

IV. Electrical Energy.

A. Scope.

An estimate of the total amount of electrical energy required by the Soviet aircraft industry is made in this report, and no attempt is made to estimate the percentage generated within individual plants.

B. Method of Estimating Electrical Energy Inputs.

The Soviet airframe plants probably use less electrical energy than the average US airframe plant. This assumption is based upon the indications that the Soviet airframe plants have a shortage of machine tools and with few exceptions can count only on standard machine tools smaller in size and capacity than the machine tools in the average US plant. 49/

Data on electrical energy consumption were obtained from 10 US airframe plants. In order to obtain an electrical energy input coefficient for Soviet airframe plants, the data for the US plant producing bombers with the lowest consumption of electrical energy per square foot of floor area were used together with the data for the lowest consumer of electrical energy among the fighter plants. The average electrical energy consumption of these 2 plants was 8.95 kilowatt-hours per square foot per year for 1 shift. Using the Soviet shift factors of 100:70:50, the following factors were determined for use in determining electrical energy consumption in Soviet airframe plants:

Scale of Effort	Electrical Input Factor (Kilowatt-Hours per Square Foot per Year)
0.45	8.95
0.77	15.21
1.00	19.69

These electrical consumption factors may be considered the minimum for Soviet airframe plants. The average electrical consumption of the 10 US plants was 14.5 kilowatt-hours per square foot of floor area per year for 1 shift or 1.62 times the average of the 2 lowest plants. Hence the electrical energy consumption of the Soviet airframe plants could conceivably be 1.62 times the amount estimated.

Although a shortage of machine tools has been assumed for the Soviet airframe industry, the indications are that the engine plants employ fabrication methods similar to those used in the US. 50/ If the aircraft engine fabrication methods are the same in the USSR as in the US, it can be assumed that the electrical energy consumption of the Soviet aircraft engine industry is equal to the consumption of the US aircraft engine industry.

Data were available for the electrical energy consumption of five US aircraft engine plants during World War II. The average consumption of these 5 plants was 40.4 kilowatt-hours per square foot per year at capacity. Therefore, this factor is used for the Soviet aircraft engine plants when operating at a 100 percent capacity. None of these five plants produced any jet engines. This average consumption figure is considered a minimum figure, since there are indications that a plant producing jet engines uses more electrical energy than a plant manufacturing reciprocating engines. 51/

C. Electrical Energy Requirements.

Using the consumption figures determined above, the electrical energy requirements were determined for each Soviet airframe plant for 1953 and capacity conditions. The results are presented in Appendix A. The requirements for the industry are presented in Table 15. These requirements are based upon the existing floor area. However, under capacity conditions, the floor area would probably be increased.

Table 15

Electrical Energy Requirements of the Soviet Airframe and Aircraft Engine Industries
1953 Production and 1954-56 Capacity

Million Kilowatt-Hours

	Electrical Energy Requirements		
Year Production	Airframe Industry	Aircraft Engine Industry	Total
1953	254	165	419
1954 (Capacity)	593	338	931
1955 (Capacity)	593	604	1,200
1956 (Capacity)	593	719	1,310

The requirements of the Soviet aircraft engine industry are also presented in Table 15 for both current and capacity conditions. Using the aircraft engine methodology developed by CIA and assuming no subcontracting, the aircraft engine industry would be operating at a 23-percent scale of effort in order to support the current production of airframes. The scales of effort required to support capacity production of airframes in 1954, 1955, and 1956 are 47 percent, 84 percent, and 100 percent, respectively. The above scales of effort multiplied by the electrical energy consumption factor determined above for aircraft engine plants were used to determine the electrical energy requirements for the aircraft engine industry.

V. Fuel and Lubricants.

A. Scope.

In addition to materials, manpower, and electrical energy, other important inputs of the aircraft industry are coal, required for heating plants, and lubricants used for machinery-lubricating oils and grease and for cutting oils.

No estimate is made of the amount of coal that might be used in generating electrical power. Therefore, the estimate of the coal requirement may be considered the minimum amount of coal required. No estimate has been made of the amount of fuel and lubricants used in testing the aircraft and aircraft engines. The amount of fuel and lubricants used in testing at the plant is insignificant in comparison to that used for civil and military purposes.

B. Method of Determining Coal Input for Heating.

The heat-emitting devices of a heating plant for a factory should be capable of delivering a quantity of heat sufficient to replace that transmitted through the structure and of heating the air which enters plus an allowance for exposure to winds. The heater should be able to supply the demands of the heat-emitting devices, service water heating, and other loads, plus an allowance for heat losses from piping and ducts and for warming up from a cold start. In general, heat is not required when the mean temperature for a 24-hour period reaches 65°F. When this temperature is used as a base, each degree that the mean daily temperature is below 65°F is a degree-day unit. As an example, a mean temperature of 25°F is 40 degree-day units per day. The daily degree-day units are added for monthly and yearly totals. Fuel consumption per square foot of radiation is approximately proportional to the number of degree-day units.

The assumption is made that the coal consumption per square foot of Soviet aircraft plants is equal to the following ratio:

$$\begin{array}{c}\text{Coal consumption per square foot}\\ \text{of US plant}\end{array} \times \frac{\text{Degree-day units of Soviet plant}}{\text{Degree-day units of US plant}}$$

Fuel consumption data were obtained from 10 US plants, but the only aircraft plant using coal for heating was the McDonnell Aircraft Corporation in St. Louis, Missouri. This plant consumed an average of 23.3 pounds of coal per square foot per year while working two shifts during 1951 and 1952. St. Louis, Missouri has 4,602 degree-day units per year. 52/ The assumption was made that the same amount of coal was consumed on each of the shifts worked and that one-third of the amount required for a work shift was required for an idle shift. Hence the following consumption factors were determined for an aircraft plant in a locality having 4,602 degree-day unts per year:

Number of Shifts Worked	Pounds of Coal Consumed per Square Foot per Year
1	16.7
2	23.3
3	30.0

The above factors together with the yearly degree-day units for the Soviet plants were used to determine the amount of coal required by the Soviet airframe industry on the basis of a 6-day work week. The aircraft engine plants would have to work only 1 shift 5 days a week in 1957 to meet airframe production requirements. A plant in a locality having 4,602 degree-day units and working on a basis of 1 shift 5 days a week would consume 14.8 pounds of coal per square foot per year.

A study of the coal consumption of individual plants in the aircraft engine industry was not made. Instead, the ratio of the total engine floor area to the total airframe floor area multiplied by the amount of coal used by the airframe industry at capacity was used to determine the 1956 aircraft engine industry requirements, at which time the aircraft engine plants would be on 3 shifts 6 days a week. The scale of effort for the aircraft engine plants in 1953 corresponds to 1 shift 5 days a week: therefore, the aircraft engine plants would use 49.3 percent of the amount of coal used in 1956. In 1954 the aircraft engine plants would be on 1 shift for 6 days a week and would use 55.7 percent of the 1956 requirements. In 1955 the aircraft engine plants would use 77.7 percent of the 1956 requirements.

C. Method of Determining Lubricating Inputs.

Of the 10 US plants submitting data on the consumption of electrical energy, of fuels, and of lubricants only 2 plants submitted data on the consumption of lubricating oils. These two plants were the Republic Aviation Corporation and Northrop Aircraft, Inc. In addition, Republic furnished data on lubricating grease and Northrop supplied data on cutting oils. From these data, the following factors were determined:

Scale of Effort (Percent)	Lubricating Grease (Pounds per Square Foot per Year)	Lubricating Oil (Gallons per Square Foot per Year)	Cutting Oil (Gallons per Square Foot per Year)
0.45	0.00313	0.0106	0.00392
0.77	0.00532	0.0180	0.00666
1.00	0.00688	0.0233	0.00862

The lubricant inputs of the Soviet aircraft engine industry are based upon the airframe industries' consumption of these inputs. The manufacture of an aircraft engine involves more machine work than does the manufacture of an airframe: therefore, an aircraft engine plant should use more lubricants per square foot than an airframe plant if both are working at the same capacity. The amount of electrical energy consumed per square foot may be used to indicate the amount of machine work. Assuming that the ratio of the consumption of lubricants per square foot of floor area of an aircraft engine plant to an airframe plant is approximately equal to the ratio of electrical energy consumption per square foot, aircraft engine plants consume 2.05 times the lubricants consumed per square foot by airframe plants. The consumption factors for lubricants for aircraft engine plants at 100-percent scale of effort is assumed to be as follows:

Lubricating Grease	0.0141 pounds per square foot per year
Lubricating Oil	0.0478 gallons per square foot per year
Cutting Oil	0.0177 gallons per square foot per year

D. Fuel and Lubricants Requirements.

The amount of fuel and lubricants required by the Soviet airframe and aircraft engine industries was estimated by the above consumption factors. The requirements of these inputs for each airframe plant are presented in Appendix A. The coal and lubricants requirements for the airframe and aircraft engine industries are summarized in Table 16.*

VI. Transportation.

A. Scope.

Transportation inputs are discussed in terms of the total tonnage of transportation required to support the production of each plant and to distribute the final product to its ultimate destination.

B. Method of Estimating Tonnage to Be Transported.

1. Airframes.

The weight of components required for each aircraft was estimated by subtracting the AMPR airframe weight plus the aircraft engine dry weight from the empty weight of the aircraft. The amount of scrap was determined by subtracting the pounds of airframe produced from the raw materials required. The assumption was made that only the MIG-15, the Type 38, the Type 24, the Yak-11, and the Yak-18 aircraft would be crated and shipped from the plant; all other aircraft are assumed to be flown away.

2. Aircraft Engines.

The weight of components required to be transported to aircraft engine plants was assumed to be 2 percent of the total weight of aircraft engines produced. The amount of scrap was determined by subtracting the pounds of engines produced from the amount of raw materials required.

---

* Table 16 follows on p. 45.

Table 16

Fuel and Lubricants Requirements of the Soviet Airframe and Aircraft Engine Industries
1953 Production and 1954-56 Capacity

		Amount											
					Capacity								
		1953			1954			1955			1956		
Input	Unit	Airframes	Aircraft Engines	Total	Airframes	Aircraft Engines	Total	Airframes	Aircraft Engines	Total	Airframes	Aircraft Engines	Total
Coal	Metric Tons	462,000	234,000	696,000	807,000	264,000	1,071,000	807,000	368,000	1,175,000	807,000	474,000	1,281,000
Lubricating Grease	Metric Tons	40	26.2	66.2	94	53.5	147.5	94	95.6	190	94	114	208
Lubricating Oil	Gallons	399,000	196,000	595,000	702,000	400,000	1,102,000	702,000	715,000	1,417,000	702,000	851,000	1,553,000
Cutting Oil	Gallons	115,000	72,400	187,000	260,000	148,000	408,000	260,000	265,000	525,000	260,000	315,000	575,000

C. Tonnage of Transportation Required.

1. Airframes

The tonnage of transportation required by each individual airframe plant is presented in Appendix A. The total tonnage of transportation required by the airframe industry is summarized in Table 17.

Table 17

Transportation Requirements of the Soviet Airframe Industry
1953 Production and 1954-56 Capacity

Metric Tons

	Products Transported to Plants					Products Transported from Plants		
Production	Engines	Components	Raw Materials	Fuel	Lubricants	Aircraft	Spare Parts	Scrap
1953	9,160	5,160	73,700	462,000	1,790	17,900	6,400	34,100
1954 (Capacity)	19,400	10,900	157,000	807,000	3,364	37,900	14,300	72,400
1955 (Capacity)	34,600	19,500	280,000	807,000	3,364	67,600	25,500	131,000
1956 (Capacity)	41,500	23,400	334,000	807,000	3,364	81,000	30,500	155,000

2. Aircraft Engines.

The tonnage of transportation required by the aircraft engine industry is summarized in Table 18.*

VII. Conclusions.

The conclusions that may be drawn from this report are as follows:

1. The USSR uses less critical materials per pound of airframe and aircraft engine weight than does the US.

---

* Table 18 follows on p. 47.

Table 18

Transportation Requirements of the Soviet Aircraft Engine Industry
1953 Production and 1954-56 Capacity

Metric Tons

					Products Transported from Plants		
	Products Transported to Plants						
Production	Components	Raw Materials	Fuel	Lubricants	Engines Shipped to Airframe Plants	Spares	Scrap
1953	412	61,900	234,000	939	9,160	11,400	41,300
1954 (Capacity)	874	131,000	264,000	1,920	19,400	24,300	87,300
1955 (Capacity)	1,560	234,000	368,000	3,430	34,600	43,200	156,000
1956 (Capacity)	1,870	281,000	474,000	4,090	41,500	51,800	188,000

2. The USSR will try to conserve critical elements such as nickel, columbium, cobalt, zinc, molybdenum, and copper in the manufacture of airframes and aircraft engines. In conserving these elements, the Russians will not lower the quality of any material that can exert a significant bearing on the operational performance of the aircraft.

3. There has been very limited use of magnesium in Soviet aircraft as compared with equivalent US types.

4. The ratio of steel to aluminum in Soviet aircraft can be expected to remain high in comparison to US aircraft.

5. The ratios of unskilled to skilled workers and managerial to production workers are higher in the Soviet aircraft industry than in the US aircraft industry.

6. The Soviet labor productivity is lower than the US: therefore, the Russians require more labor than the US to produce a given number of aircraft in a stated floor area.

7. Soviet aircraft plants have a higher density of workers per square foot of floor area than do US aircraft plants.

APPENDIX A

PLANT STUDIES

The input requirements required by the individual Soviet airframe plants to support both current and capacity production are presented in this appendix. The inputs for capacity have been based on production estimates projected 3 years in advance of January 1954.

1. **Plant Number:** 1

2. **Plant Location:**

   a. Nearest City and Coordinates: Kuybyshev 53°13'N - 50°18'E

   b. Economic Region: VI

3. **Plant Area:** 1,790,000 square feet

4. **Scale of Effort:** 45 percent

5. **Production Data:**

   a. 1953 Production:

Model	Airframe Weight (Pounds)	Units per Year	Pounds per Year (including Spares)
Unknown	Unknown	Unknown	Unknown

   b. Capacity Production:

Year	Model	Units per Year	Pounds per Year (including Spares)
1954	AMPR weight under 20,000 pounds	Unknown	10,740,000
1955	AMPR weight under 20,000 pounds	Unknown	19,080,000
1956	AMPR weight under 20,000 pounds	Unknown	22,440,000

(P. 50 Blank)

6. Input Data:

a. Materials:

Yearly Gross Requirements
(Metric Tons)

	Type of Material								
Production	Low-Carbon Steel	Alloy Steel (Not including Stainless Steel)	Stainless Steel	Aluminum	Copper Copper Base Alloys	Magnesium	Lead	Rubber	Glass and Plastics
1953									
1954 Capacity	175	2,980	28.2	5,160	195	50.2	44.8	185	63.3
1955 Capacity	311	5,290	50.2	9,170	346	89.1	79.6	329	112
1956 Capacity	367	6,240	59.2	10,800	408	105	93.8	388	133

b. Manpower:

Manpower Requirements
(Man-Years)

Production	Total	Direct	Indirect	Skilled	Unskilled	Managerial	Technical
1953	10,850	5,425	5,425	3,800	7,050	2,170	1,950
1954 Capacity	23,900	11,950	11,950	8,360	15,540	4,780	4,300
1955 Capacity	23,900	11,950	11,950	8,360	15,540	4,780	4,300
1956 Capacity	23,900	11,950	11,950	8,360	15,540	4,780	4,300

c. Electrical Energy:

Source: Kuybyshev Heat and Power Plant, TETS (0165-0130)

Alternate Source: Unknown

Production	Electrical Energy Requirements (Kilowatt-Hours)
1953	16,000,000
1954 Capacity	35,200,000
1955 Capacity	35,200,000
1956 Capacity	35,200,000

d. Fuel and Lubricants:

	Fuel	Lubricants		
Production	Coal (Metric Tons)	Lube Grease (Metric Tons)	Lube Oil (Gallons)	Cutting Oils (Gallons)
1953	27,600	2.52	18,800	6,930
1954 Capacity	49,400	5.58	41,700	15,400
1955 Capacity	49,400	5.58	41,700	15,400
1956 Capacity	49,400	5.58	41,700	15,400

e. Transportation:

	Transportation Required (Metric Tons)							
	Products Transported to Plant					Products Transported from Plant		
Production	Engines	Components	Raw Materials	Fuel	Lubricants	Aircraft	Spare Parts	Scrap
1953	Unknown	Unknown	Unknown	27,600	90	Unknown	Unknown	Unknown
1954 Capacity	Unknown	Unknown	8,880	49,400	199.6	Unknown	Unknown	4,010
1955 Capacity	Unknown	Unknown	15,800	49,400	199.6	Unknown	Unknown	7,140
1956 Capacity	Unknown	Unknown	18,600	49,400	199.6	Unknown	Unknown	8,410

1. **Plant Number:** 18

2. **Plant Location:**

   a. Nearest City and Coordinates: Kuybyshev 53°18'N - 50°19'E

   b. Economic Region: VI

3. **Plant Area:** 1,790,000 square feet

4. **Scale of Effort:** 30 percent

5. **Production Data:**

   a. 1953 Production:

Model	Airframe Weight (Pounds)	Units per Year	Pounds per Year (including Spares)
Tu-4	48,114	108	5,724,000

   b. Capacity Production:

Year	Model	Units per Year	Pounds per Year (including Spares)
1954	Tu-4	178	9,300,000
1955	Tu-4	356	18,600,000
1956	Tu-4	424	22,200,000

6. Input Data:

a. Materials:

Yearly Gross Requirements
(Metric Tons)

	Type of Material								
Production	Low-Carbon Steel	Alloy Steel (Not including Stainless Steel)	Stainless Steel	Aluminum	Copper Copper Base Alloys	Magnesium	Lead	Rubber	Glass and Plastics
1953	70.1	1,230	10.4	2,930	85.7	8.0	2.6	88.2	49.3
1954 Capacity	114	2,000	18.6	4,770	139	13.1	4.2	143	80.2
1955 Capacity	228	4,010	37.1	9,540	278	26.2	8.4	287	160
1956 Capacity	272	4,780	44.3	11,400	332	31.2	10.1	342	191

b. Manpower:

Manpower Requirements
(Man-Years)

Production	Total	Direct	Indirect	Skilled	Unskilled	Managerial	Technical
1953	7,170	3,585	3,585	2,510	4,660	1,430	1,290
1954 Capacity	23,900	11,950	11,950	8,360	15,540	4,780	4,300
1955 Capacity	23,900	11,950	11,950	8,360	15,540	4,780	4,300
1956 Capacity	23,900	11,950	11,950	8,360	15,540	4,780	4,300

c. Electrical Energy:

Source: Kuybyshev Heat and Power Plant, TETS (0165-0130)

Alternate Source: Unknown

Production	Electrical Energy Requirements (Kilowatt-Hours)
1953	10,600,000
1954 Capacity	35,200,000
1955 Capacity	35,200,000
1956 Capacity	35,200,000

d. Fuel and Lubricants:

	Fuel	Lubricants		
Production	Coal (Metric Tons)	Lube Grease (Metric Tons)	Lube Oil (Gallons)	Cutting Oils (Gallons)
1953	27,600	1.68	12,500	4,620
1954 Capacity	49,400	5.58	41,700	15,400
1955 Capacity	49,400	5.58	41,700	15,400
1956 Capacity	49,400	5.58	41,700	15,400

e. Transportation:

	Transportation Required (Metric Tons)							
	Products Transported to Plant					Products Transported from Plant		
Production	Engines	Components	Raw Materials	Fuel	Lubricants	Aircraft	Spare Parts	Scrap
1953	580	502	4,474.3	27,600	59.9	0	208	1,874
1954 Capacity	956	827	7,282.1	49,400	199.6	0	338	3,062
1955 Capacity	1,911	1,654	14,324.5	49,400	199.6	0	675	5,884
1956 Capacity	2,280	1,970	17,402.6	49,400	199.6	0	806	7,333

1. **Plant Number:** 21

2. **Plant Location:**

   a. Nearest City and Coordinates: Gor'kiy 56°19'50"N - 43°51'50"E

   b. Economic Region: VII

3. **Plant Area:** 1,337,000 square feet

4. **Scale of Effort:** 45 percent

5. **Production Data:**

   a. 1953 Production:

Model	Airframe Weight (Pounds)	Units per Year	Pounds per Year (including Spares)
MIG-15 or Variant	6065 a/	605	5,240,000

a. Airframe weight of MIG-15 or variant is assumed to be 6,065 pounds, the average of the MIG-15 and Type 38.

   b. Capacity Production:

Year	Model	Units per Year	Pounds per Year (including Spares)
1954	MIG-15 or Variant	1,039	9,000,000
1955	MIG-15 or Variant	1,846	16,000,000
1956	MIG-15 or Variant	2,170	18,800,000

6. Input Data:

a. Materials:

Yearly Gross Requirements
(Metric Tons)

	Type of Material								
Production	Low-Carbon Steel	Alloy Steel (Not including Stainless Steel)	Stainless Steel	Aluminum	Copper Copper Base Alloys	Magnesium	Lead	Rubber	Glass and Plastics
1953	114	1,980	18.6	1,760	133	7.9	16.2	32.1	46.4
1954 Capacity	196	3,400	31.8	3,020	229	13.5	27.8	55.1	79.6
1955 Capacity	348	6,040	56.6	5,360	406	23.9	49.3	98.0	142
1956 Capacity	409	7,090	66.5	6,300	477	28.1	58.0	115	166

b. Manpower:

Manpower Requirements
(Man-Years)

Production	Total	Direct	Indirect	Skilled	Unskilled	Managerial	Technical
1953	8,100	4,050	4,050	2,840	5,260	1,620	1,460
1954 Capacity	17,830	8,915	8,915	6,230	11,600	3,570	3,210
1955 Capacity	17,830	8,915	8,915	6,230	11,600	3,570	3,210
1956 Capacity	17,830	8,915	8,915	6,230	11,600	3,570	3,210

c. Electrical Energy:

Source: Outside, probably Balakhna Power Station

Alternate Source: City Power Station

Production	Electrical Energy Requirements (Kilowatt-Hours)
1953	12,000,000
1954 Capacity	26,300,000
1955 Capacity	26,300,000
1956 Capacity	26,300,000

d. Fuel and Lubricants:

	Fuel	Lubricants		
Production	Coal (Metric Tons)	Lube Grease (Metric Tons)	Lube Oil (Gallons)	Cutting Oils (Gallons)
1953	21,500	1.88	14,000	5,180
1954 Capacity	38,500	4.17	31,200	11,500
1955 Capacity	38,500	4.17	31,200	11,500
1956 Capacity	38,500	4.17	31,200	11,500

e. Transportation:

Transportation Required
(Metric Tons)

	Products Transported to Plant					Products Transported from Plant		
Production	Engines	Components	Raw Materials	Fuel	Lubricants	Aircraft	Spare Parts	Scrap
1953	543	103	4,108	21,500	67.1	2,310	708	1,728
1954 Capacity	933	177	7,052.8	38,500	149.2	3,970	1,220	2,973
1955 Capacity	1,660	314	12,523.8	38,500	149.2	7,050	2,180	5,264
1956 Capacity	1,950	369	14,709.6	38,500	149.2	8,290	2,540	6,180

1. **Plant Number:** 22

2. **Plant Location:**

   a. Nearest City and Coordinates: Kazan' 55°52'N - 49°08'E

   b. Economic Region: VI

3. **Plant Area:** 2,190,000 square feet

4. **Scale of Effort:** 65 percent

5. **Production Data:**

   a. 1953 Production:

Model	Airframe Weight (Pounds)	Units per Year	Pounds per Year (including Spares)
Tu-4	48,114	204	10,510,000

   b. Capacity Production:

Year	Model	Units per Year	Pounds per Year (including Spares)
1954	Tu-4	341	17,810,000
1955	Tu-4	480	25,100,000
1956	Tu-4	541	28,300,000

6. Input Data:

a. Materials:

	Type of Material								
	Yearly Gross Requirements (Metric Tons)								
Production	Low-Carbon Steel	Alloy Steel (Not including Stainless Steel)	Stainless Steel	Aluminum	Copper Copper Base Alloys	Magnesium	Lead	Rubber	Glass and Plastics
1953	129	2,260	21.0	5,380	157	14.8	4.8	162	90.5
1954 Capacity	218	3,840	35.5	9,130	267	25.0	8.1	275	154
1955 Capacity	307	5,410	50.1	12,900	376	35.3	11.4	387	216
1956 Capacity	347	6,100	56.5	14,500	424	39.8	12.8	436	244

b. Manpower:

	Manpower Requirements (Man-Years)						
Production	Total	Direct	Indirect	Skilled	Unskilled	Managerial	Technical
1953	19,000	9,500	9,500	6,650	12,350	3,800	3,420
1954 Capacity	29,200	14,600	14,600	10,200	19,000	5,840	5,260
1955 Capacity	29,200	14,600	14,600	10,200	19,000	5,840	5,260
1956 Capacity	29,200	14,600	14,600	10,200	19,000	5,840	5,260

c. Electrical Energy:

Source: Kazan' Heat and Power Plant, TETS No. 2 (0165-0008)

Alternate Source: Plant may have electric generating equipment

Production	Electrical Energy Requirements (Kilowatt-Hours)
1953	28,000,000
1954 Capacity	43,100,000
1955 Capacity	43,100,000
1956 Capacity	43,100,000

d. Fuel and Lubricants:

	Fuel	Lubricants		
Production	Coal (Metric Tons)	Lube Grease (Metric Tons)	Lube Oil (Gallons)	Cutting Oils (Gallons)
1953	49,900	4.44	33,200	12,300
1954 Capacity	64,200	6.84	51,000	18,900
1955 Capacity	64,200	6.84	51,000	18,900
1956 Capacity	64,200	6.84	51,000	18,900

e. Transportation:

Transportation Required
(Metric Tons)

	Products Transported to Plant					Products Transported from Plant		
Production	Engines	Components	Raw Materials	Fuel	Lubricants	Aircraft	Spare Parts	Scrap
1953	1,096	948	8,221.9	49,900	165.9	0	295	3,457
1954 Capacity	1,832	1,584	13,952.6	64,200	244.8	0	646	5,873
1955 Capacity	2,580	2,230	19,692.8	64,200	244.8	0	911	8,303
1956 Capacity	2,910	2,510	22,160.1	64,200	244.8	0	1,028	9,320

1. **Plant Number:** 23

2. **Plant Location:**

   a. Nearest City and Coordinates: Moscow 55°44'N-37°30'E

   b. Economic Region: VII

3. **Plant Area:** 1,995,600 square feet

4. **Scale of Effort:** percent

5. **Production Data:**

   a. 1953 Production:

Model	Airframe Weight (Pounds)	Units per Year	Pounds per Year (including Spares)
Aircraft Development			

   b. Capacity Production:

Year	Model	Units per Year	Pounds per Year (including Spares)
1954	AMPR weight over 20,000 pounds		14,370,000
1955	AMPR weight over 20,000 pounds		24,250,000
1956	AMPR weight over 20,000 pounds		28,130,000

6. Input Data:

a. Materials:

Yearly Gross Requirements
(Metric Tons)

	Type of Material								
Production	Low-Carbon Steel	Alloy Steel (Not including Stainless Steel)	Stainless Steel	Aluminum	Copper Copper Base Alloys	Magnesium	Lead	Rubber	Glass and Plastics
1953									
1954 Capacity	176	3,100	28.7	7,370	215	20.2	6.5	222	124
1955 Capacity	297	5,220	48.4	12,400	363	34.1	11.0	374	209
1956 Capacity	345	6,060	56.2	14,400	421	39.6	12.8	434	243

b. Manpower:

Manpower Requirements
(Man-Years)

Production	Total	Direct	Indirect	Skilled	Unskilled	Managerial	Technical
1953	12,100	6,050	6,050	4,230	7,870	2,420	2,180
1954 Capacity	26,600	13,300	13,300	9,300	17,300	5,320	4,790
1955 Capacity	26,600	13,300	13,300	9,300	17,300	5,320	4,790
1956 Capacity	26,600	13,300	13,300	9,300	17,300	5,320	4,790

c. Electrical Energy:

Source: Moscow City System

Alternate Source: Plant emergency generator

Production	Electrical Energy Requirements (Kilowatt-Hours)
1953	17,900,000
1954 Capacity	39,300,000
1955 Capacity	39,300,000
1956 Capacity	39,300,000

d. Fuel and Lubricants:

	Fuel	Lubricants		
Production	Coal (Metric Tons)	Lube Grease (Metric Tons)	Lube Oil (Gallons)	Cutting Oils (Gallons)
1953	31,100	2.80	20,900	12,300
1954 Capacity	55,900	6.22	46,500	17,200
1955 Capacity	55,900	6.22	46,500	17,200
1956 Capacity	55,900	6.22	46,500	17,200

e. Transportation:

Transportation Required
(Metric Tons)

	Products Transported to Plant					Products Transported from Plant		
Production	Engines	Components	Raw Materials	Fuel	Lubricants	Aircraft	Spare Parts	Scrap
1953				31,100	115.8			
1954 Capacity	Unknown	Unknown	11,262.4	55,900	223.2	Unknown	Unknown	4,742
1955 Capacity	Unknown	Unknown	18,965.5	55,900	223.2	Unknown	Unknown	7,957
1956 Capacity	Unknown	Unknown	22,011.6	55,900	223.2	Unknown	Unknown	9,252

1. **Plant Number:** 30

2. **Plant Location:**

   a. Nearest City and Coordinates: Moscow 55°47'N - 37°33'E

   b. Economic Region: VII

3. **Plant Area:** 1,230,000 square feet

4. **Scale of Effort:** 45 percent

5. **Production Data:**

   a. 1953 Production:

Model	Airframe Weight (Pounds)	Units per Year	Pounds per Year (including Spares)
Il-28	16,840	360	6,648,000

   b. Capacity Production:

Year	Model	Units per Year	Pounds per Year (including Spares)
1954	Il-28	484	8,860,000
1955	Il-28	817	14,950,000
1956	Il-28	948	17,350,000

6. Input Data:

a. Materials:

Yearly Gross Requirements
(Metric Tons)

	Type of Material								
Production	Low-Carbon Steel	Alloy Steel (Not including Stainless Steel)	Stainless Steel	Aluminum	Copper Copper Base Alloys	Magnesium	Lead	Rubber	Glass and Plastics
1953	126	2,180	20.5	3,800	133	11.8	6.0	187	21.1
1954 Capacity	169	2,900	27.3	5,060	177	15.7	8.0	249	28.1
1955 Capacity	285	4,890	46.1	8,540	298	26.4	13.5	420	47.4
1956 Capacity	331	5,680	53.5	9,920	346	30.7	15.7	488	55.1

b. Manpower:

Manpower Requirements
(Man-Years)

Production	Total	Direct	Indirect	Skilled	Unskilled	Managerial	Technical
1953	7,450	3,725	3,725	2,610	4,840	1,490	1,340
1954 Capacity	16,400	8,200	8,200	5,740	10,660	3,280	2,950
1955 Capacity	16,400	8,200	8,200	5,740	10,660	3,280	2,950
1956 Capacity	16,400	8,200	8,200	5,740	10,660	3,280	2,950

c. Electrical Energy:

Source: Moscow City System

Alternate Source: Plant power station

Production	Electrical Energy Requirements (Kilowatt-Hours)
1953	11,000,000
1954 Capacity	24,200,000
1955 Capacity	24,200,000
1956 Capacity	24,200,000

d. Fuel and Lubricants:

	Fuel	Lubricants		
Production	Coal (Metric Tons)	Lube Grease (Metric Tons)	Lube Oil (Gallons)	Cutting Oils (Gallons)
1953	19,200	1.73	12,900	4,770
1954 Capacity	34,400	3.84	28,700	10,660
1955 Capacity	34,400	3.84	28,700	10,660
1956 Capacity	34,400	3.84	28,700	10,660

e. Transportation:

Transportation Required
(Metric Tons)

	Products Transported to Plant					Products Transported from Plant		
Production	Engines	Components	Raw Materials	Fuel	Lubricants	Aircraft	Spare Parts	Scrap
1953	646	461	6,485.4	19,200	61.8	0	267	3,468
1954 Capacity	869	620	8,634.1	28,700	137.8	0	320	4,614
1955 Capacity	1,470	1,050	14,566.4	28,700	137.8	0	540	7,786
1956 Capacity	1,713	1,210	16,920.0	28,700	137.8	0	630	9,050

1. **Plant Number:** 31

2. **Plant Location:**

   a. Nearest City and Coordinates: Tbilisi 41°40'33"N - 44°53'E

   b. Economic Region: V

3. **Plant Area:** 1,600,000 square feet

4. **Scale of Effort:** 35 percent

5. **Production Data:**

   a. 1953 Production:

Model	Airframe Weight (Pounds)	Units per Year	Pounds per Year (including Spares)
MIG-15 or Variant	6,065	571	4,370,000

   b. Capacity Production:

Year	Model	Units per Year	Pounds per Year (including Spares)
1954	MIG-15 or Variant	976	7,470,000
1955	MIG-15 or Variant	2,120	16,210,000
1956	MIG-15 or Variant	2,560	19,620,000

6. Input Data:

a. Materials:

Yearly Gross Requirements (Metric Tons)

Production	Type of Material Low-Carbon Steel	Alloy Steel (Not including Stainless Steel)	Stainless Steel	Aluminum	Copper Copper Base Alloys	Magnesium	Lead	Rubber	Glass and Plastics
1953	95.0	1,650	15.4	1,460	111	6.5	13.5	26.7	38.6
1954 Capacity	163	2,820	26.4	2,510	190	11.2	23.0	45.8	66.1
1955 Capacity	353	6,120	57.4	5,430	412	24.3	50.0	99.2	143
1956 Capacity	427	7,400	69.4	6,580	516	29.4	60.5	120	174

b. Manpower:

Manpower Requirements (Man-Years)

Production	Total	Direct	Indirect	Skilled	Unskilled	Managerial	Technical
1953	7,460	3,730	3,730	2,610	4,850	1,490	1,340
1954 Capacity	21,300	10,650	10,650	7,450	13,850	4,260	3,830
1955 Capacity	21,300	10,650	10,650	7,450	13,850	4,260	3,830
1956 Capacity	21,300	10,650	10,650	7,450	13,850	4,260	3,830

c. Electrical Energy:

Source: Tbilisi Power Plant, TETS (0325-0011)

Alternate Source: Plant generating system

Production	Electrical Energy Requirements (Kilowatt-Hours)
1953	11,000,000
1954 Capacity	31,600,000
1955 Capacity	31,600,000
1956 Capacity	31,600,000

d. Fuel and Lubricants:

	Fuel	Lubricants		
Production	Coal (Metric Tons)	Lube Grease (Metric Tons)	Lube Oil (Gallons)	Cutting Oils (Gallons)
1953	11,600	1.75	13,100	4,830
1954 Capacity	20,800	4.99	37,300	13,800
1955 Capacity	20,800	4.99	37,300	13,800
1956 Capacity	20,800	4.99	37,300	13,800

e. Transportation:

Transportation Required
(Metric Tons)

	Products Transported to Plant					Products Transported from Plant		
Production	Engines	Components	Raw Materials	Fuel	Lubricants	Aircraft	Spare Parts	Scrap
1953	513	97	3,416.7	11,600	62.7	2,180	413	1,445
1954 Capacity	876	166	5,855.5	20,800	179.0	3,730	703	2,468
1955 Capacity	1,900	360	12,318.1	20,800	179.0	8,100	1,520	4,963
1956 Capacity	2,300	435	15,376.3	20,800	179.0	9,780	1,860	6,476

1. **Plant Number:** 39

2. **Plant Location:**

   a. Nearest City and Coordinates: Irkutsk 52°21'N - 104°12'E

   b. Economic Region: XI

3. **Plant Area:** 1,500,000 square feet

4. **Scale of Effort:** 40 percent

5. **Production Data:**

   a. 1953 Production:

Model	Airframe Weight (Pounds)	Units per Year	Pounds per Year (including Spares)
Type 35	17,000	384	7,200,000

   b. Capacity Production:

Year	Model	Units per Year	Pounds per Year (including Spares)
1954	Type 35	584	10,800,000
1955	Type 35	986	18,200,000
1956	Type 35	1,145	21,150,000

6. Input Data:

a. Materials:

Yearly Gross Requirements
(Metric Tons)

Type of Material Production	Low-Carbon Steel	Alloy Steel (Not including Stainless Steel)	Stainless Steel	Aluminum	Copper Copper Base Alloys	Magnesium	Lead	Rubber	Glass and Plastics
1953	137	2,360	22.2	4,120	144	12.7	6.5	202	22.9
1954 Capacity	206	3,540	33.3	6,180	216	19.1	9.8	304	34.3
1955 Capacity	347	5,960	56.2	10,400	363	32.2	16.5	512	57.8
1956 Capacity	403	6,920	65.2	12,100	422	37.4	19.2	594	67.2

b. Manpower:

Manpower Requirements
(Man-Years)

Production	Total	Direct	Indirect	Skilled	Unskilled	Managerial	Technical
1953	8,000	4,000	4,000	2,800	5,200	1,600	1,440
1954 Capacity	20,000	10,000	10,000	7,000	13,000	4,000	3,600
1955 Capacity	20,000	10,000	10,000	7,000	13,000	4,000	3,600
1956 Capacity	20,000	10,000	10,000	7,000	13,000	4,000	3,600

c. Electrical Energy:

Source: Thermo-electric generator located within plant area

Alternate Source: Auxiliary plant power plant

Production	Electrical Energy Requirements (Kilowatt-Hours)
1953	11,800,000
1954 Capacity	29,500,000
1955 Capacity	29,500,000
1956 Capacity	29,500,000

d. Fuel and Lubricants:

	Fuel	Lubricants		
Production	Coal (Metric Tons)	Lube Grease (Metric Tons)	Lube Oil (Gallons)	Cutting Oils (Gallons)
1953	22,200	1.87	14,000	5,160
1954 Capacity	39,900	4.69	35,000	12,900
1955 Capacity	39,900	4.69	35,000	12,900
1956 Capacity	39,900	4.69	35,000	12,900

e. Transportation:

Transportation Required
(Metric Tons)

	Products Transported to Plant					Products Transported from Plant		
Production	Engines	Components	Raw Materials	Fuel	Lubricants	Aircraft	Spare Parts	Scrap
1953	690	758	7,027.3	22,200	67.1	0	305	3,762
1954 Capacity	1,050	1,150	10,542.5	39,900	167.7	0	390	5,643
1955 Capacity	1,770	1,930	17,744.7	39,900	167.7	0	655	9,490
1956 Capacity	2,060	2,260	20,628.0	39,900	167.7	0	765	11,033

1. **Plant Number:** 47

2. **Plant Location:**

   a. Nearest City and Coordinates: Chkalov 51°48'N - 55°07'E

   b. Economic Region: VIII

3. **Plant Area:** 381,000 square feet

4. **Scale of Effort:** 45 percent

5. **Production Data:**

   a. 1953 Production:

Model	Airframe Weight (Pounds)	Units per Year	Pounds per Year (including Spares)
Type 24	6,300	192	1,500,000

   b. Capacity Production:

Year	Model	Units per Year	Pounds per Year (including Spares)
1954	Type 24	261	2,058,000
1955	Type 24	464	3,660,000
1956	Type 24	546	4,295,000

6. Input Data:

a. Materials:

Yearly Gross Requirements
(Metric Tons)

	Type of Material								
Production	Low-Carbon Steel	Alloy Steel (Not including Stainless Steel)	Stainless Steel	Aluminum	Copper Copper Base Alloys	Magnesium	Lead	Rubber	Glass and Plastics
1953	18.4	312	2.9	796	19.7	0	2.3	4.4	6.7
1954 Capacity	25.2	427	4.0	1,090	27.1	0	3.2	6.1	9.1
1955 Capacity	44.8	760	7.1	1,940	48.1	0	5.6	10.8	16.3
1956 Capacity	52.6	892	8.4	2,280	56.3	0	6.6	12.7	19.1

b. Manpower:

Manpower Requirements
(Man-Years)

Production	Total	Direct	Indirect	Skilled	Unskilled	Managerial	Technical
1953	2,290	1,145	1,145	800	1,490	458	412
1954 Capacity	5,080	2,540	2,540	1,780	3,300	1,020	914
1955 Capacity	5,080	2,540	2,540	1,780	3,300	1,020	914
1956 Capacity	5,080	2,540	2,540	1,780	3,300	1,020	914

c. Electrical Energy:

Source: Chkalov Power Plant, TETS "Krasny Mayak" (0236-004)

Alternate Source: Auxiliary plant power plant

Production	Electrical Energy Requirements (Kilowatt-Hours)
1953	3,410,000
1954 Capacity	7,500,000
1955 Capacity	7,500,000
1956 Capacity	7,500,000

d. Fuel and Lubricants:

	Fuel	Lubricants		
Production	Coal (Metric Tons)	Lube Grease (Metric Tons)	Lube Oil (Gallons)	Cutting Oils (Gallons)
1953	6,480	0.53	4,000	1,430
1954 Capacity	10,600	1.19	8,880	3,280
1955 Capacity	10,600	1.19	8,880	3,280
1956 Capacity	10,600	1.19	8,880	3,280

e. Transportation:

Transportation Required
(Metric Tons)

	Products Transported to Plant					Products Transported from Plant		
Production	Engines	Components	Raw Materials	Fuel	Lubricants	Aircraft	Spare Parts	Scrap
1953	0	0	1,162.4	6,480	16.1	549	132	482
1954 Capacity	0	0	1,591.7	10,600	42.5	746	288	658
1955 Capacity	0	0	2,832.7	10,600	42.5	1,330	334	1,173
1956 Capacity	0	0	3,327.9	10,600	42.5	1,560	388	1,380

1. Plant Number: 49/86

2. Plant Location:

   a. Nearest City and Coordinates: Taganrog 47°11'75"N - 38°52'50"E

   b. Economic Region:

3. Plant Area: 1,262,000 square feet

4. Scale of Effort: 45 percent

5. Production Data:

   a. 1953 Production:

Model	Airframe Weight (Pounds)	Units per Year	Pounds per Year (including Spares)
Type 33	5,040	133	843,000
Type 34	20,500	44	1,127,000
Li-2	13,372	135	2,318,000

   b. Capacity Production:

Year	Model	Pounds per Year (including Spares)
1954	AMPR weight under 20,000 pounds	8,520,000
1955	AMPR weight under 20,000 pounds	15,140,000
1956	AMPR weight under 20,000 pounds	17,780,000

6. Input Data:

a. Materials:

Yearly Gross Requirements
(Metric Tons)

	Type of Material								
Production	Low-Carbon Steel	Alloy Steel (Not including Stainless Steel)	Stainless Steel	Aluminum	Copper Copper Base Alloys	Magnesium	Lead	Rubber	Glass and Plastics
1953	40	759	6.4	2,009	40.2	12.6	7.7	66.2	34.3
1954 Capacity	139	2,370	22.4	4,100	155	39.8	35.6	147	50.2
1955 Capacity	247	4,200	39.8	7,280	275	70.8	63.2	261	89.3
1956 Capacity	290	4,940	46.8	8,550	323	83.1	74.2	306	105

b. Manpower:

Manpower Requirements
(Man-Years)

Production	Total	Direct	Indirect	Skilled	Unskilled	Managerial	Technical
1953	6,060	3,030	3,030	2,120	3,940	1,210	1,090
1954 Capacity	16,820	8,410	8,410	5,890	10,930	3,360	3,030
1955 Capacity	16,820	8,410	8,410	5,890	10,930	3,360	3,030
1956 Capacity	16,820	8,410	8,410	5,890	10,930	3,360	3,030

c. Electrical Energy:

Source: Outside, probably Taganrog City System

Alternate Source: Plant power station

Production	Electrical Energy Requirements (Kilowatt-Hours)
1953	8,950,000
1954 Capacity	24,800,000
1955 Capacity	24,800,000
1956 Capacity	24,800,000

d. Fuel and Lubricants:

	Fuel	Lubricants		
Production	Coal (Metric Tons)	Lube Grease (Metric Tons)	Lube Oil (Gallons)	Cutting Oils (Gallons)
1953	11,600	1.40	10,500	3,880
1954 Capacity	26,400	3.94	29,400	10,980
1955 Capacity	26,400	3.94	29,400	10,980
1956 Capacity	26,400	3.94	29,400	10,980

e. Transportation:

Transportation Required
(Metric Tons)

	Products Transported to Plant					Products Transported from Plant		
Production	Engines	Components	Raw Materials	Fuel	Lubricants	Aircraft	Spare Parts	Scrap
1953	295	274	2,975.4	11,600	50.3	0	413	1,030
1954 Capacity	Unknown	Unknown	7,059.0	26,400	141.3	Unknown	Unknown	3,196
1955 Capacity	Unknown	Unknown	12,526.1	26,400	141.3	Unknown	Unknown	5,656
1956 Capacity	Unknown	Unknown	14,718.1	26,400	141.3	Unknown	Unknown	6,653

1. Plant Number: 64

2. Plant Location:

   a. Nearest City and Coordinates: Voronezh 51°38'N-39°15'E

   b. Economic Region: VII

3. Plant Area: 1,888,400 square feet

4. Scale of Effort: 45 percent

5. Production Data:

   a. 1953 Production:

Model	Airframe Weight (Pounds)	Units per Year	Pounds per Year (including Spares)
Il-28	16,840	372	6,792,000

   b. Capacity Production:

Year	Model	Units per Year	Pounds per Year (including Spares)
1954	Il-28	743	13,600,000
1955	Il-28	1,253	22,930,000
1956	Il-28	1,453	26,600,000

6. Input Data:

a. Materials:

Yearly Gross Requirements
(Metric Tons)

Production / Type of Material	Low-Carbon Steel	Alloy Steel (Not including Stainless Steel)	Stainless Steel	Aluminum	Copper Copper Base Alloys	Magnesium	Lead	Rubber	Glass and Plastics
1953	129	2,220	21.0	3,880	136	12.0	6.2	191	21.6
1954 Capacity	259	4,450	42.0	7,780	271	24.1	12.3	383	43.2
1955 Capacity	437	7,510	70.8	13,100	458	40.6	20.8	645	72.8
1956 Capacity	507	8,710	82.0	15,200	531	47.1	24.1	748	84.4

b. Manpower:

Manpower Requirements
(Man-Years)

Production	Total	Direct	Indirect	Skilled	Unskilled	Managerial	Technical
1953	11,450	5,725	5,725	3,990	7,460	2,290	2,060
1954 Capacity	25,200	12,600	12,600	8,820	16,380	5,040	4,540
1955 Capacity	25,200	12,600	12,600	8,820	16,380	5,040	4,540
1956 Capacity	25,200	12,600	12,600	8,820	16,380	5,040	4,540

c. Electrical Energy:

Source: Voronezh Thermal Power Plant

Alternate Source: Unknown

Production	Electrical Energy Requirements (Kilowatt-Hours)
1953	16,900,000
1954 Capacity	37,200,000
1955 Capacity	37,200,000
1956 Capacity	37,200,000

d. Fuel and Lubricants:

	Fuel	Lubricants		
Production	Coal (Metric Tons)	Lube Grease (Metric Tons)	Lube Oil (Gallons)	Cutting Oils (Gallons)
1953	25,900	2.65	19,800	7,340
1954 Capacity	46,500	5.89	44,000	16,300
1955 Capacity	46,500	5.89	44,000	16,300
1956 Capacity	46,500	5.89	44,000	16,300

e. Transportation:

	Transportation Required (Metric Tons)							
	Products Transported to Plant					Products Transported from Plant		
Production	Engines	Components	Raw Materials	Fuel	Lubricants	Aircraft	Spare Parts	Scrap
1953	668	476	6,616.8	25,900	60.9	0	240	3,537
1954 Capacity	1,335	951	13,264.6	46,500	210.9	0	495	7,095
1955 Capacity	2,250	1,600	22,355.0	46,500	210.9	0	830	11,955
1956 Capacity	2,610	1,860	25,933.6	46,500	210.9	0	970	13,874

1. **Plant Number:** 82

2. **Plant Location:**

   a. Nearest City and Coordinates: Moscow 55°50'33"N - 37°27'E

   b. Economic Region: VII

3. **Plant Area:** 680,000 square feet

4. **Scale of Effort:** 45 percent

5. **Production Data:**

   a. 1953 Production:

Model	Airframe Weight (Pounds)	Units per Year	Pounds per Year (including Spares)
Experimental Work and Aircraft Parts			

   b. Capacity Production:

Year	Model	Pounds per Year (including Spares)
1954	AMPR weight under 20,000 pounds	4,590,000
1955	AMPR weight under 20,000 pounds	8,160,000
1956	AMPR weight under 20,000 pounds	9,588,000

6. Input Data:

a. Materials:

Yearly Gross Requirements
(Metric Tons)

Production	Type of Material Low-Carbon Steel	Alloy Steel (Not including Stainless Steel)	Stainless Steel	Aluminum	Copper Copper Base Alloys	Magnesium	Lead	Rubber	Glass and Plastics
1953									
1954 Capacity	75	1,270	12.1	2,210	83.3	21.4	19.2	79.1	27.1
1955 Capacity	133	2,270	21.5	3,920	148	38.1	34.0	141	48.1
1956 Capacity	157	2,660	25.2	4,610	174	44.8	40.0	165	56.6

b. Manpower:

Manpower Requirements
(Man-Years)

Production	Total	Direct	Indirect	Skilled	Unskilled	Managerial	Technical
1953	4,120	2,060	2,060	1,440	2,680	824	742
1954 Capacity	9,070	4,535	4,535	3,170	5,900	1,810	1,630
1955 Capacity	9,070	4,535	4,535	3,170	5,900	1,810	1,630
1956 Capacity	9,070	4,535	4,535	3,170	5,900	1,810	1,630

c. Electrical Energy:

Source: Probably Moskva Hydro Power Plant Tushino

Alternate Source: Plant emergency generator

Production	Electrical Energy Requirements (Kilowatt-Hours)
1953	6,080,000
1954 Capacity	13,400,000
1955 Capacity	13,400,000
1956 Capacity	13,400,000

d. Fuel and Lubricants:

	Fuel	Lubricants		
Production	Coal (Metric Tons)	Lube Grease (Metric Tons)	Lube Oil (Gallons)	Cutting Oils (Gallons)
1953	10,600	0.95	7,110	2,640
1954 Capacity	19,000	2.12	15,800	5,860
1955 Capacity	19,000	2.12	15,800	5,860
1956 Capacity	19,000	2.12	15,800	5,860

e. Transportation:

	Transportation Required (Metric Tons)							
	Products Transported to Plant					Products Transported from Plant		
Production	Engines	Components	Raw Materials	Fuel	Lubricants	Aircraft	Spare Parts	Scrap
1953	Unknown	Unknown	Unknown	10,600	34.1	Unknown	Unknown	Unknown
1954 Capacity	Unknown	Unknown	3,797.2	19,000	75.7	Unknown	Unknown	1,715
1955 Capacity	Unknown	Unknown	6,753.7	19,000	75.7	Unknown	Unknown	3,053
1956 Capacity	Unknown	Unknown	7,932.6	19,000	75.7	Unknown	Unknown	3,583

1. **Plant Number:** 84 A/B

2. **Plant Location:**

   a. Nearest City and Coordinates: Tashkent 41°19'N - 69°16'E

   b. Economic Region: X

3. **Plant Area:** 1,320,000 square feet

4. **Scale of Effort:** 35 percent

5. **Production Data:**

   a. 1953 Production:

Model	Airframe Weight (Pounds)	Units per Year	Pounds per Year (including Spares)
Il-12	16,000	70	1,406,000

   b. Capacity Production:

Year	Model	Units per Year	Pounds per Year (including Spares)
1954	Il-12	172	3,450,000
1955	Il-12	347	6,952,00C
1956	Il-12	772	15,450,000

6. Input Data:

a. Materials:

Yearly Gross Requirements
(Metric Tons)

	Type of Material								
Production	Low-Carbon Steel	Alloy Steel (Not including Stainless Steel)	Stainless Steel	Aluminum	Copper Copper Base Alloys	Magnesium	Lead	Rubber	Glass and Plastics
1953	16.0	271	2.6	868	23.6	14.0	16.0	31.3	8.3
1954 Capacity	39.1	664	6.3	2,130	57.9	34.4	39.1	76.7	20.3
1955 Capacity	78.8	1,340	12.6	4,290	117	69.4	78.8	154	41.0
1956 Capacity	175	2,970	28.0	9,540	259	154	175	344	91.2

b. Manpower:

Manpower Requirements
(Man-Years)

Production	Total	Direct	Indirect	Skilled	Unskilled	Managerial	Technical
1953	6,160	3,080	3,080	2,160	4,000	1,230	1,110
1954 Capacity	17,600	8,800	8,800	6,160	11,440	3,520	3,170
1955 Capacity	17,600	8,800	8,800	6,160	11,440	3,520	3,170
1956 Capacity	17,600	8,800	8,800	6,160	11,440	3,520	3,170

c. Electrical Energy:

Source: Tashkent City Power Supply

Alternate Source: Plant A has auxiliary power plant

Production	Electrical Energy Requirements (Kilowatt-Hours)
1953	9,100,000
1954 Capacity	26,000,000
1955 Capacity	26,000,000
1956 Capacity	26,000,000

d. Fuel and Lubricants:

	Fuel	Lubricants		
Production	Coal (Metric Tons)	Lube Grease (Metric Tons)	Lube Oil (Gallons)	Cutting Oils (Gallons)
1953	9,570	1.44	10,800	3,990
1954 Capacity	17,100	4.12	30,800	11,400
1955 Capacity	17,100	4.12	30,800	11,400
1956 Capacity	17,100	4.12	30,800	11,400

e. Transportation:

	Transportation Required (Metric Tons)							
	Products Transported to Plant					Products Transported from Plant		
Production	Engines	Components	Raw Materials	Fuel	Lubricants	Aircraft	Spare Parts	Scrap
1953	126	102	1,250.8	9,570	51.7	0	130	610
1954 Capacity	309	250	3,067.8	17,100	147.7	0	318	1,500
1955 Capacity	623	505	6,181.6	17,100	147.7	0	635	3,027
1956 Capacity	1,387	1,030	13,736.2	17,100	147.7	0	1,410	6,715

1. Plant Number: 99

2. Plant Location:

   a. Nearest City and Coordinates: Ulan-Ude 51°51'N - 107°45'E

   b. Economic Region: XI

3. Plant Area: 373,311 square feet

4. Scale of Effort: 45 percent

5. Production Data:

   a. 1953 Production:

Model	Airframe Weight (Pounds)	Units per Year	Pounds per Year (including Spares)
MIG-15 or Variant	6,065	145	1,110,000

   b. Capacity Production:

Year	Model	Units per Year	Pounds per Year (including Spares)
1954	MIG-15 or Variant	293	2,240,000
1955	MIG-15 or Variant	522	3,981,000
1956	MIG-15 or Variant	612	4,680,000

6. Input Data:

a. Materials:

Yearly Gross Requirements
(Metric Tons)

	Type of Material								
Production	Low-Carbon Steel	Alloy Steel (Not including Stainless Steel)	Stainless Steel	Aluminum	Copper Copper Base Alloys	Magnesium	Lead	Rubber	Glass and Plastics
1953	24.1	418	3.9	372	28.2	1.7	3.4	6.8	9.8
1954 Capacity	48.8	846	7.9	751	56.9	3.4	6.9	13.7	19.8
1955 Capacity	86.7	1,500	14.1	1,330	101	6.0	12.3	24.4	35.2
1956 Capacity	102	1,770	16.6	1,570	119	7.0	14.4	28.7	41.4

b. Manpower:

Manpower Requirements
(Man-Years)

Production	Total	Direct	Indirect	Skilled	Unskilled	Managerial	Technical
1953	2,240	1,120	1,120	780	1,460	448	403
1954 Capacity	4,980	2,490	2,490	1,740	3,240	996	896
1955 Capacity	4,980	2,490	2,490	1,740	3,240	996	896
1956 Capacity	4,980	2,490	2,490	1,740	3,240	996	

c. Electrical Energy:

Source: Ulan-Ude Municipal Power Plant

Alternate Source: Thermo-electric plant within plant area

Production	Electrical Energy Requirements (Kilowatt-Hours)
1953	3,340,000
1954 Capacity	7,350,000
1955 Capacity	7,350,000
1956 Capacity	7,350,000

d. Fuel and Lubricants:

	Fuel	Lubricants		
Production	Coal (Metric Tons)	Lube Grease (Metric Tons)	Lube Oil (Gallons)	Cutting Oils (Gallons)
1953	5,530	0.52	3,920	1,450
1954 Capacity	9,930	1.17	8,700	3,220
1955 Capacity	9,930	1.17	8,700	3,220
1956 Capacity	9,930	1.17	8,700	3,220

e. Transportation:

Transportation Required
(Metric Tons)

	Products Transported to Plant					Products Transported from Plant		
Production	Engines	Components	Raw Materials	Fuel	Lubricants	Aircraft	Spare Parts	Scrap
1953	129	25	867.9	5,530	18.8	554	105	365
1954 Capacity	260	50	1,754.4	9,930	41.7	1,120	209	738
1955 Capacity	464	89	3,109.7	9,930	41.7	1,990	367	1,294
1956 Capacity	544	104	3,669.1	9,930	41.7	2,340	440	1,547

1. **Plant Number**: 116

2. **Plant Location:**

   a. Nearest City and Coordinates: Semenovka 44°09'N - 133°15'E

   b. Economic Region: XII

3. **Plant Area:** 275,000 square feet

4. **Scale of Effort:** 28 percent

5. **Production Data:**

   a. 1953 Production:

Model	Airframe Weight (Pounds)	Units per Year	Pounds per Year (including Spares)
Yak-18	850	708	749,000

   b. Capacity Production:

Year	Model	Units per Year	Pounds per Year (including Spares)
1954	Yak-18	1,210	1,285,000
1955	Yak-18	2,620	2,784,000
1956	Yak-18	3,170	3,370,000

6. Input Data:

a. Materials:

Yearly Gross Requirements
(Metric Tons)

	Type of Material								
Production	Low-Carbon Steel	Alloy Steel (Not including Stainless Steel)	Stainless Steel	Aluminum	Copper Copper Base Alloys	Magnesium	Lead	Rubber	Glass and Plastics
1953	11.5	197	1.8	360	13.9	0	1.6	3.0	4.4
1954 Capacity	19.4	330	3.1	604	23.4	0	2.6	5.0	7.4
1955 Capacity	42.9	731	6.8	1,340	51.8	0	5.8	11.0	16.4
1956 Capacity	52.0	885	8.3	1,620	62.7	0	7.0	13.3	19.9

b. Manpower:

Manpower Requirements
(Man-Years)

Production	Total	Direct	Indirect	Skilled	Unskilled	Managerial	Technical
1953	1,030	515	515	360	670	206	185
1954 Capacity	3,670	1,835	1,835	1,280	2,390	734	660
1955 Capacity	3,670	1,835	1,835	1,280	2,390	734	660
1956 Capacity	3,670	1,835	1,835	1,280	2,390	734	660

c. Electrical Energy:

Source: City Power Plant

Alternate Source: Unknown

Production	Electrical Energy Requirements (Kilowatt-Hours)
1953	1,520,000
1954 Capacity	5,410,000
1955 Capacity	5,410,000
1956 Capacity	5,410,000

d. Fuel and Lubricants:

	Fuel	Lubricants		
Production	Coal (Metric Tons)	Lube Grease (Metric Tons)	Lube Oil (Gallons)	Cutting Oils (Gallons)
1953	3,200	0.24	1,790	664
1954 Capacity	5,750	0.85	6,410	2,370
1955 Capacity	5,750	0.85	6,410	2,370
1956 Capacity	5,750	0.85	6,410	2,370

e. Transportation:

Transportation Required
(Metric Tons)

	Products Transported to Plant					Products Transported from Plant		
Production	Engines	Components	Raw Materials	Fuel	Lubricants	Aircraft	Spare Parts	Scrap
1953	138	101	593.2	3,200	8.5	512	67	253
1954 Capacity	235	173	994.9	5,750	30.7	876	116	412
1955 Capacity	510	375	2,205.7	5,750	30.7	1,900	253	943
1956 Capacity	617	453	2,668.2	5,750	30.7	2,300	307	1,139

1. Plant Number: 126/130

2. Plant Location:

   a. Nearest City and Coordinates: Komsomol'sk 50°37'N - 137°05'E

   b. Economic Region: VII

3. Plant Area: 1,540,000 square feet

4. Scale of Effort: 45 percent

5. Production Data:

   a. 1953 Production:

Model	Airframe Weight (Pounds)	Units per Year	Pounds per Year (including Spares)
MIG-15 or Variant	6,065	632	4,840,000

   b. Capacity Production:

Year	Model	Units per Year	Pounds per Year (including Spares)
1954	MIG-15 or Variant	1,087	8,320,000
1955	MIG-15 or Variant	1,935	14,790,000
1956	MIG-15 or Variant	2,270	17,355,000

6. Input Data:

a. Materials:

Yearly Gross Requirements (Metric Tons)

Production	Low-Carbon Steel	Alloy Steel (Not including Stainless Steel)	Stainless Steel	Aluminum	Copper Copper Base Alloys	Magnesium	Lead	Rubber	Glass and Plastics
1953	106	1,830	17.2	1,630	123	7.3	15.0	29.7	42.9
1954 Capacity	181	3,140	29.4	2,790	211	12.5	25.7	51.0	73.6
1955 Capacity	322	5,580	52.3	4,960	376	22.1	45.6	90.6	131
1956 Capacity	378	6,550	61.4	5,820	441	26.0	53.6	106	154

b. Manpower:

Manpower Requirements (Man-Years)

Production	Total	Direct	Indirect	Skilled	Unskilled	Managerial	Technical
1953	9,220	4,610	4,610	3,220	6,000	1,840	1,660
1954 Capacity	20,500	10,250	10,250	7,170	13,330	4,100	3,690
1955 Capacity	20,500	10,250	10,250	7,170	13,330	4,100	3,690
1956 Capacity	20,500	10,250	10,250	7,170	13,330	4,100	3,690

c. Electrical Energy:

Source: Probably outside source

Alternate Source: Unknown

Production	Electrical Energy Requirements (Kilowatt-Hours)
1953	13,800,000
1954 Capacity	30,300,000
1955 Capacity	30,300,000
1956 Capacity	30,300,000

d. Fuel and Lubricants:

	Fuel	Lubricants		
Production	Coal (Metric Tons)	Lube Grease (Metric Tons)	Lube Oil (Gallons)	Cutting Oils (Gallons)
1953	30,200	2.17	16,200	5,990
1954 Capacity	54,000	4.81	35,900	13,300
1955 Capacity	54,000	4.81	35,900	13,300
1956 Capacity	54,000	4.81	35,900	13,300

e. Transportation:

Transportation Required
(Metric Tons)

	Products Transported to Plant					Products Transported from Plant		
Production	Engines	Components	Raw Materials	Fuel	Lubricants	Aircraft	Spare Parts	Scrap
1953	586	107	3,801.1	30,000	77.6	2,410	458	1,598
1954 Capacity	976	185	6,324.3	54,000	167.8	4,150	784	2,551
1955 Capacity	1,740	329	11,579.6	54,000	167.8	7,390	1,384	4,875
1956 Capacity	2,040	386	13,590	54,000	167.8	8,670	1,630	5,715

1. Plant Number: 135

2. Plant Location:

   a. Nearest City and Coordinates: Khar'kov 50°01'N - 36°16'E

   b. Economic Region: III

3. Plant Area: 710,000 square feet

4. Scale of Effort: 45 percent

5. Production Data:

   a. 1953 Production:

Model	Airframe Weight (Pounds)	Units per Year	Pounds per Year (including Spares)
MIG-15 or Variant	6,065	252	3,108,000

   b. Capacity Production:

Year	Model	Units per Year	Pounds per Year (including Spares)
1954	MIG-15 or Variant	795	4,788,000
1955	MIG-15 or Variant	1,410	8,520,000
1956	MIG-15 or Variant	1,657	10,000,000

6. Input Data:

a. Materials:

	Yearly Gross Requirements (Metric Tons)								
	Type of Material								
Production	Low-Carbon Steel	Alloy Steel (Not including Stainless Steel)	Stainless Steel	Aluminum	Copper Copper Base Alloys	Magnesium	Lead	Rubber	Glass and Plastics
1953	67.7	1,170	11.0	1,040	79	4.7	9.6	19.0	27.5
1954 Capacity	104	1,810	16.9	1,600	122	7.2	14.8	29.3	42.3
1955 Capacity	185	3,210	30.1	2,850	216	12.7	26.2	52.1	75.3
1956 Capacity	216	3,780	35.4	3,360	254	15.0	30.9	61.3	88.5

b. Manpower:

	Manpower Requirements (Man-Years)						
Production	Total	Direct	Indirect	Skilled	Unskilled	Managerial	Technical
1953	4,300	2,150	2,150	1,500	2,800	860	774
1954 Capacity	9,470	4,735	4,735	3,310	6,160	1,890	1,700
1955 Capacity	9,470	4,735	4,735	3,310	6,160	1,890	1,700
1956 Capacity	9,470	4,735	4,735	3,310	6,160	1,890	1,700

c. Electrical Energy:

Source: Khar'kov Heat and Power Plant, TETS No. 3 Krasnozarod

Alternate Source: Possibly plant power plant

Production	Electrical Energy Requirements (Kilowatt-Hours)
1953	6,350,000
1954 Capacity	14,000,000
1955 Capacity	14,000,000
1956 Capacity	14,000,000

d. Fuel and Lubricants:

	Fuel	Lubricants		
Production	Coal (Metric Tons)	Lube Grease (Metric Tons)	Lube Oil (Gallons)	Cutting Oils (Gallons)
1953	9,110	1.00	7,420	2,750
1954 Capacity	16,300	2.22	16,500	6,120
1955 Capacity	16,300	2.22	16,500	6,120
1956 Capacity	16,300	2.22	16,500	6,120

e. Transportation:

Transportation Required
(Metric Tons)

	Products Transported to Plant					Products Transported from Plant		
Production	Engines	Components	Raw Materials	Fuel	Lubricants	Aircraft	Spare Parts	Scrap
1953	226	43	2,428.5	9,110	35.6	963	716	1,020
1954 Capacity	714	135	3,746.5	16,300	79.1	3,040	0	1,575
1955 Capacity	1,270	240	6,657.4	16,300	79.1	5,390	0	2,794
1956 Capacity	1,490	282	7,843.1	16,300	79.1	6,330	0	3,307

1. Plant Number: 153

2. Plant Location:

   a. Nearest City and Coordinates: Novosibirsk 55°04'N - 82°59'E

   b. Economic Region: IX

3. Plant Area: 2,100,000 square feet

4. Scale of Effort: 35 percent

5. Production Data:

   a. 1953 Production:

Model	Airframe Weight (Pounds)	Units per Year	Pounds per Year (including Spares)
MIG-15 or Variant	6,065	755	5,780,000

   b. Capacity Production:

Year	Model	Units per Year	Pounds per Year (including Spares)
1954	MIG-15 or Variant	1,282	9,800,000
1955	MIG-15 or Variant	2,782	21,280,000
1956	MIG-15 or Variant	3,350	25,760,000

6. Input Data:

a. Materials:

Yearly Gross Requirements
(Metric Tons)

Production	Type of Material Low-Carbon Steel	Alloy Steel (Not including Stainless Steel)	Stainless Steel	Aluminum	Copper Copper Base Alloys	Magnesium	Lead	Rubber	Glass and Plastics
1953	126	2,180	20.4	1,940	147	8.6	17.8	35.4	51.1
1954 Capacity	213	3,690	34.7	3,280	249	14.7	30.2	60.0	86.7
1955 Capacity	463	8,020	75.2	7,130	540	31.8	65.6	130	188
1956 Capacity	560	9,720	91.1	8,630	654	38.5	79.4	158	228

b. Manpower:

Manpower Requirements
(Man-Years)

Production	Total	Direct	Indirect	Skilled	Unskilled	Managerial	Technica
1953	9,800	4,900	4,900	3,430	6,370	1,960	1,76
1954 Capacity	28,000	14,000	14,000	9,800	18,200	5,600	5,04
1955 Capacity	28,000	14,000	14,000	9,800	18,200	5,600	5,04
1956 Capacity	28,000	14,000	14,000	9,800	18,200	5,600	5,04

c. Electrical Energy:

Source: Novosibirsk Heat and Power Plant

Alternate Source: Unknown

Production	Electrical Energy Requirements (Kilowatt-Hours)
1953	14,500,000
1954 Capacity	41,300,000
1955 Capacity	41,300,000
1956 Capacity	41,300,000

d. Fuel and Lubricants:

	Fuel	Lubricants		
Production	Coal (Metric Tons)	Lube Grease (Metric Tons)	Lube Oil (Gallons)	Cutting Oils (Gallons)
1953	43,700	2.29	17,100	6,340
1954 Capacity	78,400	6.54	48,900	18,100
1955 Capacity	78,400	6.54	48,900	18,100
1956 Capacity	78,400	6.54	48,900	18,100

e. Transportation:

Transportation Required
(Metric Tons)

	Products Transported to Plant					Products Transported from Plant		
Production	Engines	Components	Raw Materials	Fuel	Lubricants	Aircraft	Spare Parts	Scrap
1953	678	128	4,526.3	43,700	82.0	2,880	544	1,909
1954 Capacity	1,150	218	7,658.3	78,400	234.5	4,900	966	3,215
1955 Capacity	2,500	473	16,643.6	78,400	234.5	10,600	1,990	6,994
1956 Capacity	3,010	595	20,159.0	78,400	234.5	12,800	2,480	8,479

1. Plant Number: 166

2. Plant Location:

   a. Nearest City and Coordinates: Omsk 54°58'N - 73°27'E

   b. Economic Region: IX

3. Plant Area: 1,075,000 square feet

4. Scale of Effort: 45 percent

5. Production Data:

   a. 1953 Production:

Model	Airframe Weight (Pounds)	Units per Year	Pounds per Year (including Spares)
Il-28	16,840	276	5,160,000

   b. Capacity Production:

Year	Model	Units per Year	Pounds per Year (including Spares)
1954	Il-28	423	7,740,000
1955	Il-28	714	13,060,000
1956	Il-28	829	15,150,000

6. Input Data:

a. Materials:

Yearly Gross Requirements
(Metric Tons)

	Type of Material								
Production	Low-Carbon Steel	Alloy Steel (Not including Stainless Steel)	Stainless Steel	Aluminum	Copper Copper Base Alloys	Magnesium	Lead	Rubber	Glass and Plastics
1953	98.3	1,690	15.9	2,950	103	9.1	4.7	145	16.4
1954 Capacity	147	2,530	23.9	4,420	154	13.7	7.0	218	24.6
1955 Capacity	249	4,270	40.2	7,460	260	23.1	11.8	367	41.4
1956 Capacity	288	4,960	46.7	8,650	302	26.8	13.7	426	48.1

b. Manpower:

Manpower Requirements
(Man-Years)

Production	Total	Direct	Indirect	Skilled	Unskilled	Managerial	Technical
1953	6,450	3,225	3,255	2,260	4,190	1,290	1,160
1954 Capacity	14,340	7,170	7,170	5,020	9,320	2,870	2,580
1955 Capacity	14,340	7,170	7,170	5,020	9,320	2,870	2,580
1956 Capacity	14,340	7,170	7,170	5,020	9,320	2,870	2,580

c. Electrical Energy:

Source: Omsk Municipal Power Plant

Alternate Source: Unknown

Production	Electrical Energy Requirements (Kilowatt-Hours)
1953	9,620,000
1954 Capacity	21,200,000
1955 Capacity	21,200,000
1956 Capacity	21,200,000

d. Fuel and Lubricants:

	Fuel	Lubricants		
Production	Coal (Metric Tons)	Lube Grease (Metric Tons)	Lube Oil (Gallons)	Cutting Oils (Gallons)
1953	22,400	1.51	11,300	4,170
1954 Capacity	40,200	3.35	25,000	9,260
1955 Capacity	40,200	3.35	25,000	9,260
1956 Capacity	40,200	3.35	25,000	9,260

e. Transportation:

Transportation Required
(Metric Tons)

	Products Transported to Plant					Products Transported from Plant		
Production	Engines	Components	Raw Materials	Fuel	Lubricants	Aircraft	Spare Parts	Scrap
1953	496	353	5,032.4	22,400	54.1	0	230	2,692
1954 Capacity	760	541	7,342.0	40,200	116.9	0	280	3,832
1955 Capacity	1,282	914	12,722.5	40,200	116.9	0	470	6,796
1956 Capacity	1,489	1,061	14,761.3	40,200	116.9	0	540	7,886

1. Plant Number: 168

2. Plant Location:

   a. Nearest City and Coordinates: Rostov 47°15'N - 39°43'E

   b. Economic Region: IV

3. Plant Area: 1,100,000 square feet

4. Scale of Effort: 30 percent

5. Production Data:

   a. 1953 Production:

Model	Airframe Weight (Pounds)	Units per Year	Pounds per Year (including Spares)
Yak-6	1,754	324	723,000
Yak-8	2,394	240	723,000
Yak-16	5,946	192	1,446,000

   b. Capacity Production:

Year	Model	Pounds per Year (including Spares)
1954	AMPR weight under 20,000 pounds	5,780,000
1955	AMPR weight under 20,000 pounds	12,540,000
1956	AMPR weight under 20,000 pounds	15,180,000

6. Input Data:

a. Materials:

Yearly Gross Requirements
(Metric Tons)

Production	Low-Carbon Steel	Alloy Steel (Not including Stainless Steel)	Stainless Steel	Aluminum	Copper Copper Base Alloys	Magnesium	Lead	Rubber	Glass and Plastics
	Type of Material								
1953	51.1	891	8.3	1,140	72.1	7.9	4.0	38.0	17.1
1954 Capacity	94.4	1,600	15.2	2,780	105.0	17.0	24.1	99.6	34.1
1955 Capacity	205	3,480	33.0	6,030	228.0	58.6	52.3	216	73.9
1956 Capacity	248	4,210	39.9	7,300	275.0	70.9	63.3	262	89.5

b. Manpower:

Manpower Requirements
(Man-Years)

Production	Total	Direct	Indirect	Skilled	Unskilled	Managerial	Technical
1953	4,400	2,200	2,200	1,540	2,860	880	792
1954 Capacity	14,660	7,330	7,330	5,130	9,530	2,930	2,640
1955 Capacity	14,660	7,330	7,330	5,130	9,530	2,930	2,640
1956 Capacity	14,660	7,330	7,330	5,130	9,530	2,930	2,640

c. Electrical Energy:

Source: Rostov Municipal Power Supply

Alternate Source: Unknown

Production	Electrical Energy Requirements (Kilowatt-Hours)
1953	6,500,000
1954 Capacity	21,700,000
1955 Capacity	21,700,000
1956 Capacity	21,700,000

d. Fuel and Lubricants:

	Fuel	Lubricants		
Production	Coal (Metric Tons)	Lube Grease (Metric Tons)	Lube Oil (Gallons)	Cutting Oils (Gallons)
1953	12,800	1.03	7,680	2,840
1954 Capacity	23,000	3.42	25,600	9,480
1955 Capacity	23,000	3.42	25,600	9,480
1956 Capacity	23,000	3.42	25,600	9,480

1. **Plant Number:** 272

2. **Plant Location:**

   a. Nearest City and Coordinates: Leningrad 59°59'N - 30°19'E

   b. Economic Region:

3. **Plant Area:** 305,000 square feet

4. **Scale of Effort:** 45 percent

5. **Production Data:**

   a. 1953 Production:

Model	Airframe Weight (Pounds)	Units per Year	Pounds per Year (including Spares)
Yak-18	850	708	750,000

   b. Capacity Production:

Year	Model	Pounds per Year (including Spares)
1954	AMPR weight under 20,000 pounds	2,060,000
1955	AMPR weight under 20,000 pounds	3,660,000
1956	AMPR weight under 20,000 pounds	4,300,000

[p.130 blank]

6. Input Data:

a. Materials:

Yearly Gross Requirements
(Metric Tons)

	Type of Material								
Production	Low-Carbon Steel	Alloy Steel (Not including Stainless Steel)	Stainless Steel	Aluminum	Copper Copper Base Alloys	Magnesium	Lead	Rubber	Glass and Plastics
1953	11.6	197	1.8	361	14.0	0.0	1.6	3.0	4.4
1954 Capacity	33.6	572	5.4	990	37.4	9.6	8.6	35.5	12.1
1955 Capacity	59.8	1,020	9.5	1,760	66.4	17.1	15.3	63.1	21.6
1956 Capacity	70.2	1,190	11.3	2,070	78.0	20.1	17.9	74.1	25.4

b. Manpower:

Manpower Requirements
(Man-Years)

Production	Total	Direct	Indirect	Skilled	Unskilled	Managerial	Technical
1953	1,850	925	925	650	1,200	370	333
1954 Capacity	4,070	2,035	2,035	1,420	2,650	814	732
1955 Capacity	4,070	2,035	2,035	1,420	2,650	814	732
1956 Capacity	4,070	2,035	2,035	1,420	2,650	814	732

c. Electrical Energy:

Source: City Power Station

Alternate Source: Unknown

Production	Electrical Energy Requirements (Kilowatt-Hours)
1953	2,730,000
1954 Capacity	6,000,000
1955 Capacity	6,000,000
1956 Capacity	6,000,000

d. Fuel and Lubricants:

	Fuel	Lubricants		
Production	Coal (Metric Tons)	Lube Grease (Metric Tons)	Lube Oil (Gallons)	Cutting Oils (Gallons)
1953	4,730	0.43	3,200	1,180
1954 Capacity	8,480	0.95	7,110	2,630
1955 Capacity	8,480	0.95	7,110	2,630
1956 Capacity	8,480	0.95	7,110	2,630

e. Transportation:

	Transportation Required (Metric Tons)							
	Products Transported to Plant					Products Transported from Plant		
Production	Engines	Components	Raw Materials	Fuel	Lubricants	Aircraft	Spare Parts	Scrap
1953	138	122	594.4	4,730	15.3	512	67	254
1954 Capacity	Unknown	Unknown	1,704.2	8,480	34.0	Unknown	Unknown	770
1955 Capacity	Unknown	Unknown	3,032.8	8,480	34.0	Unknown	Unknown	1,373
1956 Capacity	Unknown	Unknown	3,557.0	8,480	34.0	Unknown	Unknown	1,606

1. Plant Number: 292

2. Plant Location:

   a. Nearest City and Coordinates: Saratov 51°29'50"N - 45°57'50"E

   b. Economic Region: VI

3. Plant Area: 1,400,000 square feet

4. Scale of Effort: 45 percent

5. Production Data:

   a. 1953 Production:

Model	Airframe Weight (Pounds)	Units per Year	Pounds per Year (including Spares)
MIG-15 or Variant	6,065	1,020	6,132,000

   b. Capacity Production:

Year	Model	Units per Year	Pounds per Year (including Spares)
1954	MIG-15 or Variant	1,390	8,400,000
1955	MIG-15 or Variant	2,475	14,950,000
1956	MIG-15 or Variant	2,910	17,550,000

6. Input Data:

a. Materials:

Yearly Gross Requirements
(Metric Tons)

Production	Type of Material: Low-Carbon Steel	Alloy Steel (Not including Stainless Steel)	Stainless Steel	Aluminum	Copper Copper Base Alloys	Magnesium	Lead	Rubber	Glass and Plastics
1953	133	2,310	21.7	2,060	156	9.2	18.9	37.5	54.2
1954 Capacity	183	3,170	29.7	2,820	213	12.6	25.9	51.4	74.3
1955 Capacity	325	5,640	52.9	5,010	380	22.4	46.1	91.6	132
1956 Capacity	382	6,620	62.1	5,880	446	26.3	54.2	108	155

b. Manpower:

Manpower Requirements
(Man-Years)

Production	Total	Direct	Indirect	Skilled	Unskilled	Managerial	Technical
1953	8,490	4,245	4,245	2,970	5,520	1,700	1,530
1954 Capacity	18,660	9,330	9,330	6,530	12,130	3,730	3,360
1955 Capacity	18,660	9,330	9,330	6,530	12,130	3,730	3,360
1956 Capacity	18,660	9,330	9,330	6,530	12,130	3,730	3,360

c. Electrical Energy:

Source: Saratov TETS II

Alternate Source: Plant power station

Production	Electrical Energy Requirements (Kilowatt-Hours)
1953	12,500,000
1954 Capacity	27,600,000
1955 Capacity	27,600,000
1956 Capacity	27,600,000

d. Fuel and Lubricants:

	Fuel	Lubricants		
Production	Coal (Metric Tons)	Lube Grease (Metric Tons)	Lube Oil (Gallons)	Cutting Oils (Gallons)
1953	20,800	1.96	14,700	5,440
1954 Capacity	37,200	4.37	32,600	12,100
1955 Capacity	37,200	4.37	32,600	12,100
1956 Capacity	37,200	4.37	32,600	12,100

e. Transportation:

Transportation Required
(Metric Tons)

	Products Transported to Plant					Products Transported from Plant		
Production	Engines	Components	Raw Materials	Fuel	Lubricants	Aircraft	Spare Parts	Scrap
1953	916	173	4,800.5	20,800	70.5	3,900	0	2,120
1954 Capacity	1,250	236	6,579.9	37,200	156.4	5,310	0	2,770
1955 Capacity	2,220	421	11,700.0	37,200	156.4	9,460	0	4,920
1956 Capacity	2,610	495	13,733.6	37,200	156.4	11,100	0	5,774

1. **Plant Number:** 293/456

2. **Plant Location:**

   a. Nearest City and Coordinates: Moscow 55°54'50"N - 37°27'E

   b. Economic Region: VII

3. **Plant Area:** 605,000 square feet

4. **Scale of Effort:** 45 percent

5. **Production Data:**

   a. 1953 Production:

Model	Airframe Weight (Pounds)	Units per Year	Pounds per Year (including Spares)
Unknown	Unknown	Unknown	Unknown

   b. Capacity Production:

Year	Model	Pounds per Year (including Spares)
1954	AMPR weight under 20,000 pounds	4,080,000
1955	AMPR weight under 20,000 pounds	7,260,000
1956	AMPR weight under 20,000	8,520,000

6. Input Data:

a. Materials:

Yearly Gross Requirements (Metric Tons)

Production	Type of Material Low-Carbon Steel	Alloy Steel (Not including Stainless Steel)	Stainless Steel	Aluminum	Copper Copper Base Alloys	Magnesium	Lead	Rubber	Glass and Plastics
1953									
1954 Capacity	66.6	1,130	10.7	1,960	74.0	19.1	17.0	70.3	24.1
1955 Capacity	119	2,020	19.1	3,490	132	33.9	30.3	125	42.8
1956 Capacity	139	2,370	22.4	4,100	155	39.9	35.6	147	50.3

b. Manpower:

Manpower Requirements (Man-Years)

Production	Total	Direct	Indirect	Skilled	Unskilled	Managerial	Technical
1953	3,670	1,835	1,835	1,290	2,380	734	660
1954 Capacity	8,070	4,035	4,035	2,830	5,240	1,240	1,450
1955 Capacity	8,070	4,035	4,035	2,830	5,240	1,240	1,450
1956 Capacity	8,070	4,035	4,035	2,830	5,240	1,240	1,450

c. Electrical Energy:

Source: Outside, probably supplied by Moscow city system

Alternate Source: Unknown

Production	Electrical Energy Requirements (Kilowatt-Hours)
1953	5,420,000
1954 Capacity	11,900,000
1955 Capacity	11,900,000
1956 Capacity	11,900,000

d. Fuel and Lubricants:

	Fuel	Lubricants		
Production	Coal (Metric Tons)	Lube Grease (Metric Tons)	Lube Oil (Gallons)	Cutting Oils (Gallons)
1953	9,440	0.85	6,340	2,350
1954 Capacity	16,900	1.89	14,100	5,220
1955 Capacity	16,900	1.89	14,100	5,220
1956 Capacity	16,900	1.89	14,100	5,220

e. Transportation:

	Transportation Required (Metric Tons)							
	Products Transported to Plant					Products Transported from Plant		
Production	Engines	Components	Raw Materials	Fuel	Lubricants	Aircraft	Spare Parts	Scrap
1953	Unknown	Unknown	Unknown	9,440	30.4	Unknown	Unknown	Unknown
1954 Capacity	Unknown	Unknown	3,371.8	16,900	67.6	Unknown	Unknown	1,522
1955 Capacity	Unknown	Unknown	6,012.1	16,900	67.6	Unknown	Unknown	2,720
1956 Capacity	Unknown	Unknown	7,059.2	16,900	67.6	Unknown	Unknown	3,190

1. Plant Number: 381

2. Plant Location:

   a. Nearest City and Coordinates: Moscow 55°47'50"N - 37°33'50"E

   b. Economic Region: VII

3. Plant Area: 668,000 square feet

4. Scale of Effort: 45 percent

5. Production Data:

   a. 1953 Production:

Model	Airframe Weight (Pounds)	Units per Year	Pounds per Year (including Spares)
Subcontracting			

   b. Capacity Production:

Year	Model	Pounds per Year (including Spares)
1954	AMPR weight under 20,000 pounds	4,512,000
1955	AMPR weight under 20,000 pounds	8,016,000
1956	AMPR weight under 20,000 pounds	9,420,000

6. Input Data:

a. Materials:

Production	Type of Material Low-Carbon Steel	Alloy Steel (Not including Stainless Steel)	Stainless Steel	Aluminum	Copper Copper Base Alloys	Magnesium	Lead	Rubber	Glass and Plastics
	Yearly Gross Requirements (Metric Tons)								
1953									
1954 Capacity	73.7	1,250	11.9	2,170	81.8	21.1	18.8	77.8	26.6
1955 Capacity	131.0	2,230	21.1	3,850	145.0	37.5	33.4	138.0	47.3
1956 Capacity	154.0	2,620	24.8	4,530	171.0	44.0	39.3	162.0	55.6

b. Manpower:

	Manpower Requirements (Man-Years)						
Production	Total	Direct	Indirect	Skilled	Unskilled	Managerial	Technical
1953	4,050	2,025	2,025	1,420	2,630	810	724
1954 Capacity	8,910	4,455	4,455	3,120	5,790	1,780	1,600
1955 Capacity	8,910	4,455	4,455	3,120	5,790	1,780	1,600
1956 Capacity	8,910	4,455	4,455	3,120	5,790	1,780	1,600

c. Electrical Energy:

Source: Moskva City Supply

Alternate Source: Plant emergency station

Production	Electrical Energy Requirements (Kilowatt-Hours)
1953	5,980,000
1954 Capacity	13,100,000
1955 Capacity	13,100,000
1956 Capacity	13,100,000

d. Fuel and Lubricants.

	Fuel	Lubricants		
Production	Coal (Metric Tons)	Lube Grease (Metric Tons)	Lube Oil (Gallons)	Cutting Oils (Gallons)
1953	10,300	0.94	7,020	2,590
1954 Capacity	18,700	2.09	15,600	5,760
1955 Capacity	18,700	2.09	15,600	5,760
1956 Capacity	18,700	2.09	15,600	5,760

e. Transportation:

	Transportation Required (Metric Tons)							
	Products Transported to Plant					Products Transported from Plant		
Production	Engines	Components	Raw Materials	Fuel	Lubricants	Aircraft	Spare Parts	Scrap
1953	Unknown	Unknown	Unknown	10,300	33.6	Unknown	Unknown	Unknown
1954 Capacity	Unknown	Unknown	3,731.7	18,700	74.7	Unknown	Unknown	1,684
1955 Capacity	Unknown	Unknown	6,633.3	18,700	74.7	Unknown	Unknown	2,998
1956 Capacity	Unknown	Unknown	7,800.7	18,700	74.7	Unknown	Unknown	3,528

1. **Plant Number:** 448

2. **Plant Location:**

   a. Nearest City and Coordinates: Leningrad 59°53'N - 38°18'E

   b. Economic Region: I

3. **Plant Area:** 401,000 square feet

4. **Scale of Effort:** 45 percent

5. **Production Data:**

   a. 1953 Production:

Model	Airframe Weight (Pounds)	Units per Year	Pounds per Year (including Spares)
Yak-11	2,500	312	987,000

   b. Capacity Production:

Year	Model	Pounds per Year (including Spares)
1954	AMPR weight under 20,000 pounds	2,700,000
1955	AMPR weight under 20,000 pounds	4,810,000
1956	AMPR weight under 20,000 pounds	5,650,000

6. Input Data:

a. Materials:

Yearly Gross Requirements
(Metric Tons)

Type of Material

Production	Low-Carbon Steel	Alloy Steel (Not including Stainless Steel)	Stainless Steel	Aluminum	Copper Copper Base Alloys	Magnesium	Lead	Rubber	Glass and Plastics
1953	11.2	190	1.8	640	13.4	8.1	0.0	11.2	7.2
1954 Capacity	44.1	750	7.1	1,300	49.0	12.6	11.3	46.5	15.9
1955 Capacity	78.5	1,330	12.6	2,310	87.2	22.5	20.1	82.8	28.3
1956 Capacity	92.2	1,570	14.9	2,720	103	26.4	23.6	97.4	33.3

b. Manpower:

Manpower Requirements
(Man-Years)

Production	Total	Direct	Indirect	Skilled	Unskilled	Managerial	Technical
1953	2,430	1,215	1,215	850	1,580	486	437
1954 Capacity	5,350	2,675	2,675	1,870	3,480	1,070	963
1955 Capacity	5,350	2,675	2,675	1,870	3,480	1,070	963
1956 Capacity	5,350	2,675	2,675	1,870	3,480	1,070	963

c. Electrical Energy:

Source: Probably GRES TETS No. 1 Leningrad

Alternate Source: Unknown

Production	Electrical Energy Requirements (Kilowatt-Hours)
1953	3,590,000
1954 Capacity	7,900,000
1955 Capacity	7,900,000
1956 Capacity	7,900,000

d. Fuel and Lubricants:

	Fuel	Lubricants		
Production	Coal (Metric Tons)	Lube Grease (Metric Tons)	Lube Oil (Gallons)	Cutting Oils (Gallons)
1953	6,220	0.56	4,200	1,560
1954 Capacity	11,100	1.25	9,340	3,460
1955 Capacity	11,100	1.25	9,340	3,460
1956 Capacity	11,100	1.25	9,340	3,460

e. Transportation:

	Transportation Required (Metric Tons)							
	Products Transported to Plant					Products Transported from Plant		
Production	Engines	Components	Raw Materials	Fuel	Lubricants	Aircraft	Spare Parts	Scrap
1953	152	76	882.9	6,220	20.2	627	94	435
1954 Capacity	Unknown	Unknown	2,236.5	11,100	44.8	Unknown	Unknown	1,011
1955 Capacity	Unknown	Unknown	3,972.0	11,100	44.8	Unknown	Unknown	1,790
1956 Capacity	Unknown	Unknown	4,680.8	11,100	44.8	Unknown	Unknown	2,120

1. **Plant Number:** 464

2. **Plant Location:**

   a. Nearest City and Coordinates: Moscow 55°55'67"N - 37°31'E

   b. Economic Region: VII

3. **Plant Area:** 330,000 square feet

4. **Scale of Effort:** 45 percent

5. **Production Data:**

   a. 1953 Production:

Model	Airframe Weight (Pounds)	Units per Year	Pounds per Year (including Spares)
Yak-12	807	240	240,000
Type 24	6,300	168	1,386,000

   b. Capacity Production:

Year	Model	Pounds per Year (including Spares)
1954	AMPR weight under 20,000 pounds	2,230,000
1955	AMPR weight under 20,000 pounds	3,960,000
1956	AMPR weight under 20,000 pounds	4,650,000

6. Input Data:

a. Materials:

Yearly Gross Requirements
(Metric Tons)

	Type of Material								
Production	Low-Carbon Steel	Alloy Steel (Not including Stainless Steel)	Stainless Steel	Aluminum	Copper Copper Base Alloys	Magnesium	Lead	Rubber	Glass and Plastics
1953	20.7	353	3.3	846	22.2	0.0	2.6	5.0	7.6
1954 Capacity	36.4	619	5.9	1,070	40.5	11.4	9.3	38.4	13.2
1955 Capacity	64.7	1,100	10.4	1,900	71.9	18.5	16.5	68.3	23.4
1956 Capacity	76.0	1,290	12.2	2,240	84.4	21.7	19.4	80.2	27.4

b. Manpower:

Manpower Requirements
(Man-Years)

Production	Total	Direct	Indirect	Skilled	Unskilled	Managerial	Technical
1953	2,000	1,000	1,000	700	1,300	400	360
1954 Capacity	4,400	2,200	2,200	1,540	2,860	880	792
1955 Capacity	4,400	2,200	2,200	1,540	2,860	880	792
1956 Capacity	4,400	2,200	2,200	1,540	2,860	880	792

c. Electrical Energy:

Source: Moscow City Grid

Alternate Source: Plant power station

Production	Electrical Energy Requirements (Kilowatt-Hours)
1953	2,950,000
1954 Capacity	6,500,000
1955 Capacity	6,500,000
1956 Capacity	6,500,000

d. Fuel and Lubricants:

	Fuel	Lubricants		
Production	Coal (Metric Tons)	Lube Grease (Metric Tons)	Lube Oil (Gallons)	Cutting Oils (Gallons)
1953	5,150	0.46	3,460	1,280
1954 Capacity	9,240	1.03	7,690	2,840
1955 Capacity	9,240	1.03	7,690	2,840
1956 Capacity	9,240	1.03	7,690	2,840

e. Transportation:

Transportation Required
(Metric Tons)

	Products Transported to Plant					Products Transported from Plant		
Production	Engines	Components	Raw Materials	Fuel	Lubricants	Aircraft	Spare Parts	Scrap
1953	47	39	1,260.4	5,150	16.5	480	170	522
1954 Capacity	Unknown	Unknown	1,844.1	9,240	36.8	Unknown	Unknown	833
1955 Capacity	Unknown	Unknown	3,273.7	9,240	36.8	Unknown	Unknown	1,478
1956 Capacity	Unknown	Unknown	3,851.3	9,240	36.8	Unknown	Unknown	1,741

1. **Plant Number:** 473

2. **Plant Location:**

   a. Nearest City and Coordinates: Kiev 50°27'N - 30°24'E

   b. Economic Region: III

3. **Plant Area:** 268,334 square feet

4. **Scale of Effort:** 45 percent

5. **Production Data:**

   a. 1953 Production:

Model	Airframe Weight (Pounds)	Units per Year	Pounds per Year (including Spares)
AN-2	3,500	132	558,000
Type 36	4,710	55	324,000

   b. Capacity Production:

Year	Model	Units per Year	Pounds per Year (including Spares)
1954	Type 36	377	1,810,000
1955	Type 36	671	3,220,000
1956	Type 36	788	3,780,000

6. Input Data:

a. Materials:

Yearly Gross Requirements
(Metric Tons)

Production	Low-Carbon Steel	Alloy Steel (Not including Stainless Steel)	Stainless Steel	Aluminum	Copper Copper Base Alloys	Magnesium	Lead	Rubber	Glass and Plastics
1953	23.4	408	3.8	410	20.1	46.6	1.2	4.0	6.8
1954 Capacity	83.0	1,430	13.1	862	59.9	26.0	0	9.9	19.7
1955 Capacity	148	2,254	23.4	1,530	107	46.3	0	17.5	35.0
1956 Capacity	176	2,990	27.4	1,800	125	54.4	0	20.6	41.2

b. Manpower:

Manpower Requirements
(Man-Years)

Production	Total	Direct	Indirect	Skilled	Unskilled	Managerial	Technical
1953	1,630	815	570	570	1,060	326	293
1954 Capacity	3,580	1,790	1,790	1,250	2,330	716	644
1955 Capacity	3,580	1,790	1,790	1,250	2,330	716	644
1956 Capacity	3,580	1,790	1,790	1,250	2,330	716	644

c. Electrical Energy:

Source: City Plant

Alternate Source: Plant emergency generator

Production	Electrical Energy Requirements (Kilowatt-Hours)
1953	2,400,000
1954 Capacity	5,280,000
1955 Capacity	5,280,000
1956 Capacity	5,280,000

d. Fuel and Lubricants:

	Fuel	Lubricants		
Production	Coal (Metric Tons)	Lube Grease (Metric Tons)	Lube Oil (Gallons)	Cutting Oils (Gallons)
1953	3,320	0.38	2,820	1,040
1954 Capacity	5,950	0.84	6,260	2,310
1955 Capacity	5,950	0.84	6,260	2,310
1956 Capacity	5,950	0.84	6,260	2,310

e. Transportation:

Transportation Required
(Metric Tons)

	Products Transported to Plant					Products Transported from Plant		
Production	Engines	Components	Raw Materials	Fuel	Lubricants	Aircraft	Spare Parts	Scrap
1953	114	51	923.9	3,320	13.5	0	73	597
1954 Capacity	203	81	2,503.6	5,950	29.9	0	164	1,683
1955 Capacity	360	144	4,447.2	5,950	29.9	0	302	2,976
1956 Capacity	423	169	5,231.6	5,950	29.9	0	341	3,518

APPENDIX B

METHODOLOGY

The types of methodology used in this report have been explained in detail in the text. This appendix consists of a consolidation and summary of these types of methodology. In general, the types of methodology used have been based upon analysis of captured Soviet equipment, equivalent US production data, and reliable Soviet defectors.

1. Materials.

The materials input requirements were estimated for Soviet airframes and aircraft engines by analogy with comparable US types. Wherever possible, however, estimates of materials inputs have been based on the study of captured Soviet aircraft, notably the MIG-15. In certain cases where neither captured equipment nor comparable US aircraft were available, the gross materials input for the Soviet aircraft was computed from the gross materials input for the MIG-15: the gross input was corrected by the ratio of the estimated AMPR airframe weight of the Soviet aircraft to the AMPR airframe weight of the MIG-15. Estimates of materials input requirements for the production of Soviet aircraft engines were based almost entirely upon requirements for analogous US aircraft engines because ATIC examination had revealed that no significant quantitative differences in materials applications between the Soviet models and the US counterparts exist. The materials input coefficients were summarized in Tables 2 and 4 for airframes and aircraft engines.

2. Labor.

Estimates of manpower requirements of the Soviet airframe industry were made on the basis of the expected worker density in Soviet plants. The expected worker density was based upon the conclusion reached from examination of a captured MIG-15 that shop methods in Soviet plants making the MIG-15 would closely parallel those found during World War II in US fighter plants. The estimated worker densities expected to be in effect at Soviet plants were as follows:

Number of Full Shifts	Worker Density (Square Feet of Floor Area per Total Worker)
1	165.0
2	127.5
3	75.0

Total employment estimates were derived directly with these density figures by dividing the amount of floor space for airframe production by the density figure.

Ratios for the airframe industry of skilled labor to unskilled labor and direct to indirect labor and the percentage of managerial and technical personnel employed were obtained through the interrogations of highly reliable Soviet defectors.

Manpower requirements for the Soviet aircraft engine industry were estimated by assuming that the same relationship exists in the USSR between the number of workers in the aircraft engine industry and the airframe industry as exists in the US: namely, the aircraft engine industry employs only 30.6 percent as many workers as are employed by the airframe industry.

3. Electrical Energy.

In order to estimate the quantity of electrical energy consumed by Soviet airframe and aircraft engine plants during 1953 and during capacity production it was necessary to resort almost completely to analogous US data. Soviet airframe plants probably use less electrical energy than the average US airframe plant in view of the apparent Soviet shortage of machine tools. In order, therefore, to obtain an electrical energy input coefficient for Soviet airframe plants of the 10 US airframe plants for which data were available, the data for the plant having the lowest consumption of electrical energy per square foot of floor area of the plants producing bombers and transports were used together with data for the lowest consumer of electrical energy among the fighter plants. The average consumption of electrical energy in these 2 plants was 8.95 kilowatt-hours per square foot per year for 1 shift. Accordingly, the following factors were determined for use in estimating the consumption of electrical energy in Soviet airframe plants:

Number of Shifts	Scale of Effort	Electrical Energy Input Factor (Kilowatt-Hours per Square Foot per Year)
1	0.45	8.95
2	0.77	15.21
3	1.00	19.69

Indications are that the Soviet aircraft engine plants employ fabrication methods similar to the US. The assumption was made, therefore, that the consumption of electrical energy in the Soviet aircraft engine industry is equal to the consumption of the US aircraft engine industry. Data were available for the electrical energy consumption of five US aircraft engine plants during World War II. The average consumption of these 5 plants at capacity was 40.4 kilowatt-hours per square foot per year. Thus, the following factors were used to determine electrical energy requirements in Soviet aircraft engine plants:

Number of Shifts	Scale of Effort	Electrical Energy Input Factor (Kilowatt-Hour per Square Foot per Year)
1	0.45	18.2
2	0.77	31.1
3	1.00	40.4

4. Fuels and Lubricants.

Estimated consumption of fuels by the Soviet aircraft industry has been limited to coal required for plant heating. The lubricants considered were those for the machinery, such as oils and greases, and the lubricants necessary for machining, such as cutting oils.

US aircraft industry data were used in determining the requirements for fuel of the Soviet aircraft industry. In general, heat is not required when the mean temperature for the 24 hours reaches 65°F. When this temperature is used as a base, each degree that the mean daily temperature is below 65°F is a degree-day unit. Fuel consumption per square foot of radiation is approximately proportional to the number of degree-day units. From US data, the following consumption factors were determined for an aircraft plant in a locality having 4,602 degree-day units per year:

Number of Shifts	Fuel Input Factor (Pounds of Coal per Square Foot per Year)
1	16.7
2	23.3
3	30.0

The above factors together with the yearly degree-day units for the cities in which the Soviet plants are located were used to determine the amount of coal required by the Soviet aircraft industry.

From US data, the following lubricant input factors were determined for Soviet airframe plants:

Scale of Effort (Percent)	Lubricating Grease (Pounds per Square Foot per Year)	Lubricating Oil (Gallons per Square Foot per Year)	Cutting Oil (Gallons per Square Foot per Year)
0.45	0.00313	0.0106	0.00392
0.77	0.00532	0.0180	0.00666
1.00	0.00688	0.0233	0.00862

Assuming that the ratio of consumption of lubricants per square foot of floor area of an aircraft engine plant to an airframe plant is approximately equal to the ratio of electrical energy consumption per square foot of floor area, the conclusion was reached that aircraft engine plants consume 2.05 times the lubricants consumed per square foot of floor area by airframe plants.

5. Transportation.

It was found to be unfeasible to estimate transportation requirements in terms of the normal measure of ton-miles because of the complexity of determining the source of every input into the industry. Transportation was therefore estimated in terms of the total tons of transportation required to support the production of each plant and to distribute the final product to its ultimate destination. The pounds of components required for each aircraft were estimated by subtracting the AMPR airframe weight plus the aircraft engine dry weight from the empty weight of the aircraft. The pounds of components required for each aircraft engine were assumed to be 2 percent of the total pounds of engines produced. The amount of scrap was determined by subtracting the pounds produced from the amount of raw material required. The assumption was made that only the MIG-15, the Type 38, the Yak-11, and the Yak-18 aircrafts would be crated and shipped from the plant. All other aircraft are assumed to be flown away.

APPENDIX C

GAPS IN INTELLIGENCE

There are almost no data available on the Soviet airframe materials inputs with the exception of the MIG-15. Observations of the Yak-11, Yak-9, Tu-2, and Il-10 furnish some information as to Soviet materials application in airframes but these aircraft are considered obsolete. The procurement of Soviet jet and reciprocating bombers for complete analysis is an urgent requirement.

The data available on Soviet manpower practices of the Soviet aircraft industry are limited to the interrogation of one highly reliable and knowledgeable Soviet defector. Furthermore, the date of this defector's information is for the period 1937-47. No data exist on current Soviet manpower practices in the aircraft industry. Any information on employment, shifts, and skills of workers would be invaluable for revision of this report.

There is no intelligence available on current Soviet inputs of electrical energy, fuels, and lubricants. The data that are available are prior to 1949 and are primarily from prisoner-of-war reports. The input data in these reports are generally considered as unreliable.

[p164 blank]

APPENDIX D

SOURCES AND EVALUATION OF SOURCES

1. Evaluation of Sources.

The major sources for the materials inputs have been Air Technical Intelligence Center studies and reports of analysis of captured Soviet equipment and bills of materials for US aircraft furnished by the Air Materiel Command, Wright-Patterson Air Force Base, Ohio. These sources are considered to be highly reliable.

The source for the percentages of skilled labor and unskilled labor and of managerial and technical personnel was the interrogation of an apparently highly reliable and knowledgeable Soviet defector. The major sources for the Soviet worker density were an excellent production study of the MIG-15 by North American Aviation, Inc. and highly reliable US manpower data.

The major sources for the electrical energy, fuel, and lubricant inputs were data submitted by US aircraft plants. These data are considered reliable.

2. Sources.

1. Air, ATIC Technical Report No. TR-AC-23, "Soviet Jet Aircraft Engine Capabilities and Deficiencies," 12 Mar 1953. S.
2. Air, ATIC Study No. 102-AC-51/28-34, "Preliminary Analysis of Crashed Aircraft," 6 Aug 1951. S.
3. Air, ATIC Technical Report No. TR-AE-6, "Rough Stock -- Bill of Materials and Materials Study of the MIG-15 Airplane," 12 Nov 1952. S.
4. Air, ATIC Technical Report No. T52-5663, "Supplementary Metallurgical Examination of Selected Parts of Foreign Turbojet Engine," 11 Jul 1952. S.
   Air, ATIC Technical Report No. TR-AC-6, "Description of Soviet M-11 FR-1 Aircraft Engine," Feb 1952. C.
5. Air, ATIC Technical Report No. TR-AC-23.

[p.166 blank]

6. Air, AMC I/D Study No. 102-AC-50/47-34, "ASH-82 FNV Aircraft Engine (USSR)," Oct 1950. C.
7. Air, ATIC Technical Report No. TR-AE-6.
   Air, ATIC Bulletin, Vol. II, No. 46, 13 Nov 1953. S.
8. Air, ATIC Technical Report No. TR-AE-6.
9. Air, ATIC Study No. 102-AE-51/7-34, "Soviet ASH-62 IR Aircraft Engine Manufacturing Methods Analysis," 29 Nov 1951. S.
   Air, ATIC Technical Report No. 9, "Examination of Foreign Aircraft-Engine Pistons and Piston Assemblies," 4 Sep 1951. S.
   Air, ATIC Technical Report No. 42, "Examination of Valve Guides, Valve-Seat Inserts, and Valve Springs from Foreign-Aircraft Reciprocating Engines," 27 Oct 1952. C.
   Air, ATIC Technical Report No. 32, "Metallurgical Examination of Critical Components of a Foreign Reciprocating Aircraft Engine," 27 Jun 1952. C.
10. Air, ATIC Technical Report No. T52-5663.
   Air, ATIC Technical Report No. TR-AE-15, "Examination of Aluminized Outer Combustion Chambers in the MIG-15 Engines,' 18 Feb 1953. S.
   Air, ATIC Technical Report No. TR-AC-23.
   Air, ATIC Study No. 102-AC-51/10-34, "Analysis of MIG-15 Power Plant and Airplane Parts and Estimate of Performance Capabilities," 28 Apr 1951. S.
11. Air, ATIC Study No. 102-AC-51/11-34, "Soviet Aircraft and Engine Materials," 5 Feb 1951. S.
12. Air, ATIC Technical Report No. T52-5663.
   Air, ATIC Study No. 102-AE-53/1-34, "The Status of Aircraft Metallurgy in the USSR," 1 Sep 1953. S.
   Air, ATIC Technical Report No. TR-AC-23.
13. Air, ATIC Technical Report No. 5, "Examination of Foreign Aircraft Engine and Airframe Parts," 16 Aug 1951. S.
14. Air, ATIC Technical Report No. TR-AE-13, "Materials Study of Selected Components of a Foreign-Aircraft Airframe," 30 Jan 1953. S.
   Air, ATIC Technical Report No. 8, "Examination of Foreign Aircraft Engine Oil-Pump O-Rings," 14 Aug 1951. S.
   Air, ATIC Technical Report No. TR-AE-18, "Analysis of Soviet Thiokol Sample," 23 Jan 1953. S.

15. Air, ATIC Study No. 102-AE-52/13-34, "An Estimate of the Status of Soviet Aircraft Plastics Technology," 18 Nov 1952. S.
16. *Ibid.*
17. Air, ATIC Preliminary Report on Foreign Equipment Report No. FE-1260, "Disc Turbine RD 45," 23 May 1952. S.
18. Air, ATIC Technical Report No. TR-AC-24, "Description and Performance of Soviet VK-1 Turbojet Engine No. 14105," 22 Jul 1953. S.
19. Air, ATIC Technical Report No. TR-AE-15.
20. Air, ATIC Technical Report No. T52-5663.
21. *Air Intelligence Digest*, May 1952. S.
22. Air, ATIC Technical Report No. 10, "Examination of Valves for Foreign Aircraft Engines," 4 Sep 1951. S.
23. *Ibid.*
24. *Ibid.*
25. Air, ATIC Technical Report No. TR-AE-6.
26. *Ibid.*
27. Air, ATIC Letter No. AFOIN/ATIAW-3, "Materials Usage in Soviet Aircraft (C)," 10 Jun 1953. S.
28. *Ibid.*
29. Air, ATIC Bulletin, Vol. II, No. 46, *op. cit.*
    Air, ATIC Technical Report No. TR-AE-13, *op. cit.*
30. Air, ATIC Study No. 102-AE-51/11-34, "Soviet ASH-21 Aircraft Engine Manufacturing Methods Analysis," 27 Dec 1951. S.
31. CIA, ORR Project 33.235, *Analysis of the Aircraft Industry of the USSR*, unpublished. TS.
32. *Ibid.*
33. Air, ATIC Technical Report No. TR-AE-3, "MIG-15 Production Study," 4 Jan 1952. S.
34. Defense, WDGS, Intelligence Report No. RT-578-50 (STI-3831), 13 Jun 1950 (date of information, 1937-47). S.
35. Consolidated Vultee Aircraft Corp., "Industrial Mobilization Phase II Resources Planning Study," 21 Jul 1948. C.
36. Air, ATIC Technical Report No. TR-AE-3.
37. North American Aviation, Inc., "Statistical Summary World War II Historical Production Data Airframe Industry," Jul 1949. C.
38. Defense, WDGS, Intelligence Report No. RT-578-50.
39. *Ibid.*
40. Air, ATIC Technical Report No. TR-AE-3.

41. *Ibid*.
42. North American Aviation, Inc.
43. Air, ATIC Technical Report No. TR-AE-3.
44. CIA, I/AR Branch Memorandum 53-3-2, "Interim Method of Estimating Soviet Production." S.
45. CAA Report 101, "Military and Civil Aircraft and Engine Production," Dec 1952. C.
46. CIA, ORR Project 33.235.
47. Air, ATIC Technical Report No. TR-AE-3, *op. cit*.
    CIA, I/AR Branch Memorandum 53-3-2, *op. cit*.
48. USAF, Air Materiel Command, *Source Book of World War II Basic Data Airframe Industry*. U.
49. Air, ATIC Technical Report No. TR-AE-3.
50. Air, ATIC Technical Report No. TR-AC-23.
    Air, ATIC Conference Report No. T53-3863, "Second ATIC Propulsion Panel Meeting," 13 Apr 1953. S.
51. Industrial College of the Armed Forces, Report No. L52-95, "Jet Engine Production," 11 Feb 1952. C.
52. L.S. Marks, *Mechanical Engineers' Handbook*, Fifth Edition, p. 1,595.