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ECONOMIC INTELLIGENCE REPORT

THE SOVIET POTENTIAL FOR THE PRODUCTION OF MUNITIONS

CIA/RR 36

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TOP SECRET

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(ORR Project 31.212)

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FOREWORD

The objectives of this report are to estimate the potential of the USSR to produce munitions and to develop a check on the consistency of estimated current munitions production with budgetary allocations for munitions procurement. For the purposes of this report, munitions are defined to include all military hard goods such as aircraft, naval vessels, artillery, small arms, mortars, armored vehicles, other military vehicles, and ammunition.

CONTENTS

Appendixes

50X1

Tables

NOTE ON CLASSIFICATION

The over-all classification of this report is TOP SECRET. Appendix G, however, is classified SECRET.

THE SOVIET POTENTIAL FOR THE PRODUCTION OF MUNITIONS*

Summary

The potential of an economy to produce munitions is determined by the capability of the economy to produce total output and by the proportions of that output that can be allocated to military purposes. This allocation, for any given time period, is primarily a matter of policy, though within broadly defined limits.

The potential of the USSR to produce munitions in a future year may be estimated by alternative techniques utilizing different sets of data. The means selected in this report is to develop a systematic relationship between 1944, a year of presumably maximum allocation of economic effort toward the production of munitions, and the future year for which an estimate of potential munitions output is desired. An index of potential munitions output, with 1944 as the base year, is estimated from an index of industrial production. The value of potential munitions production in a future year is then determined as the product of the 1944 output of munitions and the munitions potential output index as projected to the future year.

The industrial production index is aggregated from indexes for three classes of activity: producer goods, consumer goods, and munitions production. Indexes for producer and consumer goods have been developed previously. The index of munitions production is estimated by combining Soviet defense budget data with munitions output data. The munitions production index serves two purposes. In addition to its use as a component of the industrial production index, it is used to check the consistency of current Soviet munitions output estimates. The industrial production index is converted into an index of potential munitions output by an upward adjustment to account for repressed consumption during a mobilization period. The resulting series, called an index of munitions-producing potential, is extrapolated to 1957:

* The estimates and conclusions contained in this report represent the best judgment of the responsible analyst as of 1 April 1954.

Year	Index
1944	100
1954	224
1955	242
1956	264
1957	286

To estimate the value of munitions production in 1944, the base year, prices for Soviet munitions produced during that year are computed and expressed in dollars because ruble prices are not available. These prices are the estimated dollar costs of producing Soviet items of munition in the US at 1945 price levels. In addition to prices for World War II equipment, dollar prices for current Soviet munitions are computed (in terms of 1945 price levels) in order to obtain comparable costs for current and World War II type Soviet weapons. Taking unit dollar prices and multiplying by the quantity of munitions produced in 1944, gives an amount equal to US $10.7 billion (in 1945 prices), the value of munitions produced in that year. This amount, multiplied by the index of munitions-producing potential, places the potential output of munitions in the USSR (in billions of US dollars at 1945 prices) as follows:

Year	Billion 1945 Dollars
1954	23.9
1955	25.8
1956	28.1
1957	30.5

These aggregate values may be expressed in units of military hard goods by combining them with the dollar costs of current Soviet weapons. For example, the 1956 aggregate value of US $28.1 billion could represent the units of military end items* shown in Table 1.**

To check the consistency of estimates of current munitions production with budgetary allocations for munitions procurement, the 1952 and 1953 values in a munitions production index, based primarily on procurement data, are multiplied by the value of munitions production in 1944.

* See Section IV, B, and Appendix E for assumptions required to derive these figures.

** Table 1 follows on p. 3.

Table 1

A Probable Distribution of Soviet Potential Munitions Production in 1956 a/

Military End Items	Amount of Production
Aircraft (Units)	38,500
Armored Vehicles (Units)	36,800
Artillery Pieces (Units)	116,000
Small Arms (Units)	4,800,000
Mortars (Units)	42,000
Naval Vessels (Displacement Tons)	173,000
Ammunition (Tons)	8,850,000
Automotive Vehicles (Units)	266,700

a. The distribution of the aggregate potential among categories is a probable one. Conceptually, the possible number of distributions is infinite, limited only by the aggregate value.

The resulting magnitudes are compared with the computed dollar cost of current munitions production estimated [redacted]. These values are shown in Table 2.* 50X1

These data indicate that current estimates of munitions production are about 10 percent too high if the munitions index is taken as the criterion. The index of munitions production, however, is not sufficiently precise to allow this conclusion without considerable qualification. It is, perhaps, as important that the two sets of independent data agree so closely.

Independent estimates of capacity output for individual items of munitions have been developed by intelligence research. These estimates, when aggregated, may be compared with the estimated potential (maximum) output of munitions given above. The individually derived capacity estimates in the aggregate are from 30 to 50 percent higher than the maximum level indicated by the analysis in this report. An aggregation of the dollar value for individual estimates of capacity output totals

* Table 2 follows on p. 4.

Table 2

Intelligence Estimates of Soviet Munitions Production
Compared with Budgetary Allocations
for Munitions Procurement

US $ Million (1945)

Year	Value Computed from Munitions Index Based on Budget	Value of Intelligence Estimates of Munitions Production a/	Percentage Difference
1952	5,240	5,800	+11
1953	5,480	5,920	+ 8

a. Intelligence estimates as of 1 April 1954 of munitions production multiplied by unit dollar costs.

from US $36 billion to US $42 billion; the comparable figure for potential value of Soviet munitions output in 1956 is about US $28 billion. This discrepancy is explained by the methods used to determine capacity output for individual items. These have often been made with reference to one limiting factor only, such as plant capacity. They may or may not take into account activities required simultaneously in other sectors of the economy.

I. Introduction.

A. Statement of Objectives.

The objectives of this report are (1) to estimate the potential of the USSR to produce munitions during selected years in the future and (2) to check the consistency of estimates of munitions production in the USSR with budgetary allocations during the post-World War II period.

b. Statement of Problem.

The potential of a nation to produce munitions is only one aspect of its national power. National power is often held to be based upon industrial capacity, natural resources, population, national morale, national character, geography, military preparedness, and diplomacy. 1/* The first three of these elements are the most significant for the purposes of determining a nation's total output of goods and services and thus indirectly the potential output of munitions. In a peacetime economy these productive resources "are conceived as being engaged with a certain rhythmic regularity in producing the national dividend, or national real income, of successive years." 2/ If the peacetime economy is "stationary,"** about the same volume of goods and services is produced and consumed each year, annual depreciation of capital goods being a part of consumption. In a progressive economy, as most modern economies are, some portion of the national real income takes the form of increments to the capital stock -- for example, net investment, which makes for a larger real income in the future.

In time of war or during full mobilization the productive resources of any economy are essentially the same as in peacetime, but they are devoted to different uses and are more intensively utilized. In such a time the goal of the national economy is maximum military effort including an optimum output of munitions. This situation usually implies running the economy at higher than normal rates. Thus, "when the normal income-producing power of the country is given, there are four principal sources from which this amount -- the real war fund, as it were -- can be drawn. They are: (1) augmented production, (2) reduced personal consumption, (3) reduced investment in new forms of capital, and (4) depletion of existing capital." 3/

The flow of total output represented by the "real war fund" will be divided between (1) finished munitions and personnel services, including all goods and services used by the armed forces and (2) capital goods for the munitions industries. The distribution of a real war fund between current munitions and capital goods for producing future munitions will depend on the conditions prevailing at time of mobilization. For instance, the output of capital goods

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** That is, if net investment is zero.

relative to the output of munitions will depend on the stock of capital goods currently available for the production of munitions -- that is, on the size of the "mobilization base," on inventories of finished munitions, and on the current "munitions needs relative to the expected requirements a few months later."* In addition, the size of the real war fund obtained from a given national income will vary with the urgency of war and the degree of governmental control.

C. Procedure for Estimating Soviet Mobilization Potential.

In making an estimate of the quantity of resources available to the USSR for the production of munitions during a future mobilization period, it is clearly not possible to take into account all of these conditions. Attention will be directed to a future period when a maximum industrial mobilization for war can be assumed. Only the hard goods component of the real war fund -- that is, munitions and capital goods production -- will be considered explicitly, and no account will be taken of personnel services, subsistence, and other factors. The distribution of this hard goods component of the real war fund between munitions and capital goods will be taken as similar to the distribution in 1944.

The magnitude of the military hard goods, or munitions, component of the real war fund is estimated indirectly. It is assumed that the budgetary allocation to munitions procurement in 1944 represents the maximum value of resources that could have been used for that purpose. It is assumed that changes in the magnitude of munitions-producing potential are uniquely related to changes in an adjusted industrial output index. These assumptions are discussed in Appendixes A and G.

The procedure used in this report thus involves the measurement of changes in munitions-producing potential in future years by means of changes in industrial production from a base year (1944) in which potential was closest to realization. The main assumption

* A country will not usually be interested in the maximum amount of munitions that could be produced in some particular year. Rather, it will be concerned with the discounted sum of the outputs of munitions that can be produced from the start of mobilization to the time when it is expected that the war will be over. That is, the country will try to arrange its productive resources so that the sum of all munitions that could be produced from the start of mobilization to the end of the

underlying this procedure is that changes in munitions potential can be measured by changes in an adjusted industrial production index.* Other magnitudes, such as manufacturing output, capital goods output, or gross national product, could be considered as alternative indicators.**

Some would argue that any of the alternative magnitudes noted above would be better indicators of changes in the capability to produce a combination of munitions and capital goods than munitions alone. Thus an additional assumption becomes necessary -- that the proportion of capital goods to munitions during the future full mobilization years would be the same as it was during the World War II base year. If this assumption holds, the adjusted industrial production index is a useful indicator of changes in munitions potential.***

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prospective war will be a maximum, making allowances for the different value placed on munitions available during the different periods of time.

* The adjustments are described in Section II.

** Except for manufacturing output these alternatives are not attractive. Capital goods output, a component of industrial output, is subject to more intense year-to-year fluctuations than the larger aggregate. Munitions potential would not be expected to vary significantly from year to year. Gross national product is not a good alternative, since the USSR is becoming relatively more industrialized with the passage of time. This situation implies that a larger share of national product could be munitions output in future mobilization years than in the past. The output of manufacturing industries, although a reasonable alternative, is not likely to differ significantly from industrial production. In addition, the availability and comprehensiveness of data favor the use of the industrial output index. See Appendix A for more detailed discussion.

*** It should be noted that the second (proportionality) assumption is not so crucial as the first. Capital goods output was a relatively small part of 1944 munitions and capital goods output. Therefore, even if the percentage of capital goods produced during a future full mobilization year is quite different than the 1944 percentage, the impact on the munitions component of the total is not very great.

The third assumption of the estimate of potential is that a single figure will adequately measure the value of the potential output of munitions. This assumption amounts to saying that munitions can be substituted for each other at ratios equal to the costs of production. Since the estimate applies only to a full mobilization period, sufficient time is available during the mobilization period for most of the adjustments in the magnitude and/or distribution of the capital stock that would be necessary.* In any event, this assumption sets an upper limit to the quantities of different types of munitions that could be produced within the total resources limitations imposed by the aggregate figure.

Several assumptions are necessary to translate this aggregate potential into items of munitions. It is hardly necessary to point out that any procedure used to arrive at quantitative estimates for a magnitude as complex as munitions-producing potential must inevitably rest on a series of these or similar assumptions. It is only possible to make what appears to be the most realistic of alternative assumptions, given the limitations imposed by the data.

* Given the stock of capital equipment available on the date of mobilization, one collection of munitions will be more consistent with it than another collection. If aircraft facilities are limited but the collection of munitions with one-half made up of aircraft is chosen, the aggregate value of munitions produced may be less than it would be if the mix with one-fourth aircraft had been selected. This would result from the relatively inefficient employment of the productive resources in the aircraft industry. A situation such as this is not likely to be present if future war requirements are adequately anticipated, nor is it likely to exist during years following the first mobilization years.

II. Munitions Expenditures, Industrial Growth, and the Potential to Produce Munitions.

A. Munitions Expenditures, 1940, 1944, and Postwar Years.

An index of munitions production is determined for the period from 1940 to 1953 by linking an index of munitions output from 1940 to 1948 to an index of munitions procurement from 1948 to 1953. The explicit allocations for defense and estimated supplementary funds for munitions procurement in the Soviet budgets for 1940 and 1944 to 1953 are given in Table 3.* The supplementary allocations listed in Table 3 are believed to be funds designated primarily for the procurement of armament from the internal and secret police allowances. The total defense allocations, including explicit and supplementary funds, probably do not include expenditures from large-scale nuclear programs. These expenditures are mainly for construction and special production equipment, items likely to show up elsewhere in the annual Soviet budget.

Military personnel costs are independent estimates of personnel pay and cost of maintenance. The figure for 1946 relative to 1945 may seem high in view of the known fact that the armed forces were drastically reduced in size. Pay rates, however, are believed to have doubled during that year. Even if the pay increase was more gradual, the postwar trend in the residual, major procurement of munitions, would not be affected.

Expenditures for military construction, operations, maintenance, and similar items are estimated at 20 percent of total defense allocations, a proportion somewhat lower than US expenditures for similar services. This figure could easily be in error by as much as 20 to 30 percent. The effect of a ± 25 percent error in this category would result only in about ± 5 to 10 percent error in the procurement figures for the postwar period. Moreover, it is of greater importance that there be consistency in the procurement estimates than that each absolute amount be correct, because the relative changes in the aggregate value of munitions procurement are the important factors for both the industrial output index and the check on intelligence estimates of munitions production.**

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* Table 3 follows on p. 10.

** See Appendix G.

Table 3

Defense Expenditures in the USSR a/
1940, 1944-53

Billion Current Rubles

	1940	1944	1945	1946	1947	1948	1949	1950	1951	1952	1953
Defense Budget b/	56.8	137.9	128.2	73.6	66.3	66.3	79.2	82.9	93.9	108.6	110.2
Supplementary Allocations c/	2.0	2.0	2.5	4.4	6.0	6.4	5.8	5.2	6.0	6.0	6.0
Total Defense Allocations	58.8	139.9	130.7	78.0	72.3	72.7	85.0	88.1	99.9	114.6	116.2
Military Personnel Costs	12.3	44.0 d/	44.0	38.0 e/	38.0	34.0	32.0	30.0	28.0	28.0	28.0
Military Construction	2.0 f/	3.0	3.0 f/	2.0	2.0	2.0	3.0	3.0	3.0	3.0	3.0
Operations, Maintenance, Research, Transportation, Military Finance, and General Overhead g/	12.0	28.0	26.0	16.0	14.0	15.0	17.0	18.0	20.0	23.0	23.0
Nonhard Goods	26.3	75.0	73.0	56.0	54.0	51.0	52.0	51.0	51.0	54.0	54.0
Residual: Major Procurement	32.5	64.9	57.7	22.0	18.3	21.7	33.0	37.1	48.9	60.6	62.2

a. Data from Appendix B.
b. Published budget allocation to defense.
c. These figures are the estimated portion, 25 percent, of the expenditures for internal security which may be expected to include outlays for personnel pay and equipment.
d. Estimated personnel costs were 42.2 billion rubles for 12 million troops. The personnel costs are increased to amount for 12.5 million troops.
e. Estimated from personnel cost for subsequent year.
f. Estimated from the 1941 economic plan, which gave a range of 3 to 4 billion rubles.
g. These expenditures were estimated at about 20 percent of total expenditures.

The above estimates of military expenditures are subtracted from the total defense appropriations, leaving munitions procurement as the residual. In order to make a comparison in real terms of munitions procurement expenditures in one year relative to other years, it is necessary to know the change in the level of munitions prices* during the period. Unfortunately, there are few indexes of price changes in the USSR for the past decade and none for price changes in the munitions sector. An index of price changes in capital equipment used as a munitions price index is listed in Table 4.

Table 4

Index of Real Munitions Based on Budgetary Allocations a/
1940, 1944-53

Year	Munitions Procurement (Billion Current Rubles)	Capital Equipment Price Index	Index of Real Munitions Output (1940 = 100)
1940	32.5	100	100
1944	64.9	82	243
1945	57.7	91	195
1946	22.0	94	72
1947	18.3	99	57
1948	21.7	104	64
1949	33.0	135	75
1950	37.1	115	99
1951	48.9	109	138
1952	60.6	106	176
1953	62.2	104	184

a. Data from Appendix B, Table 29.

* Price changes as used in this context include changes only in the prices of similar munitions; they do not include changes in price due to changes in quality or complexity.

This method of calculating a munitions output index is especially unreliable for the period 1940-48 because price indexes for the period are difficult to interpret as resources are shifted into and out of the munitions sector. Costs of munitions production vary sharply during such a period, decreasing rapidly during the conversion period while large-scale production is being achieved and changing without any clear pattern during demobilization. The price indexes are likely to be considerably more reliable during the 1948-53 period, as are the munitions procurement indexes computed from them.

In providing a more reliable index for the period 1940-48 it is possible to use the year-to-year changes in physical output during the same period. Estimates of munitions production by model and class for the USSR during World War II have been derived [redacted] 50X1
50X1
[redacted] These 50X1
data can be combined into an index of real munitions output by weighting with unit prices for the munition items.* The resulting index shown in Table 5 is accurate to the extent that the quality, complexity, and prices of the individual items remain constant.

Table 5

Index of Munitions Output in the USSR a/
1940-48

Year	Output Index
1940	100
1941	116
1942	209
1943	332
1944	370
1945	258
1946	62
1947	59
1948	66

a. Sources: Data from Appendix B, Table 30.

* Estimated dollar costs for Soviet World War II munitions are developed in Appendix C and are given in Section III; they are utilized in developing the output index.

Since the USSR did not begin extensive modernization of its military end-item program until sometime in 1946 or 1947, it is believed that the output index retains validity until that date. The use of 1945 US dollar cost weights biases the index to an extent, but it is likely that the bias is not serious. Several major changes were made in the process of developing the dollar cost weights. None of the changes appeared to make much difference in the growth rate shown by the index.

The two indexes of munitions output -- one derived from procurement (budget) data and one from production data -- are combined in Table 6* to give an index of munitions output in real terms from 1940 to 1953. The production index is used from 1940 to 1947; the procurement index, from 1949 onward. The indexes are linked in 1948 and will hereafter be referred as the combined munitions output index.

The combined index shows an increase from 1940 to 1948 somewhat greater than the procurement index because of the fact that the procurement index was lower than the output index, relative to 1940, during the year in which the two indexes were linked. It is reasonable that such would be the case, since munitions costs probably fell, relative to other industrial costs, between 1940 and 1948.** Since the procurement index is based on current ruble amounts deflated by an industrial equipment index, it will tend to understate the growth of munitions output when munitions costs decline relative to industrial costs.

B. Soviet Industrial Growth and Munitions-Producing Potential.

As indicated in Section I, it is proposed that changes in munitions-producing potential be measured in terms of changes in aggregate industrial output. Output indexes for the consumer goods and producer goods sectors of industry have been computed [redacted] 50X1

* Table 6 follows on p. 14.

** It is known that munitions costs fell considerably, relative to other industrial costs during the war period, going from 100 in 1940 to approximately 60 in 1944. 4/ While the decline in the scale of munitions output after the war probably reversed this situation, the fact that the Russians continued to produce on a moderately large scale means that part of the gain was retained. Industrial costs [redacted] 50X1
[redacted] declined slightly during the war period. 50X1

[redacted]. The index for actual defense output is taken from Table 6 and extrapolated from 1953 to 1957 at the annual rate of 5 percent per annum.* 50X1

Table 6

Indexes of Munitions Production in the USSR for Selected Years and a Combined Index 1940-53

Year	Munitions a/ Output Index (1940 = 100)	Procurement with CIA Price Index b/ (1940 = 100)	Combined Index c/ (1940 = 100)
1940	100	100	100
1941	116		116
1942	209		209
1943	332		332
1944	370		370
1945	258		258
1946	62		62
1947	59		59
1948	66	64	66
1949		75	77
1950		99	102
1951		138	143
1952		176	182
1953		184	190

a. Table 5, above.
b. Table 4, above.
c. The difference between use of the CIA price index and the UN price index is about 7 percent; the UN index would show a slightly lower postwar rate of growth than the above index with CIA prices.

* This rate of increase is the estimated cost of maintaining inventories of munitions now on hand in the USSR allowing for the introduction of new model weapons. See Appendix D.

The indexes in Table 7 are aggregated on the basis of 1951 value-added weights for both the major sectors shown directly and for the subsectors from which the major sectors were computed. The 1951 period is used as the base because of the known tendency of industrial output indexes to show a strong upward bias if weighted in accordance with outdated scarcity relationships. 5/

Table 7

Index of Soviet Industrial Output from 1940 to 1957
with 1951 Sector
and Intrasector Value-Added Weights a/

Year	Industrial Consumer Goods	Producer Goods	Defense Goods	Industrial Output
1940	76	54	70	63
1941	69	42	81	56
1942	53	24	146	49
1943	44	25	232	59
1944	38	29	259	63
1945	39	35	180	56
1946	50	42	43	45
1947	58	51	41	52
1948	71	64	46	64
1949	83	77	54	76
1950	92	91	71	89
1951	100	100	100	100
1952	107	107	127	110
1953	114	117	133	118
1954	123	129	140	129
1955	133	141	147	139
1956	143	153	154	150
1957	154	166	162	162

a. Data from Appendix B, Table 35.

The only other reliable alternative to a 1951 base period would be a 1940 base period, and the relative cost structure of Soviet industry has changed substantially since 1940.* The increases from 1955 onward in the consumer and producer goods index were projected by assuming annual increases of 7.5 percent and 8.5 percent, respectively, and are consistent with CIA estimates.

The index of Soviet industrial output shows an increase of about 160 percent between 1940 and 1957, and about 90 percent between 1940 and 1953. If a 1940 period had been used for the weight base, these figures would be about 190 percent and 115 percent respectively, or about 12 percent in excess of the figures in Table 7. The use of CIA price weights rather than the UN price weights for the defense index (see Appendix B) makes a difference of less than 1 percent.

One further adjustment is needed to convert the industrial output index into an index of growth in munitions production potential. It is clear that munitions production potential has grown by at least as much as the growth of industrial output. During World War II it was necessary to divert part of industrial output to the production of consumer goods and some capital equipment. During a future full mobilization it would be necessary to do the same, although the proportion of output so diverted might not be as large. The World War II per capita output of industrial consumer goods has therefore been projected forward on the basis of population changes. Any resources used to produce consumer goods over and above this minimum requirement could presumably be used for the munitions or capital goods sector in the event of industrial mobilization. These potential resources available from consumption cuts are added to the producer goods and defense sectors in computing the munitions potential "index." This index (Table 8**) indicates the rate of growth of industrial resources that could be used for either munitions or capital goods production. To compare industrial potential during the World War II year of maximum effort with industrial potential during future hypothetical full-mobilization years, the index is shown for selected years with the 1944 period equalling 100. For comparison, the industrial output index is presented with the same base year.

As is clear from Table 8, the munitions potential index shows a slightly larger growth than industrial output, which necessarily follows from the manner of construction. Indicators of growth in potential other

* See Appendix B.

** Table 8 follows on p. 17.

Table 8

Indexes of Munitions-Producing Potential and Industrial Output 1944, 1949-57

1944 = 100

Year	Munitions-Producing Potential [a]	Industrial Output [b]
1944	100	100
1949	124	121
1950	147	141
1951	169	159
1952	188	175
1953	203	187
1954	224	205
1955	242	221
1956	264	238
1957	286	257

a. Details of calculation shown in Appendix A, Table 22.
b. Data from Table 7, recomputed to a 1944 base.

than the adjusted industrial production index are calculated in Appendix A. Alternative calculations are all within plus 5 and minus 25 percent of the index calculated in Table 8. Reasons for the choice of the munitions-producing potential index are discussed in Appendix A.

One comment should be made concerning the nature of a munitions potential index. The measure is designed to show the relative change over time in the ability of the USSR to produce munitions under conditions of full mobilization. Thus the 1953 index of 203 may be interpreted to mean that the USSR could have produced about twice as many munitions in 1953 as they produced in 1944, provided the Russians were mobilized to the same extent and provided that shortages of particular kinds of industrial resources did not impede the munitions efforts.* Measures of munitions-producing potential for other years must be interpreted in a similar fashion.

* This would have been true, of course, only if the USSR had originated mobilization during, say, 1951.

The increase in munitions-producing potential shown above is imposing. However, the growth of Soviet economy has been equally imposing. In addition to the aggregate growth indicators discussed above and in Appendix A, the increases in availability of basic materials shown in Table 9 are instructive.

Table 9

Comparative Estimate of the Aggregate Increase in Munitions-Producing Potential with Increases in Selected Basic Materials a/ 1944, 1953-57

Indexes of Output	1944	1953	1954	1955	1956	1957
Munitions-Producing Aggregate	100	203	224	242	264	286
Steel	100	335	370	400	430	460
Copper	100	90	100	105	115	120
Aluminum	100	110	125	140	155	170
All Metals	100	260	280	310	330	355
Electric Power	100	330	370	425	470	515
Coal	100	275	290	310	330	350
POL	100	255	265	280	295	310
All Fuels	100	290	315	345	370	400

a. Further data in Appendix A, Table 24. The 1944 figures include Lend-Lease materials supplied to the USSR.

These data all show increases that seem to be of the same order of magnitude as the increase in aggregate potential, although individual items vary greatly as might be expected. Additional evidence of the general validity of the CIA estimate is contained in the fact that the metal-fabricating capacity of the USSR, as measured by the inventory of machine tools, is expected to be approximately 1.5 million units by 1956, compared to between 0.5 and 0.6 million units in 1944. This represents an expansion of from 2.5 to 3 times.

III. Dollar Cost Estimates for Major Items of Soviet Munitions.

A. Reason for Dollar Cost Estimates.

The output during World War II of various items of Soviet munitions multiplied by appropriate ruble prices would give a magnitude which should equal the estimated munitions procurement portion of the defense budget. Furthermore, ruble prices coupled with proportions among items of munitions would permit the current aggregate value of munitions procurement estimated from the defense budget to be expressed in terms of output by type of munitions. An aggregate potential value of munitions could be handled in a similar fashion. Unfortunately, ruble prices for Soviet munitions are not available.* If it is assumed that a similar relationship between cost structures in the US and USSR exists, relative dollar prices can be used as an approximation to relative ruble prices. Since the ruble aggregates mentioned above can also be expressed in dollars, the aggregates can then be translated into quantities of munitions by type. The assumption is therefore made that the cost of producing an item of munition in one munitions category relative to the cost in another is the same in the US as it is in the USSR, with due allowance for differences in US and Soviet models of munitions. That is, it is assumed that the cost of a MIG-15 fighter aircraft relative to the cost of a T-54 medium tank is the same whether these items are produced in the US or in the USSR. Estimates of the cost of producing the various items of Soviet munitions in the US at 1954 prices are presented in Table 10.**

* There are virtually no direct Soviet price data available for the major items of munitions, although it is possible to derive estimates of ruble price for some items of munitions from scattered open publications. For instance, the director of the Kirov Tank Plant in 1945 stated that "during the war the net cost of producing a heavy tank was reduced 53 percent. The saving effected by this cost reduction was 2500 million rubles." 5/ It is stated further that from the beginning of heavy tank production to the end of the war 18,000 tanks were produced by the plant. The price index for this tank is estimated to have fallen from 100 in 1941 to about 66 in 1942 and to 47 in 1945. If it is assumed that all these tanks were sold at prices which were on the average those prevailing in 1943, the average saving per tank would equal 34 percent of the 1941 cost (the average saving per tank would be 2.5 million rubles divided by 18,000, or 134,000 rubles). The resulting 1941 cost would be a little more than 400,000 rubles, and the 1945 cost would be a little less than 200,000 rubles.

** Table 10 follows on p. 20.

Table 10

Estimated Costs of Soviet World War II and Current Items of Munitions a/

1945 Dollars

Class or Item	Estimated Cost	
	World War II Model	Current Model
Aircraft		
Fighter	42,000	91,000
Ground Attack	83,000	N.A.
Bomber	127,000	417,000
Transport	48,000	72,000
Trainer	9,000	10,000
Other Aircraft		
Tanks and Assault Guns		
Light	24,970	N.A.
Medium	50,200	89,400
Heavy	90,940	135,000
Artillery		
Light (45-57 mm)	2,150	3,220
Medium (76-122 mm)	3,260	9,930
Heavy (152 mm and up)	17,100	24,260
Antiaircraft	6,340	47,700
Small Arms	60	35
Mortars	910	2,700
Ammunition (Tons)	950	1,140
Trucks and Jeeps	1,200	2,200
Naval Vessels (Displacement Tons)		
Cruiser	2,000	2,000
Destroyer	3,540	3,540
Submarine	3,460	3,460
Other Vessels	2,300	2,300

a. Data from Appendix C.

B. Methods of Estimating Dollar Cost and Cost Estimates.

Estimates of dollar costs are made by two methods: (1) on the basis of dollar cost per unit weight determined from counterpart US munitions items and (2) on the basis of dollar cost per unit weight determined from counterpart US munitions items with adjustments for differences in quantity and quality of attached and accompanying equipment, such as electronics and armaments. The latter method was used for aircraft and antiaircraft artillery, the former for all other major items. The US and Soviet counterpart models were selected on the basis of (1) function, (2) physical attributes, and (3) rate of production of US model. The first two criteria were most important. Often it was discovered that 2 or 3 US models could be compared with a particular Soviet model. In such a case the third criterion was applied, and the item with the highest rate of production in the US was used. Models with low production rates are often experimental models, the cost of which does not reflect the real costs of production for standard models.

The resulting dollar costs estimates are given for World War II type equipment and for current models in Table 10. All prices are expressed in 1945 dollars.

The dollar cost estimates for the Soviet World War II equipment given in Table 10 are probably minimum estimates. The importance of comparing US and Soviet models that were both produced in relatively large quantities lies in the fact that unit cost and scale of output are inversely correlated. That is, unit costs which presuppose efficient levels of production are lower than unit costs for new models or for models produced in small quantities.

The dollar costs for the current Soviet models of munitions excluding aircraft were computed from the most reliable current prices for US weapons.* It may be assumed that the prices for the current US models are prices for relatively high levels of production, because counterpart models were selected from those with the highest production rates. The prices for the Soviet equipment may be assumed to hold for production once conversion to economic mobilization has taken place and the initial organizational problems overcome -- that is, probably during part of the second year of mobilization and all of the third year. After the second year there may be a tendency for prices to decline, although the decline might be offset by the introduction of new and more expensive models.

* See Appendix C.

Implicit in some of the computations of dollar cost of current Soviet models is an assumption concerning changes in the quality of munitions. For artillery, small arms, and ammunition, there is little data on the latest Soviet models. The most recent US models in quantity production have been selected as counterparts. The USSR is assumed to have introduced changes in the quality of these particular weapons as rapidly as has the US. For all other items, counterpart models have been selected as carefully as possible on the basis of physical similarity.

Dollar cost estimates for Soviet aircraft were made from comparisons with US aircraft with respect to function and physical characteristics. The cost for the counterpart US aircraft was divided among airframe, engine, electronics and communications, and government-furnished equipment including armament. The cost of the airframe and the engine was divided by the empty weight. This cost per unit weight was multiplied by the empty weight of the Soviet aircraft to obtain the cost of the Soviet airframe and engine.

Generally, Soviet aircraft are equipped with less complex types of communications and electronics and other accessories. In order to make adjustments for these differences, estimates of the value of such equipment carried on Soviet aircraft relative to the value carried on counterpart US aircraft were made. 6/ These percentages were applied to the cost of equipment for counterpart US aircraft to obtain the dollar costs of the equipment for the Soviet aircraft.

The costs for the counterpart US aircraft are costs at relatively high levels of output, 5,000 units per year for fighter aircraft and 1,000 units for other aircraft. 7/ The resulting cost estimates are therefore comparable to the cost estimates for other munitions and may be expected to apply for the second year of mobilization.

The rate of technological advance, insofar as costs are concerned, has been less rapid in the design of naval craft than it has for most other items of munitions. Therefore, dollar costs per unit weight for US World War II ships have been used to make dollar cost estimates of current Soviet models.*

* Bureau of Ships estimated costs per displacement ton for many different US models in 1947 are generally consistent when adjusted for price changes with the 1945 costs per ton used to compute the costs of Soviet ships. The few discrepancies between the two can be explained on the basis of scale of output.

IV. Production of Munitions in 1944, and Potential Output of Munitions by Class in Future Years.

A detailed inspection of Soviet munitions production in 1944 is made in this section to develop a base year magnitude for comparison with later years and to calculate the relative magnitudes of major munitions classes in the past. The relative magnitudes of munitions classes, or the munitions mix, for future mobilization years cannot be forecast with accuracy for any country. It can, however, be anticipated within ranges. Furthermore, broad limits must be placed on the proportions of the munitions mix during a future Soviet mobilization period if the aggregate munitions-producing potential is to be expressed in units of armament. Past Soviet experience will be of aid in setting up alternative mixes, particularly when coupled with estimated wartime munitions requirements.

Once a munitions mix or a series of mixes has been constructed, the potential value of munitions production in future years, determined from the indexes cited in Tables 3-8 and the value of munitions production in 1944, can be expressed in units of munitions. Two such examples are given in part B of this chapter. Units of munitions derived in this manner but in accord with the proportions among items of military hardware required by an expected Soviet war plan should be taken as the maximum quantities of such hardware available to the USSR from current production.

A. Production of Munitions in 1944.

Data on munitions production during 1944 is presented in Table 11* classified by major groups of military end items. Estimates of expenditures on spare parts, signal and engineering equipment, and other costs are included. The data are expressed in both physical units and 1945 dollar costs** in Table 11.

The total value of munitions produced in 1944 is given in Table 11 as $10.7 billion. This amount must be considered a minimum for a number of reasons. First, the dollar cost estimates are based on the assumption of highly efficient production levels. This

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* Table 11 follows on p. 24.

** When dollar costs are referred to in subsequent sections of this report, it will be understood that dollars at 1945 price levels are meant.

Table 11

Dollar Value and Percentage Distribution
of Soviet Munitions Production a/*
1944

Class of Munitions	Production (Units)	Dollar Value (Thousand Dollars)	Percentage of Total
Aircraft			
Fighter	17,300	727,000	6.8
Ground Attack	11,700	971,000	9.1
Bomber	5,200	660,000	6.2
Transport	1,000	48,000	0.5
Other Aircraft	4,800	410,000	3.8
Total		2,816,000	26.4
Armored Vehicles			
Light	9,710	243,000	2.3
Medium	17,420	874,000	8.2
Heavy	2,400	218,000	2.1
Other Armored Vehicles		267,000	2.5
Total		1,602,000	15.0
Artillery	87,100	402,000	3.8
Small Arms	6,980,000	395,000	3.7
Mortars	100,000	91,000	0.9
Naval Vessels			
Destroyers	1	7,000	0.1
Submarines	7	20,000	0.2
Total		27,000	0.3

* The footnote for Table 11 follows on p. 25.

Table 11

Dollar Value and Percentage Distribution
of Soviet Munitions Production a/
1944
(Continued)

Class of Munitions	Production (Units)	Dollar Value (Thousand Dollars)	Percentage of Total
Ammunition (Tons)	3,680,000	4,062,000	38.1
Trucks	79,400	123,000	1.1
Communications and and Electronics	N.A.		2.7
Engineering Equipment	N.A.		1.8
Transportation Equipment	N.A.		1.8
Other Munitions	N.A.		4.5
Dollar Total		10,659,000	100.0
Ruble Total (Thousand Rubles)		(64,900,000)	

a. Data from Appendix F, Table 48.

assumption may be valid for many of the items, but for classes of munitions with rapid qualitative changes, highly efficient production levels may never have been reached. Second, the estimates for spares and other categories not given directly are conservative. Except for trucks, spare parts estimates relative to the pertinent categories never exceed and usually are less than similar US ratios. In general, Soviet equipment may have endured more intensive use than counterpart US equipment. Hence, the spare parts maintenance cost may well have exceeded US practice. Third, many items have not been included because production has never been determined. For instance, many armored cars and caissons for artillery pieces were known to have been produced but are not included, because the quantity of such items produced cannot be determined.

In spite of these qualifications, there is little reason to suspect serious inaccuracies in the percentage distribution among the major classes of munitions in Table 11. In the absence of specific information, it is assumed throughout the report that the relative ruble prices are the same as relative dollar prices.*

The ruble: dollar ratio of 6.1:1 that can be computed from the aggregate values of Table 11 is subject to a sizable margin of error. The ratio may be high since the aggregate dollar value is a minimum; it may be too low if the ruble procurement total is understated. Thus, the ruble prices obtained as the product of estimated dollar cost and the ruble: dollar ratio may differ from actual ruble prices used for procurement accounting purposes. The use of these ruble prices for different years (other than 1944) implicitly assumes that the procurement of unimportant and unidentified items of munitions relative to the major items remains constant except when differences are openly taken into account.** However, this ratio is presented only as a point of interest and does not form an integral part of the study.

B. Potential Production of Munitions by Major Class in Future Years.

Indexes for determining changes in Soviet munitions potential were developed in Section II. This potential may be expressed in dollars, given the dollar value of 1944 munitions production. For instance, the munitions potential index, with 1944 as 100, increases to 242 in 1955. In the preceding section, the value of munitions production in 1944 was estimated at $10.659 billion. Multiplying the munitions potential index by $10.659 billion gives a figure of about $25.8 billion as the potential value of munitions production in 1955. Potential munitions value for 1954-57 are listed in Table 12.***

In order to translate these aggregate values into specific items of munitions, relative magnitudes of major munitions classes must be given. The relative magnitudes of the major classes of munitions

* The question of subsidies is distinct from this problem so long as procurement accounting remains unchanged.

** It should be emphasized that for purposes of calculating munitions potential, relative prices of munitions, rather than absolute prices, and the distribution of the major categories are the only determinants.

*** Table 12 follows on p. 27.

Table 12

Potential Value of Munitions Production in the USSR
1944, 1954-57

Year	Munitions Potential Index	Dollar Value of Potential (Billion Dollars)
1944	100	10.659
1954	224	23.9
1955	242	25.8
1956	264	28.1
1957	286	30.5

for 1944 are shown in Table 11.* These proportions, however, cannot be used without adjustment for a future Soviet mobilization year, because future war conditions are unlikely to be similar to conditions prevailing in World War II. To observe the nature of changes in such proportions over time, the relative value of major classes of munitions produced by the US may be inspected.

Relative values of five major classes of munitions in the US procurement program are shown in Table 13** for 2 World War II years, 2 peacetime years, and the expected average proportions for 3 future mobilization years.

It is clear from casual inspection that there is considerable variation in the munitions mix of the US from period to period. Circumstances unique to the US will explain these variations in part. In general, however, the munitions mix for a mobilization period is dependent on: (1) war strategy and the resulting initial requirements to arm the military forces, (2) the level of munitions inventories, and (3) expected rates of attrition.

* P. 24, above.
** Table 13 follows on p. 28.

Table 13

Proportions of Major Classes of Munitions
for the US in World War II, in 1952 and 1953,
and in a Future Mobilization Period

Class of Munitions	1943 8/	1944 9/	1952 a/	1953 a/	Three-Year Mobilization Period
Aircraft	23.9	27.8	49.0	46.5	33.0
Ships	23.9	23.2	5.4	5.9	12.0
Combat Vehicles	6.2	3.6	10.0	13.0	6.0
Weapons and Fire Control	6.1	5.1	2.7	2.9	3.9
Ammunition	9.4	10.0	10.9	14.7	19.1
Other	30.6	30.3	22.0	17.0	26.0
Total	100.0	100.0	100.0	100.0	100.0

50X1

A recent study [redacted] has 50X1
attempted to determine the Soviet Bloc requirements for the first and succeeding years of a war beginning in mid-1954. 10/ From these requirements the demands on the USSR alone can be computed. These demands may be used with qualification as a measure of the probable munitions procurement mix. The estimated requirements for the first and succeeding years of a war beginning in 1954 do not include the initial weapons to arm the forces, but only the weapons used up during the period. Further, no account of the effect of beginning inventories on the munitions mix is made. If the estimated requirements are averaged for a 2-or-3 year period, however, the resulting mix may be similar to the proportions in a munitions procurement program.

These proportions (with arbitrary adjustments -- see Appendix E) should be interpreted as one of an infinite number of possible distributions of munitions by class. The proportions selected may be expected to be valid only within broad limits. For instance, armored

vehicles may make up as much as 25 to 30 percent of munitions in a war in which the USSR would rely primarily on a ground offensive. Contrariwise, aircraft may make up 40 percent or more of all munitions in war fought primarily in the air. It is clear that such possibilities can cause unlimited variations from any given set of proportions. The proportions of Table 14*, and the resulting numbers of munitions by type, should, therefore, be interpreted as only one of an infinite set of proportions and numbers of Soviet items of munitions in a future mobilization period. The only limiting factor lies in the aggregate value of munitions, which cannot exceed $25.8 billion in 1955, $28.1 billion in 1956, and $30.5 billion in 1957.** Potential output of munitions by class, computed from the proportions, are shown in Tables 14 and 15*** for 1954 and 1956.

* Table 14 follows on p. 30.

** These amounts are the products of estimated munitions production in 1944 and the index of munitions production potential of Table 8, p. 17, above.

*** Table 15 follows on p. 32.

Table 14

A Probable Wartime Distribution
of Soviet Munitions Output
1954

Class of Munitions	Percentage of Total a/*	Dollar Allocation b/ (Millions)	Dollar c/ Cost per Unit	Number d/ of Units
Aircraft (Units)				
Fighter	7.3	1,723	91,000	18,900
Bomber	8.6	2,030	417,000	4,900
Transport	1.1	260	72,000	3,600
Trainer	0.3	71	14,000	5,100
Other	2.7	637		
Total	20.0	4,700		
Armored Vehicles (Units)				
Medium Tanks and Assault Guns	10.2	2,407	89,000	27,000
Heavy Tanks and Assault Guns	2.3	543	135,000	4,000
Other	2.5	590		
Total	15.0	3,540		
Artillery (Units)				
Light (57-mm)	0.8	189	3,200	59,100
Medium (85-100 mm)	0.9	212	10,600	20,000
Heavy (122-mm and up)	0.5	118	15,400	7,700
Antiaircraft	2.3	543	48,000	11,300
Other	0.5	118		
Total	5.0	1,180		

* Footnotes for Table 14 follow on p. 31.

Table 14

A Probable Wartime Distribution
of Soviet Munitions Output
1954
(Continued)

Class of Munitions	Percentage of Total a/	Allocation b/ (Millions)	Dollar c/ Cost per Unit	Number d/ of Units
Small Arms (Units)	0.6	142	35	4,057,000
Mortars (Units)	0.4	94	2,700	34,800
Naval Vessels				
Cruisers (1,500-Ton)	1.0	236	30,000,000	7.9
Destroyers			9,560,000	30
(2,700-Ton)	1.2	283	9,560,000	30
Submarines (1,500-Ton)	0.8	189	5,200,000	36
Other	3.0	708		
Total	6.0	1,416		
Ammunition (Tons)	26.0	6,136	820	7,480,000
Automotive Vehicles (Units)				
Trucks	1.8	425	2,350	180,900
Jeeps	0.2	47	1,050	44,800
Total	2.0	472		
Other	25.0	5,900		
Total	100.0	23,600 e/		

a. Estimate from Appendix E, Tables 47.
b. Total dollar estimate from Section IV, p. 26. Other data derived from total and first column.

Table 14

A Probable Wartime Distribution
of Soviet Munitions Output
1954
(Continued)

c. Data from Appendix E, Table 46.
d. Column two divided by column three.
e. The computed value of $23.6 billion for potential in 1954 was later adjusted to $23.9 billion.

Table 15

A Probable Wartime Distribution
of Soviet Munitions Output
1956

Class of Munitions	Percentage of Total a/*	Dollar Allocation b/ (Millions)	Dollar c/ Cost per Unit	Number d/ of Units
Aircraft (Units)				
Fighter	7.3	2,037	91,000	22,400
Bomber	8.6	2,400	417,000	5,800
Transport	1.1	307	72,000	4,300
Trainer	0.3	84	14,000	6,000
Other	2.7	753		
Total	20.0	5,580		
Armored Vehicles (Units)				
Medium Tanks and Assault Guns	10.2	2,846	89,000	32,000
Heavy Tanks and Assault Guns	2.3	642	135,000	4,800

* Footnotes for Table 15 follow on p. 34.

Table 15

A Probable Wartime Distribution
of Soviet Munitions Output
1956
(Continued)

Class of Munitions	Percentage of Total a/	Dollar Allocation b/ (Millions)	Dollar c/ Cost per Unit	Number d/ of Units
Armored Vehicles (Units) (Continued)				
Other	2.5	698		
Total	15.0	4,185		
Artillery (Units)				
Light (57-mm)	0.8	223	3,200	69,700
Medium (85-100 mm)	0.9	251	10,600	23,700
Heavy (122-mm and up)	0.5	140	15,400	9,100
Antiaircraft	2.3	642	48,000	13,400
Other	0.5	140		
Total	5.0	1,395		
Small Arms	0.6	167	35	4,770,000
Mortars	0.4	112	2,700	41,500
Naval Vessels				
Cruisers (1,500-Ton)	1.0	279	30,000,000	9.3
Destroyers (2,700-Ton)	1.2	335	9,560,000	35

Table 15

A Probable Wartime Distribution
of Soviet Munitions Output
1956
(Continued)

Class of Munitions	Percentage of Total a/	Dollar Allocation b/ (Millions)	Dollar c/ Cost per Unit	Number d/ of Units
Naval Vessels (Continued)				
Submarines (1,500-Ton)	0.8	223	5,200,000	43
Other	3.0	837		
Total	6.0	1,674		
Ammunition (Tons)	26.0	7,254	820	8,850,000
Automotive Vehicles				
Trucks	1.8	502	2,350	213,700
Jeeps	0.2	56	1,050	53,000
Total	2.0	558		
Other	25.0	6,975		
Total	100.0	27,900 e/		

a. Estimate from Appendix E, Table 47.
b. Total dollar estimate from Section IV, p. 26. Other data derived from total and first column.
c. Data from Appendix C.
d. Column two divided by column three.
e. The computed value of $27.9 billion for potential in 1956 was later adjusted to $28.1 billion.

V. Internal Consistency of Munitions Production and Capacity Estimate.

A. Introduction.

The munitions prices presented in Section III can be used to check the internal consistency of two kinds of intelligence estimates that have been developed through other procedures. Postwar estimates of the production of military end items can be developed from price and procurement data and can be checked against the results of estimates derived from study of individual items. Similarly, the capacity outputs estimated for individual munitions items can be checked against the aggregate capacity estimates developed in this report.

B. Munitions-Production Estimates.

Comprehensive estimates have been made of the postwar output of military end items in the USSR. It is apparent that if ruble prices for these output estimates were available, an estimate of the total ruble value of munitions produced could be developed. This estimate could then be compared to the procurement total derived from budgetary data. Alternatively, the same principle could be applied in a slightly different fashion. If the dollar cost of the Soviet munitions output program could be developed, the same type of comparison could be made if the ruble procurement figures could be converted into dollars. The latter procedure serves the same purpose as the former, since there is a correspondence between the relative prices of various types of munitions in the US and in the USSR. The implicit ruble: dollar conversion ratio is, as explained in Section III, an artificial construct that can be used only within the framework of this report.

The munitions price data in Section III do not apply to munitions produced during the entire postwar period. The prices really apply to only two periods -- the World War II period when the wartime models were being produced on a large scale and the current period during which the new models are presumably being produced under relatively efficient conditions. Sufficiently detailed information from which prices applicable to the years between these two periods can be developed is not available. Therefore, only the period in the neighborhood of 1952 and 1953 can be tested by means of the procedure described above.* Even here, the check is subject to a sizable and

* For a table presenting an index based on dollar costs for the two periods and estimated quantities of output from 1949-53, see Appendix F, Table 51.

indeterminate margin of error, due both to possible inaccuracies in the price data and to insufficient detail concerning the composition of the current Soviet procurement effort. Information concerning the magnitude of such things as the guided missile and electronics programs is very sketchy. As indicated in Table 16, it is necessary to make a rough guess as to the probable expenditure on these and similar programs where detailed information is lacking. Table 16 shows the estimated dollar cost of the 1952 and 1953 Soviet munitions production effort.

Table 16

Soviet Munitions Production by Classes a/
1952-53

Munitions Class	1952 Number of Items (Units)	1952 1945 Dollar Cost (Millions)	1952 Percent of Total Cost	1953 Number of Items (Units)	1953 1945 Dollar Cost (Millions)	1953 Percent of Total Cost
Aircraft	11,606	1,568	27.0	12,742	1,708	28.9
Armored Vehicles	10,950	1,371	23.6	10,644	1,321	22.3
Artillery	12,800	273	4.7	12,800	273	4.6
Small Arms	317,500	11	0.2	317,500	11	0.2
Mortars	16,200	44	0.8	16,200	44	0.7
Naval Vessels	184	596	10.3	184	596	10.1
Ammunition (Tons)	316,000	360	6.2	316,000	360	6.1
Trucks and Jeeps	50,000	127	2.2	50,000	127	2.2
All Other	0	1,450	25.0		1,480	25.0
Total		5,801	100.0		5,921	100.0

a. Data from Appendix F, Tables 49 and 50.

The "all other" category in Table 16 is intended to cover such categories as communications and electronic equipment, engineering equipment, signal corps equipment, and any weapons not specifically listed in the detailed breakdown. A somewhat smaller category for the US, one that excludes weapons completely, is expected to be about 26 percent of total procurement during the 3-year period 1952-53. Spare parts are included in the itemized expenditure for each weapon class.

The dollar totals shown in Table 16 can be compared with the dollar totals derived from the procurement index. Estimates are made in Section III of the total dollar expenditure during 1944 by the USSR. An index of munitions output is constructed in Section II. Combining these two, an estimate of Soviet munitions expenditures in dollars can be obtained during any desired postwar year. The latter figure can then be compared to the dollar totals developed in Table 16.

The data in Table 17 indicate that the two estimates agree remarkably well, in view of the very crude nature of the calculation contained in both estimates.

Table 17

Comparison of Estimated Aggregate Value of Postwar Munitions Output in the USSR

Year	Munitions a/ Output Index (1940 = 100)	Implied Value b/ of Output (Million 1945 Dollars)	Computed Value c/ of Output Estimates (Million 1945 Dollars)	Percentage Difference
1944	370	10,659	10,659	
1952	182	5,240	5,801	+11
1953	190	5,480	5,921	+ 8

a. Data from Section II, Table 6.
b. 1944 value from Section IV, Table 11. Other values derived from index in column one.
c. Data from Section V, Table 16.

If it can be assumed that both the munitions output index and the relative dollar prices are exact, then it would follow that physical output estimates for munitions are about 10 percent too high during 1952 and 1953. Even if these assumptions were correct, it would still be impossible to say which output estimates were too high, since this procedure can only be used to indicate that the individual estimates are or are not consistent with the aggregate limitations imposed by the total.

However, the evidence does not warrant any conclusions being drawn concerning the consistency of these two sets of data. The two sets of data are not completely independent, since production estimates were used from 1940-48. The price index used to deflate the budgetary procurement data (see Section II) is very rough and cannot be relied upon at this stage. Thus the output index derived from the procurement data is equally rough, and could certainly be in error by as much as the 10-percent difference observed above. It is worth noting, however, that the ruble price index is more likely to be biased downward than upward, implying that the real procurement index is likely to be biased in the opposite direction. If this were the case the real discrepancy between the two estimates would be greater than calculated above. Similarly, it is more likely that the prices used to build up the aggregate total from the physical output estimates are biased downward than upward, since the prices are meant to apply to a period when all items are being produced in an efficient, large-scale manner. It is probable that such was not the case for all military end items during 1952 and 1953. In that event, the total value of output would be understated, and the proper correction would again tend to increase the difference observed above. On balance, it does seem likely that the data indicate that current estimates of Soviet munitions output are overstated by an indeterminate amount.

C. Munitions-Producing Capacity Estimates.

Intelligence estimates of capacity production for specific items of Soviet munitions have in recent years been made from time to time for numerous reasons. It is almost always true that these estimates are made with reference to one limiting factor only, such as plant capacity. It has not been possible, in general, to take account of the production of the other items of munitions or other goods. Thus, each item has been examined in isolation without regard to the concurrent demands on manpower, raw materials, sub-contracted parts and other demands.

It has, of course, been clear that accurate estimates could not be made by these procedures, but no alternative has been available. The weakness of the capacity-by-individual-item procedure can perhaps best be illustrated by a single example. At any period of time it is usually true that an economy has what could be called excess plant capacity. Most productive establishments work only on a one-shift basis although presumably they could work on a multiple-shift basis if necessary, subject to somewhat higher maintenance costs. But it is perfectly clear that the capacity of the economy cannot be calculated as the sum of the capacities for each productive unit, since this would imply that the total output of the economy could be from, say, 50 to 100 percent higher than it actually is. Yet, provided that unemployment is not substantial, the total output of the economy cannot be increased very greatly over its current level, even though the output of any particular item could be expanded very substantially, if need be.

The notion of capacity developed in this report is that of an aggregate of resources that could be utilized for the production of munitions. No estimate of capacity for individual items can be obtained via this procedure, since extensive substitutability of items for each other is assumed. (See Appendix G). However, a rough check can be made as to the mutual compatability of the individual capacity estimates. Estimated capacity for each item is multiplied by the dollar price per item. The sum of these prices multiplied by quantity is really a measure of the total assumed amount of resources that would be required to produce all items simultaneously at capacity levels. This total may be compared with the total amount of resources estimated actually to be available for munitions production, that is, with the aggregate potential of the Soviet economy to produce munitions. Table 18* shows these calculations.

Table 19** indicates that the USSR, if all munitions were produced simultaneously at capacity rates, would require an aggregate amount of resources valued from 36 to 42 billion dollars. Estimates of the total amount of resources (in 1945 dollars) that the USSR would be able to devote to munitions production during a period of mobilization can be obtained from Sections II and IV. Section II shows an index of growth in munitions-producing potential and Section IV shows the magnitude of the 1944 Soviet munitions effort.

* Table 18 follows on p. 40.
** Table 19 follows on p. 42.

Table 18

Capacity Estimates and Dollar Costs
for Soviet Munitions a/*

Munitions Class	Estimated Capacity Output	1945 Dollar Cost (Dollars)	Total 1945 Dollar Value (Millions)
Aircraft (Units)			
Fighter	20,000	90,000	1,800,000
Ground Attack	2,000	117,000	234,000
Bombers	6,000	417,000	2,502,000
Transport	3,000	72,000	216,000
Trainer	5,000	14,000	70,000
Other	7,000	10,000	70,000
Total	43,000		4,892,000
Armored Vehicles (Units)			
Medium	45,000	89,000	4,005,000
Heavy	15,000	135,000	2,025,000
Total	60,000	3,200	6,030,000
Artillery (Units)			
Light (20-75-mm)	4,000	3,200	12,800
Medium (76-100-mm)	45,000	10,600	477,000
Heavy (122-mm and up)	25,500	15,400	392,700
Antiaircraft	31,000	48,000	1,488,000
Total	105,500		2,371,000
Small Arms (Units)	10,000,000	35	350,000
Mortars (Units)	200,000	2,700	540,000

* The footnote for Table 18 follows on p. 41.

Table 18

Capacity Estimates and Dollar Costs
for Soviet Munitions a/
(Continued)

Munitions Class	Estimated Capacity Output	1945 Dollar Cost (Dollars)	Total 1945 Dollar Value (Millions)
Naval Vessels (Units)			
Cruisers	18	30,000,000	540,000
Destroyers	68	10,600,000	720,800
Submarines	170	2,500,000	425,000
Other	N.A.	N.A.	758,600
Total			2,444,000
Ammunition (Tons)	13,000,000	820	10,660,000
Trucks and Jeeps (Units)	200,000	2,200	440,000
Other Munitions (25-35 percent)		9,096,000	14,693,000
Total		36,382,000	41,980,000

a. Data from Appendix F, Table 52.

Table 19

Comparison of Amounts of Resources Available in the USSR
to Produce Munitions with Amounts Required
to Produce All Munitions at Estimated Capacity Levels

Year	Index a/ of Munitions Potential	Value of Maximum b/ Munitions Effort (Million 1945 Dollars)	Resources Required c/ for Simultaneous Capacity (Million 1945 Dollars)
1944	100	10,659	
1953	203	21,600	
1954	224	23,900	
1955	242	25,800	
1956	264	28,100	36,382 to 41,980
1957	286	30,500	

a. Data from Section II, Table 8.
b. Data from Section IV, Table 12, combined with column 1.
c. Data from Table 18, above.

Table 19 indicates that it would require from 30 to 50 percent more resources than the USSR would have if all military end items were produced at estimated capacity rates which are assumed to apply to 1956. Or, put in another way, the USSR would not be able to produce more than 65 to 80 percent, on the average, of the estimated capacity rates for all items. It would not follow, of course, that each capacity estimate was too high. Estimates for some classes of munitions may be quite reasonable; others may be several hundred percent too high. It can only be concluded that in the aggregate the capacity estimates are from 30 to 50 percent too high.

It is apparent that there is a serious discrepancy between the sum of the individual estimates and the aggregate estimate developed in this report. Either the individual estimates are too high collectively or the aggregate estimate understates potential. Examination of the nature of the aggregate estimate, however, does not support the latter hypothesis. In the first place, the index of munitions-producing potential is likely to overstate, if anything. Of several other alternatives examined in Section II all but one

showed a lower growth rate than the index used above, and the exception was less than 5 percent higher. If the index is not biased downward, the only other valid explanation is that the dollar prices presented in Section III tend to cause either understatement of aggregate potential or overstatement of resource requirement for achievement of capacity output levels. Either situation would be possible if the prices developed for World War II munitions were low relative to those developed for current items. But the same procedure was used to develop all the prices involved, so that it becomes difficult to see how a systematic bias could enter in this direction. The last possibility is that the comparison of US and Soviet items was such as to overstate the increase in complexity for Soviet munitions between the World War II period and the present.* A large element of indetermination shows up here. It can only be said that considerable care was taken in developing the comparisons and that no known bias exists. In any event, it is hard to believe that a systematic bias of the order of 30 to 50 percent could have been accounted for.

* Some might object that Soviet munitions are much less complex relative to US munitions, so that comparisons would inevitably tend to give an upward bias. But the essential comparison being made is not between US and Soviet weapons directly, but between changes in US weapons and changes in Soviet weapons. While it is perfectly true that US weapons are more costly and complex, it is also true that this has always been the case, and certainly was during the World War II period.

APPENDIX A

AGGREGATE INCREASE IN SOVIET MUNITIONS-PRODUCING POTENTIAL

Several indicators that might be used to measure changes in Soviet potential to produce combat armaments were discussed in Section II. A measure of the munitions-producing potential of the USSR is needed that can be estimated for both World War II and for future years, so that the difference between the World War II year and the future year can be quantified as a ratio. It is evident that such magnitudes as the level of industrial output, capital goods output, or total output (National Income) would all give a rough indication of armament-producing potential; the problem is to select the one that seems most reliable. The selection problem can be decided on analytical grounds, that is, which measure ought, in principle, to be better, or on empirical grounds, that is, which measure has worked better than others in the past. It may turn out that all of the possible measures yield results so similar to each other that the selection problem ceases to be significant.

Since it is desired to measure this change so that Soviet potential in the future can be compared with potential during World War II, any index that is used must be based on some World War II year. The use of this period raises several difficult problems. The level of armament output achieved by the USSR during World War II does not bear a clear-cut relationship to either prewar or wartime Soviet aggregate measures. The USSR was invaded by Germany in the middle of 1941 and did not recover all overrun territory until late in 1944. Thus the prewar potential was never fully exploited on this account.*

* The index of Soviet industrial output during the period illustrates this fact. Based on 1940 = 100, the index ran about as follows:

	1940	1941	1942	1943	1944	1945
Industrial Production	100	88	78	93	99	88

As is indicated, the index never reached the prewar level, although it would undoubtedly have far exceeded the prewar level in the absence of invasion.

On the other hand, the USSR received a sizable amount of unilateral Lend-Lease assistance from the Western Allies during the course of the war. Thus the potential indicated by the size of the internal wartime economy was augmented by outside assistance, which in itself tends to cause overstatement. The same is true of the effects of Lend Lease on prewar measures. Since the problem is to find that Soviet economic aggregate which best measures armament-producing potential during World War II, it will be necessary to adjust both the prewar and wartime aggregates to reflect the influence of the invasion and of Lend-Lease aid.

A. Indexes of Potential Based on Prewar Magnitudes.

The difficulties inherent in the use of prewar data as a base for comparing World War II potential with potential in later years can be handled, in principle, by proper manipulation of the pre-World War II base year. The Lend-Lease assistance problem could be handled in similar fashion. The advantage of using a prewar base period is that aggregate measures of output during peacetime tend to be inherently more reliable than aggregate wartime measures. Accurate measurement is difficult during periods of drastic shifts in the pattern of output.

In comparing aggregates before World War II to aggregates before a hypothetical mobilization year, it will be assumed that the 1940 Soviet GNP (gross national product) should be reduced by 25 percent in order to obtain a figure consistent with the 1944 munitions potential.* This estimate was derived in the following manner.

* This adjustment is intended to account for two kinds of differences: the difference between the 1940 GNP that would have been required to produce the 1944 military effort in the USSR in the absence of invasion, as compared to the actual 1940 GNP; and, the difference between the 1944 munitions effort that the USSR could have achieved in the absence of Lend-Lease aid and the munitions effort that they did, in fact, achieve. These differences are opposite in direction, that is, 1940 GNP overstates 1944 munitions-producing potential because of the invasion and understates it because of Lend-Lease aid.

The actual Soviet GNP index over this period was as follows:

GNP Index (1940 = 100)*	Year	
	1940	1944
	100	87

This index, if the USSR had not been invaded, might have increased at 5 percent per year, which would have given:

Hypothetical GNP Index	1940	1944
	100	121

Since GNP might have been expected to increase by some 21 percent between 1940 and 1944, it would follow that the 1940 level of GNP that best indicates 1944 potential would be 83 percent of achieved 1944 GNP. This hypothetical level turns out to be roughly 70 percent of realized 1940 GNP. This hypothetical GNP level, however, does not reflect the role of Lend Lease in increasing the World War II munitions output above the level implied by the prewar data. Since part of the Lend-Lease aid may be reflected in the achieved wartime GNP and thus in the hypothetical 1940 GNP, an upward adjustment of 5 percentage points (about 7 percent) seems to be reasonable.**

Similarly, for comparing the prewar magnitudes of industrial output and capital goods output with those before years of hypothetical mobilization, it has been assumed that the 1940 output for both of these aggregates should be reduced by 20 percent in estimating 1944 potential. These estimates are based on a procedure similar to that described above, supplemented with the fact that the reduction in industrial output and capital goods output resulting from invasion

* Data from Table 20.

** Lend Lease is estimated to be about 10 percent of Soviet domestic GNP. Some of these supplies undoubtedly entered into our GNP indexes, for example, steel and nonferrous metal supplies enabled the USSR to achieve a more favorable distribution of output. Thus the allocation of resources was better than it would otherwise have been, and total output, even assuming that the steel itself is not counted as output, would be somewhat higher. The specific adjustment used is purely arbitrary.

was less than the reduction in GNP. The differential reduction in these aggregates was due partly to more intensive reconstruction efforts and partly to the wholesale evacuation of industrial equipment that took place during the early part of the invasion.

The results of the manipulations described above are summarized in Table 20 below. Both unadjusted and adjusted indexes are presented. The adjusted index is interpreted as being that level of prewar GNP, industrial output, and capital goods output that would have made the actual 1944 munitions effort possible, provided that no invasion had taken place and that Lend-Lease aid had not been supplied.

Table 20

Indexes of Soviet GNP, Industrial Output, and Producer Goods Output

1940 = 100

Index	1940	1944
GNP a/	100	87
Adjusted GNP	75	87
Industrial Output b/	100	99
Adjusted Industrial Output	80	99
Capital Goods Output c/	100	54
Adjusted Capital Goods Output	80	54

a. Data from Table 28.
b. Data from Table 25.
c. Data from Table 26, and Appendix B, Table 36.

Indicators of munitions potential based on these three aggregate measures can be constructed by comparing the above 1940 adjusted indexes with similar indexes calculated for a period several years earlier than the future year during which full mobilization is being assumed. That is, we estimate the increase in munitions-producing potential between 1944 and 1955, say, by comparing the increase in

GNP between 1940 as adjusted above, and 1953, these years being regarded as the base of the respective full mobilization years. Table 21 shows these comparisons and is to be interpreted in the manner described above.

Table 21

Indicators of Munitions-Producing Potential, Comparing Pre-World War II Base Years with Pre-Hypothetical-Mobilization-Years Base

Base Year	Full Mobilization Year	GNP a/ Index (1948 = 100)	Industrial b/ Output Index (1951 = 100)	Adjusted Producer c/ Goods Index (1951 = 100)	Munitions-Potential d/ Indexes (1944 = 100) Based on Column 3	4	5
(1)	(2)	(3)	(4)	(5)			
1940	1944	74	50	46	100	100	100
1951	1953	134	100	100	181	200	219
1952	1954	144	110	111	194	220	243
1953	1955	153	118	120	207	236	263
1954	1956	162	129	131	219	258	287
1955	1957	171	139	142	231	278	311

a. Data from Table 28, modified for 1940 as indicated above.
b. Data from Table 25, modified for 1940 as indicated above.
c. Data from Table 26, modified for 1940 as indicated above.
The adjusted rather than the unadjusted capital goods index is used because the sum of producer goods output plus defense procurement presents a more accurate picture during peacetime years of the size of the producer goods industries.
d. Derived from columns three, four, and five, respectively.

B. Indexes of Potential Based on Wartime Magnitudes.

As pointed out above, the increase in Soviet munitions-producing potential can be obtained by comparing aggregate magnitudes during years when full mobilization is assumed to exist, rather than during years when the level of output constitutes the peacetime base for future mobilization programs. The main problems involved are (1) the weakness of aggregate measures during historical full mobilization years, (2) the existence of Lend-Lease assistance during World War II, which causes the aggregates to overstate the achieved munitions effort, and (3) the fact that differences exist between the level of output under mobilization conditions and under cold-war conditions, so that Soviet aggregates for future years of hypothetical full-mobilization are too low if projected under cold-war assumption (which they are, of course). The second and third of these factors tend to cancel out, and it will be assumed that these do cancel out.*

One further adjustment will be made in constructing these indexes. Since the indexes are being used as measures of change in munitions-producing potential, it is clearly desirable that any components that do not contribute directly to increasing the potential should be excluded. Both the GNP and industrial output index contain sizable components of consumer goods output. Some of the resources used in producing consumer items would be transferred to either the capital goods or munitions-producing sectors in the event of mobilization. Some minimum amount of resources would have to remain in the consumer sector. In the following computations, it has been assumed that the 1944 per capita level of resource usage in the consumer sectors of both industrial output and GNP would have to be retained, with the remainder being available for direct or indirect military production. These minimum consumption requirements have been projected forward on the basis of population changes. The resulting munitions-potential indexes are shown in Table 22.*

* The assumption is not unreasonable. The Soviet aggregates for the World War II period understate potential by approximately 10 percent. The difference between cold-war output and hot-war output in, say, 1955 or 1956, could not be too much different from 10 percent. The Soviet economy is presently at forced draft. A more intensive use of resources would probably not add very much to the achievable level of output, though some increase in output would certainly be possible. Since there seems to be no strong indication of bias in one direction or the other, an assumption that the biases will cancel out seems as good as any.

** Table 22 follows on p. 51.

Table 22

Indicators of Munitions-Producing Potential for the USSR, Comparing Changes in Amounts of Resources Available Over and Above Minimum Consumption Requirements

Full-Mobilization Year	Adjusted a/ GNP Index (1948 = 100)	Munitions-Producing Potential b/ Index (1944 = 100)	Industrial Output c/ Index (1951 = 100)	Munitions-Producing Potential d/ Index (1944 = 100)
1944	79	100	59	100
1953	187	237	120	203
1954	201	254	132	224
1955	216	273	143	242
1956	231	292	156	264
1957	246	311	169	286

a. Data from Table 28.
b. Derived from first column.
c. Data from Table 25.
d. Derived from third column.

C. Summary and Conclusions.

Five indicators of munitions-producing potential have now been constructed; three based on a comparison of peacetime pre-mobilization year aggregates, and the other two based on a comparison of wartime full-mobilization year aggregates. Both types of comparisons involve heroic manipulations of data and can be taken to indicate orders of magnitude only. The peacetime year comparisons are especially dubious because of the difficulties mentioned above. It is thought that the last index shown, adjusted industrial output under conditions of full mobilization, is probably the best suited from a purely analytical point of view. The following table presents all five indexes:

Table 23

Indexes of Munitions-Producing Potential

1944 = 100

Type of Index	Year of Full Mobilization					
Peacetime Base a/	1944	1953	1954	1955	1956	1957
GNP	100	181	194	207	219	231
Industrial Output	100	200	220	236	258	278
Capital Goods Output	100	219	243	263	287	311
Wartime Base b/						
GNP	100	237	254	273	292	311
Industrial Output	100	203	224	242	264	286

a. Data from Table 21. The year for which the index is computed is different from the full mobilization year shown above, since we are comparing the size of mobilization base years.
b. Data from Table 22.

The amount of variation shown by the several indexes is not overly large considering the very crude nature of the adjustments and the unreliability of the basic data.* The lack of wide divergence can be

* The divergence between the estimates of aggregate potential based on peacetime years and those based on wartime years is not encouraging, since it is not possible to select one kind of comparison as being inherently more reliable. Both kinds of comparisons have one especially weak aspect. The pre-mobilization year comparison rests on an estimate of the amount of reduction in the 1940 aggregates that would produce an estimate consistent with both the reduction of potential due to invasion and the increment of potential due to Lend Lease. The full mobilization year comparisons rest on estimates of 1944 aggregate output levels; these estimates are highly tenuous due to the nature of wartime product mix.

explained partly by "inbreeding," since all of these estimates use the same data in part. The capital goods index is one of the major components of the industrial output index, which, in turn, is one of the major components of the GNP index. Similarly, the GNP index was adjusted to take account of the relatively larger fraction of postwar GNP that could be used for munitions production as compared to prewar. Since industrial output and capital goods output have increased at a more rapid pace than GNP, this adjustment tends to cause more of a cluster in the estimates.

It has already been indicated that the data on which these estimates are based contain a considerable margin of error. In view of the function to be served by the estimate, it is probable that the adjusted industrial output index is the most reasonable one to use. This particular combination of sectors in the economy is more closely geared to munitions-producing activities than any of the sectors covered by our alternative indexes. In addition, the procedure being developed here is inherently bound to indicate an upper limit to Soviet potential.* Since the industrial output index shows one of the largest increases in potential of any of our indexes, it is certain that a reasonably firm upper limit will be obtained if industrial output is used as the indicator of increase in aggregate potential to produce combat armaments.

Other kinds of data are available as a means for verifying the rough magnitudes calculated above. One might expect that the output of basic metals and energy should increase by something of the same magnitude as the increase in aggregate potential, although there is no reason why the output increase for any one item should be the same as the aggregate increase. Table 24** tabulates these data for the relevant time period.

The increases in output of basic materials seem to be of roughly similar magnitudes to the estimated increase in aggregate munitions-producing capabilities. The commodity figures themselves need some qualifications. Data on commodity supply during the war years is unusually weak, since it is necessary to combine estimates of domestic

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* The methodology is such that a completely flexible economy must be assumed. It is known that no economy does conform to this ideal, and that, in fact, shortages and rigidities will tend to make actual performance fall somewhat short of the performance level indicated by the complete flexibility assumption. See Appendix G.

** Table 24 follows on p. 54.

Table 24

Comparison of the Estimated Increase
in Munitions-Producing Potential
with Increases of Selected Basic Materials
for the USSR a/
1944, 1953-57

Index	Year					
	1944	1953	1954	1955	1956	1957
Aggregate Munitions-Producing Potential b/	100	203	224	242	264	286
Steel Output c/	100	335	370	400	430	460
Copper Output c/	100	90	100	105	115	120
Aluminum Output c/	100	110	125	140	155	170
All Metals c/	100	260	280	310	330	355
Electric Power c/	100	330	370	425	470	515
Coal c/	100	275	295	310	330	350
POL	100	255	265	280	295	310
All Fuels d/	100	290	315	345	370	400

a. Data rounded to nearest five percentage points.
b. See Table 23, above.
c. Commodity output estimates [redacted] with an adjustment for Lend-Lease supplies 11/ to the USSR. The data used to derive the commodity indexes were as follows: 50X1

Commodity	Unit	1944	1953	1954	1955	1956	1957
Ingot Steel	Million Metric Tons	10.6 aa/	35.6	39.5	42.6	45.6	49.0
Copper	Thousand Metric Tons	345 bb/	310	335	365	395	425
Primary Aluminum	Thousand Metric Tons	255 cc/	280	320	360	400	440
POL	Million Metric Tons	18.6 dd/	47.5	49.5	525	55	58
Coal	Million Metric Tons	85	235	250	265	280	296
Electric Power	Billion Kilo-watt-Hours	40	131	148	170	188	206

Table 24

Comparison of the Estimated Increase
in Munitions-Producing Potential
with Increases of Selected Basic Materials
for the USSR a/
1944, 1953-57
(Continued)

aa. Includes an estimated 0.7 million metric tons of Lend-Lease supplies in 1944.
bb. Includes an estimated 195 thousand metric tons of Lend-Lease supplies in 1944.
cc. Includes an estimated 172 thousand metric tons of Lend-Lease supplies in 1944.
dd. Includes an estimated 0.1 million metric tons of Lend-Lease supplies in 1944.
d. Energy index [redacted] No adjustment was made for Lend Lease in supplies during the war period because the magnitude was too small to make a noticeable difference. The Metals Index was [redacted] with a crude adjustment for the effect of wartime Lend-Lease aid. The nonferrous component of the 1943 and 1944 metals indexes was doubled to reflect the Lend-Lease Shipments; the ferrous component was left unchanged.

50X1

50X1

Soviet production during a period of industrial relocation and rapid shifts in industrial output patterns with estimates of the metal content of Lend-Lease Shipments. The resulting supply figures are rough approximations at best. On the other hand, no amount of conjecture about the reliability of war-period data can obscure the fact of an almost four-fold increase in the supply of both basic metals and energy resources between the period 1944 to 1957.*

* An increase of (X) percent between 2 periods in the supply of a commodity such as steel does not necessarily indicate that the amount of steel available for the production of munitions (or armaments) has increased in a like proportion. Under some circumstances the increase in the total will be proportionately greater than the increase in the amount available for military purposes. Under most circumstances the reverse would be true. See Appendix G.

Table 25

Industrial Production Indexes
Selected Years, 1940-57

(1951 = 100)

Year	Industrial a/ Production Index	Adjusted b/ Index
1940	63	60
1943	59	54
1944	63	59
1948	64	59
1950	89	87
1951	100	100
1952	110	111
1953	118	120
1954	129	132
1955	139	143
1956	150	156
1957	162	169

a. Data from Appendix B, Table 36.

b. Adjustments made by removing from the industrial production index that amount of consumer goods output estimated to be the minimum civilian requirement. Thus, the adjusted index grows more rapidly than the original index since consumer goods output is estimated to grow more rapidly under cold-war conditions than the minimum consumer goods requirements for hot-war conditions.

Year	Consumer Goods aa/ $W_{51} \times Q_1/Q_0$	Minimum Requirement Consumer Goods	Producer Goods aa/ $W_{51} \times Q_1/Q_0$	Defense Goods aa/ $W_{51} \times Q_1/Q_0$	Total (1-2+3+4)	Index
1940	2,431	1,170	3,008	938	5,207	60
1943	1,355	1,170	1,393	3,109	4,687	54
1944	1,170	1,170	1,615	3,471	5,086	59
1948	2,187	1,201	3,565	616	5,167	59

Table 25

Industrial Production Indexes
Selected Years, 1940-57
(Continued)

Year	Consumer Goods aa/ $W_{51} \times Q_1/Q_0$	Minimum Requirement Consumer Goods	Producer Goods aa/ $W_{51} \times Q_1/Q_0$	Defense Goods aa/ $W_{51} \times Q_1/Q_0$	Total (1+2+3+4)	Index
1950	2,834	1,269	5,069	951	7,585	87
1951	3,080	1,299	5,570	1,340	8,691	100
1952	3,296	1,313	5,960	1,702	9,645	111
1953	3,511	1,336	6,517	1,782	10,474	120
1954	3,788	1,357	7,185	1,876	11,492	132
1955	4,096	1,379	7,854	1,970	12,541	143
1956	4,404	1,404	8,522	2,064	13,586	156
1957	4,743	1,444	9,246	2,171	14,716	169

aa. Data from Appendix B, Table 36. The 1951 weight (W_{51}) is the percentage of total value added attributable to each sector. The Q_1/Q_0 ratio is the quantity relative based on 1951 = 100.

Table 26

Capital Goods Production for the USSR

(1951 = 100)

Year	Producer Goods Index a/*	Adjusted Index b/
1940	54	57
1948	64	61
1950	91	87
1951	100	100
1952	107	111
1953	117	120

* Footnotes for Table 26 follow on p. 58.

Table 26

Capital Goods Production for the USSR
(Continued)

(1951 = 100)

Year	Producer Goods Index a/	Adjusted Index b/
1954	129	131
1955	141	142
1956	153	153
1957	166	166

a. Data from Appendix B, Table 36.
b. The capital goods index was adjusted to include defense industry output for peacetime years only. No index is given for wartime years since the purpose of this comparison is to indicate the growth of the capital goods industries that form the base for munitions production during a mobilization period.

Year	Producer Goods aa/ $W_{51} \times Q_1/Q_0$	Defense Goods aa/ $W_{51} \times Q_1/Q_0$	Total of Columns 1 and 2	Index
1940	3,008	938	3,946	57
1948	3,565	616	4,181	61
1950	5,069	951	6,020	87
1951	5,570	1,340	6,910	100
1952	5,960	1,702	7,662	111
1953	6,517	1,782	8,299	120
1954	7,185	1,876	9,061	131
1955	7,854	1,970	9,824	142
1956	8,522	2,064	10,586	153
1957	9,246	2,171	11,417	166

aa. Data from Appendix B, Table 36. The 1951 weight (W_{51}) is the percentage of total value added attributable to each sector. The Q_1/Q_0 ratio is the quantity relative based on 1951 = 100.

Table 27

Gross National Product Indexes for the USSR

(1948 = 100)

Sector	Weight	1940	1943	1944	1948	1951	1957
Industry a/	36.2	98	92	98	100	157	254
Agriculture b/	23.4	114	85	85	100	116	144
Construction c/	5.6	91	65	77	100	137	190
Transportation c/	8.3	N.A.	N.A.	N.A.	100	149	202
Communication c/	1.0	N.A.	N.A.	N.A.	100	132	203
Trade c/	3.6	N.A.	N.A.	N.A.	100	105	117
Services c/	21.8	N.A.	N.A.	N.A.	100	112	136
GNP d/	100.0	99	77	84	100	134	189

a. Data from Table 25, recomputed to a 1948 base.

b. Data from [redacted] 50X1

c. Data from 1940 to 1948 estimated from total labor force employed by these industries plus manpower in military services. An arbitrary productivity adjustment was made, as indicated. Data for years after 1948 taken from [redacted] 50X1

Year	Labor Force aa/ (Millions)	Productivity bb/ Index	Output Index (1948 = 100)
1940	22.1	100	91
1943	22.3	71	65
1944	24.6	77	77
1948	24.4	100	100

aa. Military services manpower estimated as follows: 1940, 4.0 million; 1943 and 1944, 12.0 million; and 1948, 3.5 million.

bb. Data based on following reasoning 12/: [redacted] 50X1

[redacted] (1) productivity rose by 9 percent per year during the war years, (2) productivity was about equal in 1940 and 1948, and (3) productivity fell from 1945 to 1946 due to reconversion. In order to make all these statements reasonably consistent, it is necessary that productivity should have fallen about 40 percent from 1940 to 50X1

Table 27

Gross National Product Indexes for the USSR
(Continued)

1941. These statements refer to industrial productivity. It is assumed here that productivity in the service industries moved in the same way.

d. The GNP calculations are as follows:

Sector	Weight aa/	1940	1943	1944	1948	1951	1957
Industry	36.2	354	333	354	362	568	919
Agriculture	23.4	267	199	199	234	271	337
Construction	5.6	367	262	310	56	77	106
Transportation	8.3	N.A.	N.A.	N.A.	83	124	168
Communication	1.0	N.A.	N.A.	N.A.	10	13	20
Trade	3.6	N.A.	N.A.	N.A.	36	38	42
Services	21.8	N.A.	N.A.	N.A.	218	244	296
GNP	100.0	98.8	79.4	86.3	100.0	133.5	188.8

Interpolation between 1951 and 1957 are as follows, using straight line basis:

	1952	1953	1954	1955	1956
GNP	141	150	159	168	177

aa. The weights are the estimated distribution of value added in the USSR [redacted] 50X1

Table 28

Gross National Product Index

(1948 = 100)

Year	GNP Index a/	Adjusted GNP Index b/
1940	99	102
1943	79	67
1944	86	79
1948	100	100
1950	122	136
1951	134	155
1952	144	172
1953	153	187
1954	162	201
1955	171	216
1956	180	231
1957	189	246

a. Data from Table 27. Data for 1951-57 interpolated on a constant increment basis.
b. Consumption in 1944 taken as necessary minimum, assumed to be 50 percent of total GNP. 13/ This minimum was projected on the basis of population changes, assuming per capita consumption would be reduced to the 1944 level. The calculations are shown below.

Year	GNP $W_{48} \times Q_1/Q_0$	Minimum Consumption	Total of Columns 1 and 2	Index
1940	9,880	4,175	5,705	102
1943	7,940	4,175	3,765	67
1944	8,630	4,175	4,455	79
1948	10,000	4,384	5,616	100
1950	12,200	4,550	7,650	136

Table 28

Gross National Product Index
(Continued)

Year	$W_{48} \times GNP_{Q_1/Q_0}$	Minimum Consumption	Total of Columns 1 and 2	Index
1951	13,350	4,634	8,716	155
1952	14,350	4,697	9,653	172
1953	15,250	4,772	10,478	187
1954	16,150	4,847	11,303	201
1955	17,060	4,922	12,138	216
1956	17,970	5,001	12,969	231
1957	18,880	5,076	13,804	246

APPENDIX B

INDUSTRIAL PRODUCTION INDEXES FOR THE USSR

A. Introduction.

A recent series of ORR projects 14/ -- have examined the structure and growth of industrial output in the USSR. These studies have concentrated primarily on the late postwar period from 1947 on, and have paid only cursory attention to the 1940-47 period. For purposes of this report it will be necessary to examine the prewar and wartime period more intensively, since this period forms the basis for many calculations. Particular attention will be paid to the defense component of industrial output, again because of its importance during the wartime period.

B. Defense Output Index.

An index of military end-item output can be calculated in either of two ways. The value of munitions procurement data in current rubles can be estimated, and a price deflator constructed in order to isolate changes in real output. Alternatively, the physical output data can be aggregated into an index of munitions production, provided that adequate weights can be obtained for the individual items. Both procedures are used in this section. Good price deflators for the procurement series are not obtainable for the 1940-47 period; the physical output data from the year 1948 on are unreliable because of changes in the characteristics and complexity of the end items.

Estimates of the value of munitions procurement have been obtained from published Soviet defense budgets, 15/ as shown in Table 3.*

In order to make a comparison in real terms of munitions procurement in one year relative to others, it is necessary to correct this series for changes in the level of munitions prices. Two such price indexes are shown in Table 29**, one estimated by CIA and the other derived from UN estimates.

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* P. 10, above.

** Table 29 follows on p. 64.

Table 29

Indexes of Price Changes and Changes in Soviet Expenditures for Munitions 1940 and 1944-53

Year	Alternative Price Indexes for Capital Equipment: CIA a/ Index	Alternative Price Indexes for Capital Equipment: Adjusted 16/ UN Index	Current Munitions b/ (Billion Rubles)	Munitions Index with CIA Price Index	Munitions Index with UN Price Index
1940		100	32.5	100	100
1944		82	64.9		243
1945		91	57.7		195
1946		94	22.0		72
1947		99	18.3		57
1948	104	104 c/	21.7	64	64
1949	135	135	33.0	75	75
1950	115	127	37.1	99	90
1951	109	116	48.9	138	130
1952	106 d/	113 d/	60.6	176	165
1953	104 d/	111 d/	62.2	184	172

a. This index is an index computed by CIA from a comparison of official figures for capital equipment investment in real and ruble prices.
b. Data from Table 3.
c. Interpolated value.
d. CIA estimates.

Since a reliable munitions output index covering the entire 1940-53 period is needed, physical output data must be utilized. Soviet munitions production by model and class during World War II has been estimated from [redacted] published Soviet data. 50X1
Physical output estimates for the postwar period have been made by CIA [redacted]. These estimates may be combined into 50X1
an index of change in real munitions output by weighting with unit prices, as shown in Table 30.*

* Table 30 follows on p. 65.

Table 30

Units, 1945 Dollar Value, and Index of Munitions Output in the USSR
1940 to 1948

Class of Munitions	1945 Dollar Cost [a]/*	Production [17]/ 1940	1941	1942	1943	1944	1945	1946	1947	1948
Aircraft										
Fighter (Units)	64,200	5,760	8,930	18,000	26,860	29,000	24,000	3,276	2,863	2,175
Bomber (Units)	127,000	3,000	3,597	3,900	4,800	5,200	4,000	1,162	1,449	1,860
Transport (Units)	48,000	240	190	120	1,000	1,000	800	600	772	1,183
Other (Units)	9,000	3,000	2,079	3,600	4,600	4,800	3,200	4,211	5,097	4,460
Cost (Thousand US $)		789,300	1,058,000	1,689,100	2,423,400	2,613,400	2,116,000	424,600	450,600	472,800
Armored Vehicles										
Light (Units)	24,970	3,200	4,500	5,050	4,250	9,110	1,460	N.A.	N.A.	N.A.
Medium (Units)	50,200	1,200	2,850	9,000	16,770	17,420	13,848	6,275	5,457	4,872
Heavy (Units)	90,940	200	50	500	970	2,400	2,810	1,941	2,324	3,419
Cost (Thousand US $)		158,300	260,000	623,400	1,036,200	1,320,200	987,200	491,500	485,300	555,500
Artillery										
Under 76-mm (Units)	2,150	1,260	2,300	28,000	28,000	17,500	9,500	2,100	1,000	500
76-mm and Above (Units)	3,550	8,960	16,160	36,250	38,100	47,600	18,400	11,058	9,781	9,107
Antiaircraft (Units)	6,340	3,780	6,800	16,600	19,300	22,000	11,200	5,000	4,000	4,700
Cost (Thousand US $)		58,500	105,400	294,100	317,800	346,100	156,800	75,500	62,200	63,400

* Footnotes for Table 30 follow on p. 67.

Table 30

Units, 1945 Dollar Value, and Index of Munitions Output in the USSR
1940 to 1948
(Continued)

Class of Munitions	1945 Dollar Cost a/	Production 17/								
		1940	1941	1942	1943	1944	1945	1946	1947	1948
Small Arms										
Small Arms (Units)	60	2,040,000	2,040,000	3,160,000	6,320,000	6,980,000	6,444,000	N.A.	N.A.	N.A.
Cost (Thousand US $)		122,400	122,400	189,600	379,200	418,800	386,400	143,000 c/	112,000 c/	128,000 c/
Mortars										
Mortars (Units)	910	9,000	9,000	46,000	91,000	100,000	93,000	N.A.	N.A.	N.A.
Cost (Thousand US $)		8,200	8,200	41,900	82,800	91,000	84,600	31,000 c/	25,000 c/	28,000 c/
Naval Vessels										
Cruisers (Units)	17,100,000	1	4	N.A.	1	N.A.	N.A.	N.A.	N.A.	N.A.
Destroyers (Units)	6,500,000	13	10	N.A.	3	1	N.A.	N.A.	N.A.	N.A.
Submarines (Units)	2,900,000	28	25	11	7	7	3	4	8	12
Cost (Thousand US $)		182,800	205,900	31,900	56,900	26,800	8,700	11,600	23,200	34,800
Ammunition										
Small Arms (Tons)	1,460	N.A.	50,000	120,000	180,000	200,000	170,000	N.A.	N.A.	N.A.
Mortar (Tons)	1,500	854,000	110,000	380,000	670,000	730,000	490,000			
Artillery (Tons)	950	N.A.	650,000	1,300,000	2,250,000	2,500,000	1,400,000			
Other (Tons)	1,200		65,000	120,000	225,000	250,000	140,000			
Cost (Thousand US $)		913,800	933,500	2,136,200	3,674,800	4,062,000	2,481,200	300,000	240,000	270,000 d/

Table 30

Units, 1945 Dollar Value, and Index of Munitions Output in the USSR
1940 to 1948
(Continued)

Class of Munitions	1945 Dollar Cost [a]	Production [17] 1940	1941	1942	1943	1944	1945	1946	1947	1948
Trucks										
Trucks (Units)	1,200	157,500	91,000	41,400	51,900	79,400	20,000	25,000	30,000	40,000
Cost (Thousand US $)		189,000	109,200	49,700	62,300	95,300	24,000	30,000	36,000	48,000
Total (Thousand US $)		2,422,300	2,802,600	5,055,900	8,033,400	8,973,600	6,244,900	1,507,200	1,434,300	1,600,500
Index		100	116	209	332	370	258	62	59	66

a. Average 1945 dollar costs per unit from Appendix C. Dollar costs per displacement ton for naval vessels are multiplied by estimated average tonnage of 8,545 tons for cruisers, 1,850 tons for destroyers, and 850 tons for submarines.
b. The ammunition figures in tons are from the following units of output in thousands of rounds:

Year	1941	1942	1943	1944	1945
Output (thousand rounds)					
Small Arms	1,700,000	4,600,000	6,700,000	7,400,000	6,200,000
Mortar	17,000	56,000	100,000	110,000	87,000
Artillery	35,000	70,000	120,000	130,000	60,000

For purposes of constructing the index, 1940 small arms and mortar output was assumed equal to 1941 output.
The figures on trucks for 1945-48 are about 20 percent of total truck production in these years.
c. The dollar values of small arms and mortar output were projected from 1945 to 1948 by use of the index of munitions output in Table 4, Section II.
d. The dollar value and tonnage figures for ammunition were assumed to be 10 percent of munitions procurement as computed from Table 4, Section II.

The two indexes of munitions output, one derived from procurement data and the other from production data, are combined in Table 6.*

C. Consumption and Producer Goods Indexes.

The defense industry index can now be integrated into the industrial output indexes calculated [redacted]. Adjustments must first be made in the weighting system used to combine the components of this index. The weighting system previously consisted of 1941 Plan value added weights, assumed to be equivalent to 1948 value added weights. It is now felt that this assumption was not valid, since the output pattern planned for 1941 consisted of a very heavy concentration -- for a semi-peacetime year -- on munitions. In addition, it is probably true that the relative importance of different industries in the producer goods sector changed between the 1941 and 1948 Plans. It was thus thought desirable to work out a completely new set of weights for a different base year or base years. 50X1

With this objective in mind, estimates of value added weights for industrial sectors were made for both 1940 and 1951. No one set of weights can be thought of as the proper weights, particularly since the output index extends over a 17-year period. Ideally, it is desirable to make fairly frequent changes in the base year and the weighting year. Scarcity relationships and price relationships may be expected to change drastically in any rapidly growing economy. This fact alone will usually mean that a set of weights taken from an early year would overstate the rate of growth in later years. Conversely, a set of weights taken from a late year would tend to understate the relationship of output in early years to output in late years. Both of these statements rest on the presumption that changes in relative prices will be negatively correlated, that is, that the most rapidly growing industrial sectors should be expected to show price declines relative to less rapidly growing sectors.

Two sets of industrial value added weights were thus estimated for 1940 and 1951. The weights were derived by multiplying estimates of the industrial labor force in each sector for these two years, multiplying the labor force estimates by the 1941 Plan average wage rate per industrial sector, and adjusting these wage bill estimates to account for the costs of using capital in each sector. The capital cost adjustment was arbitrary, consisting of a doubling of the 1941 Plan depreciation allowance for each sector in deriving in 1940 weights,

* P.14, above.

and a quadrupling of the 1941 Plan depreciation allowance for each sector in deriving the 1951 weights. Since 1941 Plan wage rates were used to derive both sets of weights, it is likely that the estimated 1940 weights are a closer approximation to the "real" 1940 weights than would be the 1951 weights in respect to their "real" counterpart. The reason is that there is no account for any changes in the structure of relative wages that might have taken place between 1941 and the respective weight base years. Such changes are not likely to have been significant between 1940 and 1941; they may well have been significant between 1941 and 1951. Tables 31 and 32* show the estimated value added weights for 1940 and 1951.

Table 31

Estimated 1940 Value Added Weights
for Industrial Sectors 18/ a/**

Sector	Weights: Producer Goods	Weights: Consumer Goods	Total
Electric Power	2.0	0.4	2.4
Coal	6.4	0	6.4
POL	2.3	0.3	2.6
Ferrous	8.8	0	8.8
Nonferrous	3.6	0	3.6
Fabricated Metal	14.2	2.9	17.1
Defense	15.0	0	15.0
Wood	3.3	1.0	4.3
Paper	0	0	0
Chemicals	3.2	0	3.2
Textiles	0	7.8	7.8
Light	0	4.1	4.1
Food	0	10.1	10.1
Construction Materials	2.0	1.1	3.1
Other	4.6	6.8	11.4
Total	65.5	34.5	100.0 b/

* Table 32 follows on p. 70.
** Footnotes for Table 31 follow on p. 70.

Table 31

Estimated 1940 Value Added Weights
for Industrial Sectors 18/ a/
(Continued)

a. Data derived by multiplying 1940 labor force per industrial sector by 1941 plan average wage rates. Depreciation allowances per sector (1941 plan) were doubled and added to the wage bill; the total value added was then reduced to the above percentage contribution.
b. Rounding error of 0.1.

Table 32

Estimated 1951 Value Added Weights
for Industrial Sectors a/*

Sector	Weights		
	Producer Goods	Consumer Goods	Total
Electric Power	2.9	0.6	3.5
Coal	9.6	0	9.6
POL	3.6	0.4	4.0
Ferrous	8.9	0	8.9
Nonferrous	3.4	0	3.4
Fabricated Metal	16.7	3.4	20.1
Defense	13.4	0	13.4
Wood	2.7	0.9	3.6
Paper	0	0	0
Chemicals	3.4	0	3.4
Textiles	0	5.5	5.5
Light	0	3.4	3.4
Food	0	9.3	9.3
Construction Material	1.7	0.8	2.5
Other	2.9	6.5	9.4
Total	69.2	30.8	100.0 b/

* Footnotes for Table 32 follow on p. 71.

Table 32

Estimated 1951 Value Added Weights
for Industrial Sectors a/
(Continued)

a. Data derived by multiplying 1951 labor force in each industrial sector by 1941 plan average wage rates. Depreciation allowances per sector (1941 plan) were quadrupled and added to the wage bill; the total value added was then reduced to the above percentage contributions. The distribution between producer goods and consumer goods was assumed to be approximately the same as the 1940 distribution for those sectors that contribute to both producer and consumer goods output.
b. Rounding error of 0.1.

The industrial output indexes were then recomputed using both revised sets of weights and the revised defense index. One other minor change was made in the basic data. The chemical industry output index was revised for the 1940-46 period. The revision was based on the fact that incomplete product coverage during the wartime years was originally treated by assuming that products not covered were not produced at all. This assumption does not seem plausible and therefore the alternative assumption was made that products not covered during this period moved in the same way as the four products that were covered. The original chemical industry index and the revised index are shown in Table 33.*

Recomputation of the consumer and producer goods sector indexes with the two sets of weights indicates that divergencies are not overly serious for the 1940-46 period. After the latter date, however, the very rapid growth of Soviet industrial output begins to result in serious discrepancies. As might be anticipated, the index based on 1940 weights begins to outrun the index based on 1951. The indexes again move in tandem after 1952, since all changes after 1952 were based on the most recent growth estimates by CIA. 19/ The results of the sector index recomputations are shown in Table 34.**

* Table 33 follows on p. 72.
** Table 34 follows on p. 72.

Table 33

Original and Revised Indexes of Output
in the Chemical Industry
1940-46

	1940	1941	1942	1943	1944	1945	1946
Original Index 20/	80	14	9	15	16	25	61
Revised Index a/	80	40	40	45	48	52	61

a. Estimated on the basis of movements from 1940-46 in the following items: reclaimed rubber, nitric acid, synthetic ammonia, and caustic soda. Rule of thumb adjustments were made on the basis of the 1940 and 1946 outputs of other products that were not reported or estimated during the wartime period.

Table 34

Consumer and Producer Goods Indexes Recomputed
with 1940 and 1951
Value Added Weights 21/

1940 = 100

	Consumer Goods Indexes		Producer Goods Indexes	
Year	1940 Weights	1951 Weights	1940 Weights	1951 Weights
1940	100	100	100	100
1941	88	91	75	78
1942	66	70	43	44
1943	54	58	44	46
1944	47	50	51	54
1945	50	51	62	65
1946	65	66	77	78
1947	78	76	100	94
1948	98	93	130	118
1949	116	109	160	142
1950	132	121	194	168
1951	143	132	213	185

Table 34

Consumer and Producer Goods Indexes Recomputed
with 1940 and 1951
Value Added Weights 21/
(Continued)

1940 = 100

	Consumer Goods Indexes		Producer Goods Indexes	
Year	1940 Weights	1951 Weights	1940 Weights	1951 Weights
1952	153	141	228	198
1953	163	150	249	216
1954	175	162	275	239
1955	190	175	300	261
1956	204	188	326	283
1957	219	203	354	307

It can be readily observed from Table 34 that the use of different weights makes a substantial difference only during the period 1947-51. The wartime period is not much different and the period from 1952 upward cannot show any divergence due to the manner in which the figures were derived. It is likely that the 1951 weights give a more accurate picture of the real rate of growth during the 1947-51 period, since the 1951 data would certainly show a more accurate picture of postwar scarcity relationships than the 1940 data.

D. Industrial Output Index.

The three major sector indexes -- consumer goods, producer goods, and defense -- are combined into an index of industrial output in Table 35.*

The major changes in the industrial production index stemming from the recalculation are concentrated in the 1940-47 period. The consumer and producer goods indexes have not been altered very greatly, although the long-term growth rate has probably showed some slight increase. This is due to the fact that use of 1951 weights tends to

* Table 35 follows on p. 74.

Table 35

Soviet Index of Industrial Output
1951 Weights

Year	Sector (1951 = 100)			Industrial Output	
	Consumer (30.8 Percent of Sector)	Producer (55.7 Percent of Sector)	Defense (13.4 Percent of Sector)	1951 = 100	1940 = 100
1940	76	54	70	63	100
1941	69	42	81	56	88
1942	53	24	146	49	78
1943	44	25	232	59	93
1944	38	29	259	63	99
1945	39	35	180	56	88
1946	50	42	43	45	71
1947	58	51	41	52	82
1948	71	64	46	64	101
1949	83	77	54	76	120
1950	92	91	71	89	141
1951	100	100	100	100	159
1952	107	107	127	110	175
1953	114	117	133	118	187
1954	123	129	140	129	205
1955	133	141	147	139	221
1956	143	153	154	150	238
1957	154	166	162	162	257

depress the prewar and wartime levels of output relative to postwar. On the other hand, the revision of the defense index has occasioned major changes, particularly during the wartime period. The rate of increase in Soviet munitions during World War II is now estimated to be much higher than previously, and the postwar reduction is estimated to be somewhat greater. The rate of growth in the late postwar period is about the same. The net result of these changes is to raise the wartime period relative to both postwar and prewar, and depress the entire postwar period

relative to prewar. The reduction in the postwar relative to the prewar period caused by adjustment of the defense index balances the increase caused by the adjustment of the consumer and producer goods indexes. On balance, therefore, the main result has been a raising of the wartime period relative to all other years.

Table 36 shows the index of industrial output calculated with 1940 weights. As pointed out, the main difference from the 1951 weight index shows up during the early postwar period, when the rate of growth was extremely high.

Table 36

Soviet Index of Industrial Output
1940 Weights a/

	Sector (1940 = 100)			Industrial Output	
Year	Consumer (34.5 Percent of Sector)	Producer (50.5 Percent of Sector)	Defense (15.0 Percent of Sector)	1951 = 100	1940 = 100
1940	100	100	100	56	100
1941	88	75	116	48	86
1942	66	43	209	43	76
1943	54	44	332	51	91
1944	47	51	370	54	97
1945	50	62	258	49	87
1946	65	77	62	40	71
1947	78	100	59	48	86
1948	98	130	66	61	109
1949	116	160	77	75	133
1950	132	194	102	89	159
1951	143	213	143	100	178
1952	153	228	182	110	195
1953	163	249	190	118	210
1954	175	275	200	129	229
1955	190	300	210	140	249
1956	204	326	220	150	268
1957	219	354	231	162	289

a. Data from Tables 6 and 34.

APPENDIX C

DOLLAR COST ESTIMATES OF SOVIET ITEMS OF MUNITIONS

The estimates of dollar costs for Soviet items of munitions used in the analysis are made by two methods: (1) on the basis of dollar cost per unit weight determined from counterpart US munitions items, and (2) on the basis of dollar cost per unit weight determined from counterpart US munitions items with adjustments for differences in quantity and quality of attached and accompanying equipment such as electronics. The latter method was used for aircraft and anti-aircraft artillery, the former for all other major items. The US and Soviet counterpart models were selected on the basis of: (1) function, (2) physical attributes, and (3) rate of production of US model. The first two criteria were most important. Often it was discovered that two or three US models could be compared with a particular Soviet model. In such a case the third criterion was applied, and the item with the highest rate of production in the US was used. Models with low production rates are often experimental models for which the cost does not reflect the real costs of production for standard models.

Dollar cost estimates are made for World War II type equipment and for current models. All prices are expressed in 1945 dollars.

The cost estimates for all Soviet World War II items except aircraft and ships are shown in Table 37.*

* Table 37 follows on p. 78.

Table 37

Estimated 1945 Dollar Costs of Major World War II Items of Soviet Munitions Excluding Aircraft and Naval Vessels

Item	Unit Weight 22/ (Pounds)	Cost per Thousand Pounds (US $ 1945) a/*	1945 Dollar Cost per Item
			Units
Tanks and Assault Guns			
Light Assault Guns (33) 24/b/	24,000	1,040	24,970
Medium Tanks and Assault Guns (59)	62,750	800	50,200
Heavy Tanks and Assault Guns (8)	96,740	940	90,940
Trucks			
Light (GAZ-MM) (8)	4,000	260	1,040
Heavy (ZIS-5) (2)	6,840	265	1,810
Average Cost			1,200
Artillery			
45-mm Antitank (54)	1,245	1,170	1,450
57-mm Antitank (46)	2,535	1,170	2,970
Average Cost			2,150
76-mm Gun (72)	2,460	1,170	2,880
76-mm Howitzer (12)	1,323	1,170	1,550
85-mm Gun (1)	3,748	1,170	4,390
100-mm Gun (1)	7,628	1,170	8,930
122-mm Howitzer (15)	4,960	1,170	5,800
Average Cost			3,260

* Footnotes for Table 37 follow on p. 80.

Table 37

Estimated 1945 Dollar Costs of Major World War II Items of Soviet Munitions Excluding Aircraft and Naval Vessels (Continued)

Item	Unit Weight 22/ (Pounds)	Cost per Thousand Pounds (US $ 1945) a/	1945 Dollar Cost per Item
			Units
Artillery (Continued)			
152-mm Howitzer and Gun Howitzer c/ (87)	11,830	1,050	12,420
203-mm Howitzer (13)	39,021	1,240	48,390
Average Cost			17,100
37-mm Antiaircraft d/ (82)	4,630	820	3,800
85-mm Antiaircraft d/ (18)	9,480	1,890	17,920
Average Cost			6,340
Small Arms			
Rifle and Carbine (30)	8.8	7,000	60
Submachine Gun (20)	6.6	2,200	15
Machine Gun (6)	107	2,070	220
Average Cost			60
Mortars			
82-mm (6)	128	1,885	240
120-mm (2)	606	1,885	1,140
160-mm (1)	2,381	1,885	4,490
Average Cost			910

Table 37

Estimated 1945 Dollar Costs of Major World War II Items of Soviet Munitions Excluding Aircraft and Naval Vessels (Continued)

Item	Unit Weight 22/ (Pounds)	Cost per Thousand Pounds (US $ 1945) a/	1945 Dollar Cost per Item
			Units
Ammunition (Tons)			
Small Arms	0.054	730 e/	N.A. f/
Light Artillery (45-57-mm) (2)	13.7)	710 e/	N.A.
Medium Artillery (76-122-mm) (250)	23.2)	510 e/	N.A.
Heavy Artillery (152-mm and up) (1)	117.0)	180 e/	N.A.
Average Artillery Cost	23.0	475	
Mortar	7	750 e/	
Bombs	444	180 e/	

a. The weights in parentheses and price per unit weight are rounded from unit production figures and prices per unit weight with more significant digits than shown. This procedure accounts for small arithmetical errors. Price per unit weight was determined for similar US items from US publications. 23/ The selection of the counterpart items was contingent on physical characteristics and quantity of output during World War II. Given two or more US items as probable counterpart items, the one produced most was selected. The prices are mostly in 1945 dollars, although a few are for the last date of production prior to 1945.
b. Figures in parentheses are used to determine the average prices of the last column.
c. The gun and gun-howitzer are combined in a one-to-one ratio [redacted] 50X1
[redacted] 50X1
d. The counterpart antiaircraft models selected were the simplest models of similar caliber.

Table 37

Estimated 1945 Dollar Costs of Major World War II Items of Soviet Munitions Excluding Aircraft and Naval Vessels (Continued)

e. The ammunition prices per unit weight are the prices of the most common types of ammunition averaged by estimated type proportions for each class.
f. Not applicable.

The dollar cost estimates for the Soviet World War II equipment given in Table 37 are probably minimum estimates. In short, unit costs figured in the above manner, which presupposes efficient levels of production are lower than unit costs for new models or for models produced in small quantities.

Dollar costs for current Soviet munitions except aircraft and naval vessels are given in Table 38.

Table 38

Estimated 1945 Dollar Costs of Major Current Items of Soviet Munitions Excluding Aircraft and Naval Vessels

Item	Unit Weight a/* (Pounds)	Cost per Thousand Pounds 27/ b/ (US $ 1953)	Cost per Unit 1953	Cost per Unit 1945 c/
Tanks and Assault Guns				
Medium Tanks and Assault Guns	81,950	1,880	154,100	89,400
Heavy Tanks and Assault Guns	101,200	2,300	232,800	135,100

* Footnotes for Table 38 follow on p. 84.

Table 38

Estimated 1945 Dollar Costs of Major Current Items
of Soviet Munitions Excluding Aircraft and Naval Vessels
(Continued)

Item	Unit Weight a/ (Pounds)	Cost per Thousand Pounds 27/ b/ (US $ 1953)	Cost per Unit 1953	Cost per Unit 1945 c/
Trucks and Jeeps d/				
ZIS-151 (3)	N.A.	N.A.	N.A.	2,500
ZIS-150 (32)	N.A.	N.A.	5,500	3,200
GAZ-51 (54)	N.A.	N.A.	3,200	1,850
GAZ-63 (3)	N.A.	N.A.	N.A.	1,850
GAZ-67 (b) (Jeep) (8)	N.A.	N.A.	N.A.	1,050
Average Cost				2,200
Artillery				
57-mm Antitank	2,535	2,495	6,320	3,220
Average Cost			6,320	3,220
85-mm Gun (4) e/	3,748	3,660	13,720	6,990
100-mm Gun (4)	7,628	3,660	27,920	14,230
122-mm Howitzer (8)	4,960	3,660	18,150	9,250
Average Cost			19,490	9,930
152-mm Howitzer and Gun Howitzer (15)	11,830	3,570	42,230	21,520
203-mm Howitzer (1)	39,021	3,280	127,990	65,240
Average Cost			47,590	24,260

Table 38

Estimated 1945 Dollar Costs of Major Current Items
of Soviet Munitions Excluding Aircraft and Naval Vessels
(Continued)

Item	Unit Weight a/ (Pounds)	Cost per Thousand Pounds 27/ b/ (US $ 1953)	Cost per Unit 1953	Cost per Unit 1945 c/
57-mm Antiaircraft Gun (1)	N.A.	N.A.	150,000	76,500
100-mm Antiaircraft Gun (2)	15,000	4,370	65,500	33,400
Average Cost			93,670	47,700
Small Arms				
Rifle and Carbine (74)	8.8	8,000	70	36
Submachine Guns (22)	6.6	5,000 f/	33	17
Machine Gun (4)	39.3	5,500	216	110
Average Cost				35
Mortars				
82-mm (1)	128	5,730	730	370
120-mm (2)	606	5,730	3,470	1,770
160-mm (1)	2,381	5,730	13,640	6,950
Average Cost				2,700
Ammunition				
Small Arms (5.5)	.054	2,160	N.A.	1,100 per 1,000 lbs
Light Artillery (57-mm) (10)	14	1,600	N.A.	815 per 1,000 lbs
Medium Artillery (76-122-mm) (57)	38	830	N.A.	420 per 1,000 lbs

Table 38

Estimated 1945 Dollar Costs of Major Current Items
of Soviet Munitions Excluding Aircraft and Naval Vessels
(Continued)

Item	Unit Weight a/ (Pounds)	Cost per Thousand Pounds 27/ b/ (US $ 1953)	Cost per Unit 1953	Cost per Unit 1945 c/
Ammunition (Continued)				
Heavy Artillery (152-mm and up) (8)	110	600	N.A.	310 per 1,000 lbs
Mortars (12.0)	25	1,430	N.A.	730 per 1,000 lbs
Grenades, Land Mines, and Rockets (2.5)	15.5	N.A.	N.A.	600 per 1,000 lbs
Average Cost				570 per 1,000 lbs

a. Unit weights are from Table 37 except for 100-mm antiaircraft, machine guns, and artillery and mortar ammunition. The 100-mm antiaircraft gun weight is estimated from the weight of the US 90-mm antiaircraft. Machine gun weight is the average weight of machine guns. 25/ The artillery and mortar ammunition weights are average weights. 26/

b. The 57-mm antiaircraft artillery price was determined from the estimated quantity production price of $250,000 for the 75-mm US "Skysweeper." 28/ Total costs include $190,000 for fire control equipment and $60,000 for the gun. It was assumed that the Soviet fire control equipment would be less complex and could be made for about $95,000. This amount in addition to $60,000 for the gun gives the estimated round figure of $150,000. The ammunition prices per unit weight by class are prices per unit weight by type of ammunition. 29/

c. The 1953 dollar costs, except for armored vehicles, were converted to 1945 dollar costs by means of the following Department of Labor price index for metal and metal products:

Year	Metal and Metal Products 1947-49 = 100	1945 = 100
1945	65.9	100
1953	129.3	196.2

Table 38

Estimated 1945 Dollar Costs of Major Current Items
of Soviet Munitions Excluding Aircraft and Naval Vessels
(Continued)

The index for converting the prices of armored vehicles was the Department of Labor index for Machinery and Motive as follows:

	Machinery and Motive	
Year	1947-49 = 100	1945 = 100
1945	71.6	100
1953	123.4	172.3

d. Proportions among truck models are estimated from current production. The proportions of jeeps to trucks are estimates based on Order of Battle.
e. The figures in parentheses are used to compute average prices. 30/
f. The price of counterpart US submachine gun was judged too high. The cost per 1,000 pounds was $11,000, a figure which would give a real cost increase of about 100 percent over 1945. There have been no changes in the Soviet counterpart model to justify such an increase. The cost per unit weight is an estimate.

The dollar costs for the current Soviet models of munitions excluding aircraft were computed from the most reliable current prices for US weapons. 31/ It may be assumed that the prices for the current models are prices for relatively high levels of production, because counterpart models were selected from those with the highest production rates. The prices for the Soviet equipment may be assumed to hold for production, once conversion to economic mobilization has taken place and the initial organizational problems overcome, that is, probably during part of the second year of mobilization and all of the third year. After the second year there may be a tendency for prices to decline, although the decline might be offset by the introduction of new and more expensive models.

Implicit in some of the computations of dollar cost of current Soviet models is an assumption concerning changes in the quality of munitions. For artillery, small arms, and ammunition, there is little data on the latest Soviet models. As counterpart US models, the most recent models in quantity production have been selected. Thus, it has been assumed that the USSR has introduced changes in the quality of these particular weapons as rapidly as the US has. For all other items counterpart models have been selected as carefully as possible on the basis of physical similarity. Hence, technological improvements have been taken into account directly.

Dollar cost estimates for Soviet aircraft were made from comparisons with US aircraft. A list of Soviet aircraft, including World War II and current models, was drawn up and matched as closely as possible with respect to function and physical characteristics with US aircraft. The cost for the counterpart US aircraft was divided among airframe, engine, electronics and communications, and government-furnished equipment including armament. The cost of the airframe and the engine was divided by the empty weight (the weight of the airframe and engine) to obtain cost per unit of empty weight. This cost per unit weight was multiplied by the empty weight of the Soviet aircraft to obtain the cost of the Soviet airframe and engine.

Generally, Soviet aircraft are equipped with less complex types of communications and electronics and other accessories than US aircraft. In order to make adjustments for these differences, [redacted] estimates of the value of such equipment carried on Soviet aircraft relative to the value carried on counterpart US aircraft. These percentages were applied to the cost for communications and electronics and government-furnished equipment including armament on the counterpart US aircraft to obtain the dollar costs of equipment for Soviet aircraft. The sum of all costs is the estimated dollar cost for Soviet aircraft. 50X1

Cost estimates are presented in Tables 39 and 40.* Table 40 gives the estimates for World War II Soviet models. Table 40 gives the estimates for current models.

* Tables 39 and 40 follow on pp. 87 and 90, respectively.

Table 39

Estimated 1945 Dollar Cost of Soviet World War II Aircraft 32/

Comparison Number a/*	US Model Aircraft	Soviet Model Aircraft	Empty Weight (Pounds)	Airframe Cost (Dollars)	Engine Cost (Dollars)	Airframe and Engine Cost b/ (Dollars)	Electronics Cost (Dollars)	GFAE Cost c/ (Dollars)	Total Cost (Dollars and Year Priced)	Total Cost d/
1	C-47		17,865	39,900	20,100	60,000	8,400	5,700	74,100 (1943)	66,200
		Li-2	17,629			60,000	1,680 e/	3,990 e/	65,670 (1943)	
2	C-45		5,850	35,400	10,800	46,200	2,600	3,900	52,700 (1944)	28,600
		Yak-6	3,200			25,270	780 f/	2,340 f/	28,390 (1944)	
2'	C-45		5,850	35,400	10,800	46,200	2,600	3,900	52,700 (1944)	33,900
		Yak-8	3,860			30,490	780 f/	2,340 f/	33,600 (1944)	
3	Ryan St-4		1,235	5,900	2,800	8,700	Negligible	Negligible	8,700 (1942)	9,640
		UT-2	1,360			9,580	Negligible	Negligible	9,580 (1942)	
4	P-40		5,590	29,900	13,800	43,700	2,900	3,300	49,900 (1942)	40,100
		Yak-7	4,679			36,600	580 g/	2,640 g/	39,820 (1942)	
5	PT-17		1,960	5,700	2,700	8,400	100	600	9,100 (1942)	8,310
		PO-2	1,750			7,560	100 h/	600 h/	8,260 (1942)	
6	P-51		6,551	22,500	21,300	43,800	2,000	4,400	50,200 (1944)	35,900
		Yak-7, 9, 3	4,678			31,300	1,800 i/	3,500 i/	35,600 (1944)	

* Footnotes for Table 39 follow on p. 88.

Table 39

Estimated 1945 Dollar Cost of Soviet World War II Aircraft 32/
(Continued)

Comparison Number a/	US Model Aircraft	Soviet Model Aircraft	Empty Weight (Pounds)	Airframe Cost (Dollars)	Engine Cost (Dollars)	Airframe and Engine Cost b/ (Dollars)	Electronics Cost (Dollars)	GFAE Cost c/ (Dollars)	Total Cost (Dollars and Year Priced)	Total Cost d/
7	P-47		11,017	50,900	27,900	78,800	2,600	8,700	90,100 (1944)	
		La-5, 7	6,000			43,000	500 j/	7,000 j/	50,500 (1944)	50,910
8	P-40		5,590	29,900	13,800	43,700	2,900	3,300	49,900 (1942)	
		IL-2	8,180			63,400	600 k/	2,600 k/	66,600 (1942)	67,000
9	B-25		16,769	83,300	34,900	118,200	10,400	39,700	168,300 (1941)	
		TU-2	14,639			103,000	4,200 l/	29,800 l/	137,200 (1941)	143,000
9	B-25		16,769	83,300	34,900	118,200	10,400	39,700	168,300 (1941)	
		PE-2	12,788			90,130	4,200 l/	29,800 l/	124,140 (1941)	129,800
10	B-17		27,650	97,600	57,700	155,300	17,000	62,800	235,100 (1942)	
		PE-8	45,000			253,000	15,300 m/	34,500 m/	302,800 (1942)	305,100
11	DC-2 B-18-A								110,000 (1945)	
		IL-4	11,300						110,000 (1945)	110,000 n/

a. Each model is numbered to facilitate comparison with aircraft that have superseded these earlier models. Newer types are listed in Table 40.
b. The costs of Soviet engines and airframes are equal per unit of aircraft empty weight to the US counterpart.
c. GFAE includes government-furnished equipment and armament.
d. The price index for converting prices to 1945 dollars is the Department of Labor index for machinery and motive. It is as below:

	Machinery and Motive	
Year	(1947-49 = 100)	1945 = 100
1937	66.2	92.5

Table 39

Estimated 1945 Dollar Cost of Soviet World War II Aircraft 32/
(Continued)

	Machinery and Motive	
Year	(1947-49 = 100)	1945 = 100
1940	66.2	92.5
1941	68.6	95.8
1942	71.2	99.4
1943	71.0	99.2
1944	71.0	99.2
1945	71.6	100

e. The respective Soviet proportions of US costs for electronics and communications, and GFAE, are 20 percent and 70 percent.
f. The respective proportions are 30 percent and 60 percent.
g. The respective proportions are 20 percent and 80 percent.
h. Both proportions are 100 percent.
i. The respective proportions are 90 percent and 80 percent.
j. CIA estimated respective proportions are 20 percent and 80 percent.
k. The respective proportions are 20 percent and 80 percent.
l. The respective proportions are 40 percent and 75 percent.
m. The respective proportions are 90 percent and 55 percent.
n. No breakdown of components of the DC-2 is possible. The IL-4 is similar enough to the DC-2 to allow the price of the latter to be used for its cost.

Table 40

Estimated 1945 Dollar Costs of Current Soviet Aircraft 33/ a/*

Comparison Number b/	US Model Aircraft	Soviet Model Aircraft	Empty Weight (Pounds)	Airframe Cost (Dollars)	Engine Cost (Dollars)	Airframe and Engine Cost (Dollars)	Electronics Cost (Dollars)	GFAE Cost (Dollars)	Total Cost (Dollars and Year Priced)	Total Cost c/
1	C-54		38,656	231,900	63,300	295,200	6,000	11,500	312,700 (1945)	308,000
		IL-18	38,800			295,200	3,600 d/	9,200 d/	308,000 (1945)	
2	T-29		29,840	400,000	100,000	500,000	65,000	90,000	655,000 (1953)	279,500
		IL-12	23,190			388,600	39,000 e/	54,000 e/	481,600 (1953)	
3	AT-6		3,800	12,900	7,000	19,900	1,300	3,600	24,800 (1943)	23,700
		Yak-11	3,819			19,900	390 f/	3,240 f/	23,530 (1943)	
4	T-33		8,084	75,000	19,000	94,000	7,200	12,735	113,935 (1953)	49,500
		U-Yak-17	6,495			75,500	2,200 g/	7,600 g/	85,300 (1953)	
5	Ryan St-4		1,235	5,900	2,800	8,700	Negligible	Negligible	8,700 (1942)	11,300
		Yak-18	1,595			11,240	Negligible	Negligible	11,220 (1942)	
6	F-80		8,084	75,000	19,000	94,000	7,200	12,735	113,935 (1953)	46,800
		Yak-23	6,100			70,900	2,200 h/	7,600 h/	80,700 (1953)	
7	F-84-F		13,420	185,000	75,000	260,000	13,000	50,000	323,000 (1953)	108,000
		MIG-15	7,536			146,000	5,200 i/	35,000 i/	186,200 (1953)	
7'	F-86		10,434	90,000	40,000	130,000	9,500	32,000	171,500 (1953)	69,700
		MIG-15	7,536			93,900	3,800 i/	22,400 i/	120,100 (1953)	

* Footnotes for Table 40 follow on p. 91.

Table 40

Estimated 1945 Dollar Costs of Current Soviet Aircraft 33/ a/
(Continued)

Comparison Number b/	US Model Aircraft	Soviet Model Aircraft	Empty Weight (Pounds)	Airframe Cost (Dollars)	Engine Cost (Dollars)	Airframe and Engine Cost (Dollars)	Electronics Cost (Dollars)	GFAE Cost (Dollars)	Total Cost (Dollars and Year Priced)	Total Cost c/
8	F-84-D		9,933	140,000	32,000	172,000	6,000	36,000	214,000 (1953)	117,000
		IL-10	10,327			178,800	2,400 j/	20,300 j/	201,500 (1953)	
9	B-57		24,290	375,000	150,000	525,000	75,000	53,000	653,000 (1953)	380,000
		Type-35	25,312			547,000	60,000 k/	48,000 k/	655,000 (1953)	
10	B-29		71,500	399,500	108,500	508,000	34,700	98,900	641,600 (1945)	621,000
		TU-4	70,194			499,000	28,000 l/	94,000 l/	621,000 (1945)	
11	B-57		24,290	375,000	150,000	525,000	75,000	53,000	653,000 (1953)	359,000
		IL-28	23,620			510,000	60,000 m/	48,000 m/	618,000 (1953)	
12	B-47		77,950	1,144,000	271,000	1,415,000	102,000	430,000	1,947,000 (1953)	959,000
		EF-150	66,400			1,205,000	82,000 n/	366,000 n/	1,653,000 (1953)	

a. Costs of Soviet airframe and engine are figured as the same cost per unit of empty weight applicable to the US aircraft. Electronics and communications, and GFAE, government-furnished equipment including armament, of Soviet aircraft are determined as specific proportions of such equipment on US aircraft.

b. Each model in this table is numbered to indicate the aircraft it has replaced as indicated in Table 39.

c. Costs were converted to 1945 dollars by means of the Department of Labor index of machinery and motive. It is as follows:

Year	1937	1940	1941	1942	1943	1944	1945	1950	1951	1952	1953
1947-40 = 100	66.2	66.2	68.6	71.2	71.0	71.0	71.6	108.6	118.0	121.5	123.4
1945 = 100	92.5	92.5	95.8	99.4	99.2	99.2	100	151.7	164.8	169.7	172.3

d. The respective proportions are 60 percent and 80 percent.

Table 40

Estimated 1945 Dollar Costs of Current Soviet Aircraft 33/ a/
(Continued)

e. The respective proportions are 60 percent and 60 percent.
f. The respective proportions are 30 percent and 90 percent.
g. The respective proportions are 30 percent and 60 percent.
h. The respective proportions are 30 percent and 60 percent.
i. The respective proportions are 40 percent and 70 percent.
j. The respective proportions are 40 percent and 70 percent.
k. The respective proportions are 80 percent and 90 percent.
l. The respective proportions are 80 percent and 95 percent.
m. The respective proportions are 80 percent and 90 percent.
n. The respective proportions are 80 percent and 85 percent.

Each US and Soviet comparison of aircraft is given a number in Tables 39 and 40. These numbers indicate the succeeding models of Soviet aircraft. Number 1, in both tables indicates that the Soviet aircraft IL-18 has replaced the Li-2, World War II model. A comparison of the 1945 dollar cost of the IL-18 to the Li-2 shows a ratio of more than 4.5 to 1. This ratio is a measure of the increase in cost due to changes in complexity of aircraft performing similar functions. Complexity ratios may be determined for each model. They will be found to vary from a little more than 1 to 1 for the U-Yak-17, to nearly 10 to 1 for IL-12 to the Yak-6.*

When noting changes in complexity of the MIG-15 relative to the La-5 and La-7, two comparisons are possible. If the La-5 and La-7 are compared to the P-47, the MIG-15 should be compared to the F-84-F. But when the MIG-15 is compared to the F-86, the La-5 and La-7 should be compared to the P-36, not shown in Table 40. The cost of the P-36, in 1945 dollars is about $110,000. 34/

The cost for the US aircraft are costs at relatively high levels of output, 5,000 units per year for fighter aircraft and 1,000 units for other aircraft. 35/ The resulting cost estimates are therefore comparable to the costs estimates for other munitions and may be expected to apply for the second year of mobilization.

Average dollar costs of Soviet World War II aircraft by category are given in Table 41.**

* The IL-12 may also be compared to the Yak-8, as noted in Table 39, in which case the ratio is a little more than 8 to 1.

** Table 41 follows on p. 94.

Table 41

Average Costs of World War II Soviet Aircraft by Category

Model and Category	Cost per Unit a/* (US $ 1945)	Ratio of Type to Class 36/	Total b/ Cost (Thousand US $)	Average c/ US Dollar Cost
Fighter				
Yak-3, 7, 9	36,000	875	31,500	
La-5, 7	51,000	270	13,770	
Lagg-3	51,000 d/	400	20,400	
Total		1,545	65,670	42,000
Ground Attack				
IL-2	67,000	620	41,540	
IL-10	117,000	300	35,100	
Total		920	76,640	83,000
Bomber				
PE-2	130,000	190	24,700	
PE-8	305,000	15	4,580	
IL-4	110,000	210	23,100	
TU-2	143,000	30	4,290	
Total		445	56,670	127,000
Transport				
Li-2	66,000	60	3,960	
Yak-6	29,000	55 e/	1,595	
Total		115	5,555	48,000

* Footnotes for Table 41 follow on p. 95.

Table 41

Average Costs of World War II Soviet Aircraft by Category
(Continued)

Model and Category	Cost per Unit a/* (US $ 1945)	Ratio of Type to Class 36/	Total b/ Cost (Thousand US $)	Average c/ US Dollar Cost
Trainer				
UT-2	10,000	150	1,500	
PO-2	8,000	300	2,400	
Total		450	3,900	9,000

a. Dollar costs from Table 39.
b. Total cost is the product of the two preceding columns.
c. Average cost is the quotient of total cost divided by the total number of aircraft of the second column.
d. The Lagg-3 is estimated to cost the same as the La-5 and La-7.
e. There are 35 Schcha-2 included in this figure.

Average dollar costs of current Soviet aircraft by category are given in Table 42.

Table 42 a/*

Average Costs of Current Soviet Aircraft by Category

Model and Category	Ratio of Type to Class b/	Cost 1945 US $
Fighter		
MIG-15	100	90,000 (91,000) c/
Ground Attack		
IL-10	100	117,000

* Footnotes for Table 42 follow on p. 96.

Table 42 a/

Average Costs of Current Soviet Aircraft by Category
(Continued)

Model and Category	Ratio of Type to Class b/	Cost 1945 US $
Bomber		
TU-4	8	621,000
IL-28	34	359,000
Type 35	54	380,000
EF-150	4	960,000
Average Cost		417,000
Transport		
IL-12	15	279,000
Li-2	8	66,000
An-2, Yak-6	35	29,000
Yak-8, Yak-14, Yak-16	42	34,000
Average Cost		72,000
Trainer		
Yak-11	8	23,700
Yak-18	82	11,300
Average Cost		14,000
Other		10,000 d/

a. Based on Table 40 Appendix C.
b. Proportions are estimated from current estimates and estimated mobilization requirements.
c. Estimated price when Type 38 is included.
d. Estimated figure.

The production of naval craft in 1944 was insignificant. Hence, dollar cost estimates have been made for current models only.

The rate of technological advance, insofar as costs are concerned, has been less rapid in the design of naval craft than it has for most other items of munitions. Therefore, dollar costs per unit weight for US World War II ships have been used to make dollar cost estimates of current Soviet models.* The estimated costs by category are given in Table 43. The cost per displacement ton is the figure most frequently used in the text.

Table 43

Estimated Costs of Current Soviet Naval Craft by Class

Vessel Class	Average Vessel 37/ Displacement (Tons)	Cost 38/ a/ per Ton (US $ 1945)	Cost b/ per Vessel (Thousand US $)
Cruiser	15,000	2,000	30,000
Destroyer	3,000	3,540	10,600
Submarine-Long Range	1,500	3,460	5,200
Submarine-Coastal	400	3,460	1,400
Patrol Craft	300	2,900	900
Anti-Submarine	240	4,340	1,000
Mine Craft	600	2,650	1,600
PT Boats	40	5,630	200

a. Dollar costs per displacement ton are computed costs per ton for similar US vessels.
b. These costs per vessel are the products of the preceding two columns.

* Bureau of Ships estimated costs per displacement ton for many different US models in 1947 are generally consistent when adjusted for price changes with the 1945 costs per ton used to compute the costs of Soviet ships. The few discrepancies between the two can be explained on the basis of scale of output.

APPENDIX D

TECHNOLOGICAL CHANGE AND THE COST OF MUNITIONS

In order to project the index of munitions output to 1957, given assumptions concerning inventories, it is necessary to know the relationship of technological advancement in weapons design to changes in real cost. Table 44* gives the dollar cost of World War II and current models of Soviet munitions as computed in Appendix C. The ratios of costs for the two types of munitions are given in the third column. The World War II types of munitions are separated from the current models by about 10 years of research and development and a constant rate of advancement in munitions design is assumed. The rates of increase (decrease), compounded annually, that indicate the actual cost changes by class are given in the fourth column. The final column shows the value of each class of munitions relative to the total value of the munitions represented in the table. These relative values are used to weight the rates of cost change to obtain the average annual cost change for the items listed. These relative values, from 1953 estimated munitions output, yield the average rate of increase in costs of 9 percent a year for the items shown. The items of the table represent about 60 percent of the estimated munitions output for 1953. It may be assumed that the items accounted for are the items for which technological advancement is positively correlated with real cost increases. The remaining 40 percent, primarily non-combat equipment, undoubtedly includes items which have undergone simplification and cost decreases with advances in design. In sum, it is assumed there are no changes in real cost for the remaining 40 percent. Hence, the 9 percent increase for 60 percent of munitions output is equal to 5 percent increase for 100 percent of munitions, the last figure in Table 44. With the assumption that current production is sufficient only to restock inventories with the most advanced equipment, it follows that munitions production will continue to increase at a rate of 5 percent per year.

* Table 44 follows on p. 100.

Table 44

Cost Ratios of Current and World War II Items of Munitions and Average Annual Compound Rates of Cost Increase

Class of Munitions	Cost of World War II Model a/* (US $ 1945)	Cost of Current a/ Model (US $ 1945)	Ratio of Cost in Two Periods b/	Annual Compound Rate of Cost c/ (Increase or Decrease)	Percentage of Items Represented d/
Aircraft (Units)					
Fighter	42,000	91,000	2.17	8	16.3
Bomber	127,000	417,000	3.28	13	20.5
Transport	48,000	72,000	1.50	4	3.2
Trainer	9,000	14,000	1.56	4	.7
Armored Vehicles (Units)					
Medium	50,200	89,400	1.78	6	17.9
Heavy	90,940	135,100	1.49	4	12.4
Artillery (Units)					
Medium (76-122-mm)	3,260	9,930	3.05	12	1.8
Heavy (152-mm and up)	17,100	24,260	1.42	3	1.5
Antiaircraft	6,340	47,700	7.52	22	3.3

* Footnotes for Table 44 follow on p. 102.

Table 44

Cost Ratios of Current and World War II Items of Munitions and Average Annual Compound Rates of Cost Increase (Continued)

Class of Munitions	Cost of World War II Model a/ (US $ 1945)	Cost of Current a/ Model (US $ 1945)	Ratio of Cost in two Periods b/	Annual Compound Rate of Cost c/ (Increase or Decrease)	Percentage of Items Represented d/
Artillery (Units) (Continued)					
Small Arms	60	35	.58	-5	.3
Mortars	910	2,700	2.97	12	1.2
Naval Vessels (Units)					
Cruiser	17,100,000	30,000,000	1.75	6	4.7
Destroyer	6,500,000	10,000,000	1.63	5	5.2
Ammunition (Tons)					
Small Arms	1,460	2,200	1.51	4	1.1
Mortar	1,500	1,460	.97	Negligible	1.5
Artillery	800	930	1.16	1	6.1
Trucks (Units)	1,200	2,350	1.96	7	2.3

Table 44

Cost Ratios of Current and World War II Items of Munitions
aand Average Annual Compound Rates of Cost Increase
(Continued)

Class of Munitions	Cost of World War II Model a/ (US $ 1945)	Cost of Current a/ Model (US $ 1945)	Ratio of Cost in two Periods b/	Annual Compound Rate of Cost c/ (Increase or Decrease)	Percentage of Items Represented d/
Average Annual Compound Rate for Items Represented. e/				9	100.0
Average Annual Compound Rate for all Munitions. f/				5	

a. See Appendix C.
b. The second column divided by the first column.
c. The period for the changes in models and resulting costs is about 10 years. The rates of this column are the average compound rates, to the nearest percent, of increase for the 10-year period.
d. These proportions are from the proportions among major classes, adjusted to 100 percent base, in 1953. See Table 50, Appendix F.
e. Average annual compound rate is the average of compound rates by class weighted by percentage of total (last column).
f. The items of the table represent about 60 percent of munitions produced in 1953. The 9 percent increase for 60 percent of total munitions is equal to 5 percent for total munitions, assuming no cost increases for the other 40 percent.

APPENDIX E

AN ESTIMATE OF SOVIET WARTIME REQUIREMENTS FOR MUNITIONS

50X1
50X1

[redacted] estimated Soviet Bloc wartime requirements for a war beginning in mid-1954. From these requirements, the requirements on the USSR alone are computed as annual averages for a 3-year period and given in Table 45.

Table 45

Soviet Munition Requirements by Major Class
for a Future Mobilization Period

Class of Munitions	First War Year a/*	Subsequent War Year a/	Three-Year Average b/
Aircraft c/ (Units)			
Fighter	13,872	13,872	13,870
Ground Attack	721	721	720
Bomber	3,739	3,739	3,740
Transport	2,798	2,798	2,800
Trainer	4,028	4,028	4,030
Other	2,200	2,200	2,200
Armored Vehicles (Units)			
Medium Tanks and Assault Guns d/	29,314	34,248	32,600
Heavy Tanks and Assault Guns	4,377	4,992	4,800
Artillery			
Light (57-mm)	15,948	33,408	27,600
Medium (85-100-mm)	7,570	9,576	8,900
Heavy (122-mm and up)	2,792	3,324	3,100
Antiaircraft	5,160	5,160	5,200

* Footnotes for Table 45 follow on p. 104.

Table 45

Soviet Munition Requirements by Major Class
for a Future Mobilization Period
(Continued)

Class of Munitions	First War Year a/	Subsequent War Year a/	Three-Year Average b/
Small Arms (Units)	2,555,705	3,058,344	2,891,000
Mortars (Units)	28,360	32,412	31,000
Naval Vessels c/			
Cruiser (15,000 Tons)	9	9	9
Destroyer (2,700 Tons)	34	34	34
Submarines (1,500 Tons)	38	38	38
Patrol Craft (225 Tons)	290	290	290
PT Boats (40 Tons)	202	202	202
Mine Craft (600 Tons)	263	263	263
Other (120 Tons)	363	363	363
Ammunitions (Tons)	11,162,500	12,706,300	12,192,000
Automotive Vehicles	174,462	144,840	154,700

a. Computed from total Soviet Bloc requirements. 39/
b. The average for three years of mobilization is the average of the first column plus the second column doubled.
c. Aircraft and ship requirements are total Soviet Bloc estimates for the first year of a war beginning in mid-1954.
d. A small number of light assault guns are included in this category.

The wartime requirements of Table 45 are expressed in dollar amounts in Table 46.

Table 46

Relative Magnitudes of Soviet Wartime Munitions Requirements

Class of Munitions	Annual Wartime Requirements [a]*	Cost [b] (US $ 1945)	Value (Thousand US $ 1945)	Percentage of Total
Aircraft [c] (Units)				
Fighter	13,870	90,000	1,248,300	
Ground Attack	720	117,000	84,240	
Bomber	3,740	417,000	1,559,580	
Transport	2,800	72,000	201,600	
Trainer	4,030	14,000	56,420	
Other	2,200	10,000	22,000	
Spares [d]			475,800	
Total			3,647,900	13.3
Armored Vehicles (Units)				
Medium Tanks and Assault Guns	32,600	89,000	2,901,400	
Heavy Tanks and Assault Guns	4,800	135,000	648,000	
Spares [d]			709,900	
Total			4,259,300	15.5
Artillery (Units)				
Light (57-mm)	27,600	3,200	88,320	
Medium (85-100-mm)	8,900	10,600	94,340	

* Footnotes for Table 46 follow on p. 107.

Table 46

Relative Magnitudes of Soviet Wartime Munitions Requirements
(Continued)

Class of Munitions	Annual Wartime Requirements a/	Cost b/ (US $ 1945)	Value (Thousand US $ 1945)	Percentage of Total
Artillery (Units) (Continued)				
Heavy (122-mm and up)	3,100	15,400	47,740	
Antiaircraft	5,200	48,000	249,600	
Fire Control d/			34,560	
Spares d/			24,000	
Total			538,600	2.0
Small Arms (Units)	2,891,000	35	101,190	
Total			101,200	.4
Mortars (Units)	31,000	2,700	83,700	
Total			83,700	.3
Naval Vessels				
Cruisers (15,000 Tons)	9	30,000,000	270,000	
Destroyers (2,700 Tons)	34	9,560,000	325,040	
Submarines (1,500 Tons)	38	5,200,000	197,600	
Patrol Craft (225 Tons)	290	650,000	188,500	
PT Boats (40 Tons)	202	200,000	40,400	
Mine Craft (600 Tons)	263	1,600,000	420,800	
Other (120 Tons)	363	360,000	130,680	
Total			1,573,000	5.7

Table 46

Relative Magnitudes of Soviet Wartime Munitions Requirements
(Continued)

Class of Munitions	Annual Wartime Requirements a/	Cost b/ (US $ 1945)	Value (Thousand US $ 1945)	Percentage of Total
Ammunitions (Tons) e/	12,192,000	820	9,997,400	
Total			9,997,000	36.3
Automotive Vehicles				
Trucks and Jeeps	154,700	2,200	340,340	
Spares d/			102,100	
Total			442,400	1.6
Other f/			6,880,900	25.0
Grand Total			27,524,000	

a. Data from Table 45.
b. Data from Table 47, Appendix E.
c. Average aircraft prices are unit prices from Appendix C weighted as follows:

	Percentage of Class	Average Price US $ (1945)
Fighter		
MIG-15	100	90,000
Ground Attack		
IL-10	100	117,000
Bomber		
TU-4	8	621,000

Table 46

Relative Magnitudes of Soviet Wartime Munitions Requirements
(Continued)

	Percentage of Class	Average Price US $ (1945)
Bomber (Continued)		
IL-28	34	359,000
Type 35	54	380,000
EF-150	4	960,000
Total		417,000
Transport		
IL-12	15	279,000
Li-2	8	66,000
An-2, Yak-6	35	29,000
Yak-8, Yak-14, Yak-16	42	34,000
Total		72,000
Trainer		
Yak-11	8	23,700
Yak-18	82	11,300
Total		14,000
Other		estimated 10,000

The weights for bombers are from requirements by type. 40/
d. Except for fire control, assumed to be 15 percent of weapons cost, these categories are the same as in 1944. See Table 48, Appendix F.
e. The average price for ammunition is computed from the prices in Appendix C, and prices for other items from the same sources weighted as follows:

Table 46

Relative Magnitudes of Soviet Wartime Munitions Requirements
(Continued)

Ammunition Class	Percentage of Total	Cost per Ton (US $ 1945)
Bombs (Conventional)	15.7	360
Small Arms	3.4	2,200
Mortar	7.6	1,460
Light Artillery (37-57-mm) (Including Aircraft Ammunition)	7.1	1,630
Medium Artillery (76-100-mm)	13.7	840
Heavy Artillery (120-152-mm)	49.9	620
3-inch Naval or smaller	.1	3,000
3-inch Naval or larger	.5	1,500
Torpedoes	.2	8,200
Naval Mines	1.8	750
	Average Cost per Ton	820

f. It is assumed that 25 percent of total munitions procurement consists of communications and electronic equipment, engineering equipment, guided missiles, nuclear energy outlays, and other items. This proportion is considerably higher than the assumed World War II proportion. The many new developments in armament and war technology having no World War II counterparts are included in this category.

The proportions of major munitions classes in Table 46 when compared to the proportions in 1944 seem probable except for ammunition and aircraft. The ammunition figure, which does not include guided missiles or atomic or hydrogen bombs, seems high when it is noted that technological advancement has been greater for most other major classes of munitions resulting in more expensive items of munitions. Aircraft, the major class with the greatest rate of technological development, has declined relatively when compared to 1944. The war conditions [redacted] 50X1
[redacted] may have been responsible for this result. In part, the low 50X1

value of aircraft is due to the assumption of Table 46 that there would be no increase in aircraft production in the second and third war years. In any case, these two categories do not seem reasonable, nor does the small value for artillery, which probably reflects the fact that the initial requirements were not included. Hence, a downward adjustment of the relative value of ammunition is made, and the resulting increment is divided between aircraft and artillery* to give the mix of Table 47.

Table 47

A Probable Distribution of Major Classes of Soviet Munitions in a Future War

Major Class of Munitions	Percentage of Total a/
Aircraft	20
Armored Vehicles	15
Artillery	5
Small Arms and Mortars	1
Naval Vessels	6
Ammunition	26
Automotive Vehicles	2
Other	25
Total	100

a. Values are from Table 46 except for rounding and a decrease of 10 percent of total munitions for ammunition, an increase of 7 percent for aircraft, and 3 percent for artillery.

* As a result of the downward adjustment in the relative magnitude of ammunition, the annual wartime expenditure of ammunition excluding bombs, assuming the same total amount of munitions required, would be about 7.4 million tons. This compares to 3 million tons of ammunition estimated by CIA to have been expended in 1944.

APPENDIX F

REFERENCE TABLES

Table 48

Dollar Value and Percentage Distribution
of Soviet Munitions Production in 1944

Class of Munitions (Units)	1944 Production a/*	Cost b/ (US $ 1945)	Total Value (Thousand US $ 1945)	Percentage of Total
Aircraft				
Fighter	17,300	42,000	726,600	6.82
Ground Attack	11,700	83,000	971,100	9.11
Bomber	5,200	127,000	660,400	6.20
Transport	1,000	48,000	48,000	.45
Other (Including Trainers)	4,800	9,000	43,200	.41
Spares c/			367,000	3.44
Total			2,816,300	26.42
Armored Vehicles				
Light Assault Guns	9,710	24,970	242,500	2.27
Medium Tanks and Assault Guns	17,420	50,200	874,500	8.20
Heavy Tanks and Assault Guns	2,400	90,960	218,300	2.05
Spares d/			267,000	2.50
Total			1,602,300	15.03

* Footnotes for Table 48 follow on p. 114.

Table 48

Dollar Value and Percentage Distribution
of Soviet Munitions Production in 1944
(Continued)

Class of Munitions (Units)	1944 Production a/	Cost b/ (US $ 1945)	Total Value (Thousand US $ 1945)	Percentage of Total
Artillery				
Light (45-57-mm)	17,500	2,150	37,600	.35
Medium (76-122-mm)	46,600	3,260	151,900	1.42
Heavy (152-mm up)	1,000	17,100	17,100	.16
Antiaircraft	22,000	6,340	139,500	1.31
Antiaircraft Fire Control e/			22,300	.21
Other Fire Control f/			16,500	.15
Spares g/			17,300	.16
Total			402,200	3.77
Small Arms				
Machine Guns	580,000	220	127,600	1.20
Submachine Guns	2,600,000	15	39,000	.37
Rifles	3,800,000	60	228,000	2.14
Total			394,600	3.70
Mortars	100,000	910	91,000	.85
Naval Vessels				
Destroyer	1	6,500,000	6,500	.06
Submarines	7	2,900,000	20,300	.19
Total			26,800	.25

Table 48

Dollar Value and Percentage Distribution
of Soviet Munitions Production in 1944
(Continued)

Class of Munitions (Units)	1944 Production a/	Cost b/ (US $ 1954)	Total Value (Thousand US $ 1945)	Percentage of Total
Ammunition				
Small Arms (Tons)	200,000	1,460	292,000	2.74
Mortar (Tons)	730,000	1,500	1,095,000	10.27
Artillery (Tons)	2,500,000	950	2,375,000	22.28
Other (Tons)	250,000	1,200	300,000	2.81
Total			4,062,000	38.11
Trucks				
GAZ-MM	63,500	1,040	66,000	.62
ZIS-5	15,900	1,810	28,800	.27
Spares h/			28,400	.27
Total			123,200	1.16
Communications and Electronics i/			285,000	2.67
Engineering Equipment i/			190,000	1.78
Transportation Equipment i/			190,000	1.78
Other (Including Bombs) i/			476,000	4.47
Total			10,659,400	100.00
			(64,900 Million Rubles)	

Table 48

Dollar Value and Percentage Distribution
of Soviet Munitions Production in 1944
(Continued)

a. Table 11, p. 25, and references.
b. Section II.
c. Spares are estimated at 15 percent of the value of the aircraft or about 60 percent of the US figure in 1945. 42/
d. Spares are estimated at 20 percent of the cost of the vehicles.
e. Fire control equipment for antiaircraft artillery is estimated to cost 16 percent of the artillery, or about one-half the US ratio.
f. Fire control equipment for other artillery is estimated to cost 8 percent of the artillery pieces or about three-fourths the US relative cost.
g. Spares are estimated to be 5 percent of the cost of the artillery pieces.
h. Spares are estimated to be 30 percent of the cost of the trucks.
i. These amounts were estimated percentages of each category to the total of munitions excluding these items from US proportions in 1944. They are as follows:

Percentages of Particular Classes of Munitions Relative to Other Munitions
1944

Class of Munitions	Percent	
	US	Soviet
Communications and Electronics	7.9	3
Engineering Equipment	5.8	2
Transportation Equipment	3.2	2
Other (Including Repair and Testing Equipment for the Air Forces)	4.6	5

The last category for other items includes bombs for the USSR. The amount may be as much as $250 million. This estimate is based on the average weight and price of Appendix C and production of 3.2 million bombs. 43/

Table 49

Production of Munitions in the USSR in 1952 and the Relative Significance of Classes a/*

Class of Munitions (Units)	Average Cost (US $ 1945)	Estimated Production	Total Value	Percentage of Total
Aircraft				
Fighter	91,000	5,277	480,207	
Bomber	417,000	1,926	803,142	
Transport	72,000	403	29,016	
Trainer	14,000	3,000	42,000	
Other	10,000	1,000	10,000	
Spares b/			203,835	
Total			1,568,200	27.0
Armored Vehicles				
Medium	89,000	7,300	649,700	
Heavy	135,000	3,650	492,750	
Spares b/			228,450	
Total			1,370,900	23.6
Artillery				
Light (57-mm)	3,200	500	1,600	
Medium (76-100-mm)	10,600	6,200	65,720	
Heavy (122-mm and up)	15,400	3,600	55,440	
Antiaircraft	48,000	2,500	120,000	
Fire Control			18,400	
Spares			12,100	
Total			273,300	4.7

* Footnotes for Table 49 follow on p. 116.

Table 49

Production of Munitions in the USSR
in 1952 and the Relative Significance
of Classes a/
(Continued)

Class of Munitions (Units)	Average Cost (US $ 1945)	Estimated Production	Total Value	Percentage of Total
Small Arms	35	317,500	11,100	0.2
Mortars	2,700	16,200	43,700	0.8
Naval Vessels				
Cruisers	30,000,000	5.7	171,000	
Destroyer	10,600,000	18	190,800	
Submarines				
Long Range	5,200,000	20	104,000	
Coastal	1,400,000	30	42,000	
Other	800,000		88,000	
Total			595,800	10.3
Ammunition (Tons)			360,000	6.2
Trucks and Jeeps				
Trucks	2,350	35,000	82,750	
Jeeps	1,050	15,000	15,750	
Spares b/			29,400	
Total			127,400	2.2
Other			1,450,100	25.0
Total			5,800,500	100.0

a. Data from Table 51, p. 121.
b. Spares are as follows: aircraft, 13 percent of category not including spares; armored vehicles, 17 percent; and trucks and jeeps, 23 percent.

Table 50

Production of Munitions in the USSR
and Relative Significance of Classes
1953

Class of Munitions (Units)	Average Cost a/* (US $ 1945)	Estimated 44/ Production 1953	Total Value of Class (Thousand US $)	Percentage of Total
Aircraft				
Fighter	91,000	6,471	588,860	
Bomber	417,000	1,788	745,600	
Transport	72,000	1,599	115,130	
Trainer	14,000	1,728	24,190	
Other	10,000	1,156	11,560	
Spares b/			222,800	
Total			1,708,100	28.85
Armored Vehicles				
Medium	89,000	7,300	649,700	
Heavy	135,000	3,344	451,440	
Spares b/			220,200	
Total			1,321,300	22.32
Artillery				
Light (57-mm)	3,200	500	1,600	
Medium (76-100-mm)	10,600	6,200	65,720	
Heavy (122-mm and up)	15,400	3,600	55,440	
Antiaircraft	48,000	2,500	120,000	

* Footnotes for Table 50 follow on p. 119.

Table 50

Production of Munitions in the USSR
and Relative Significance of Classes
1953
(Continued)

Class of Munitions (Units)	Average Cost a/ (US $ 1945)	Estimated 44/ Production 1953	Total Value of Class (Thousand US $)	Percentage of Total
Artillery (Continued)				
Fire Control b/			18,400	
Spares b/			12,100	
Total			273,300	4.62
Small Arms	35	317,500	11,100	.19
Mortars	2,700	16,200	43,700	.74
Naval Vessels				
Cruisers (15,000 Tons)	30,000,000	5.7	171,000	
Destroyers (3,000 Tons)	10,600,000	18	190,800	
Submarines (Long Range) (1,500 Tons)	5,200,000	20	104,000	
Submarines (Coastal) (400 Tons)	1,400,000	30	42,000	
Other (250 Tons) ($2,300 per Ton)	800,000	110	88,000	
Total			595,800	10.06

Table 50

Production of Munitions in the USSR and Relative Significance of Classes
1953
(Continued)

Class of Munitions (Units)	Average Cost a/ (US $ 1945)	Estimated 44/ Production 1953	Total Value of Class (Thousand US $)	Percentage of Total
Ammunition				
Small Arms	2,200	17,500	38,500	
Mortar	1,460	37,800	55,190	
Artillery	930	237,100	220,500	
Grenades, Land Mines and Rockets	1,200 c/	23,900	28,680	
Other d/			17,100	
Total			360,000	6.08
Trucks and Jeeps 46/				
Trucks	2,350	35,000 e/	82,250	
Jeeps	1,050	15,000 e/	15,750	
Spares b/			29,400	
Total			127,400	2.15
Communications and Electronics Engineering Equipment Other	d/		1,480,300	25.00
Total			5,921,000	100.00

a. Average prices are computed from prices by item in Table 48 weighted by production estimated by model.

Table 50

Production of Munitions in the USSR
and Relative Significance of Classes
1953
(Continued)

b. Spares and fire control are proportions from Appendix A.
c. Average price per ton for grenades, land mines, and bombs, is computed from estimated production by item multiplied by price per unit weight. 45/
d. Other ammunition including conventional bombs estimated at 5 percent of total ammunition.
e. The truck figure differs from that of Table 51, because 20 percent of total production was assumed to represent truck production in the early postwar years. Hence, for reasons of consistency, the same proportion was used to determine the index of munitions production from 1949-53.

Table 51

Production of Munitions in the USSR in Units and Dollars
1949-53

Class of Munitions	Cost per Unit a/* (US $ 1945)	Production 48/ b/ 1949	1950	1951	1952	1953
Aircraft (Thousand US $)		860,200	582,800	1,095,600	1,352,400	1,478,400
Fighter (Units)	91,000	1,732	2,987	4,747	5,277	6,471
Bomber (Units)	417,000	1,478	609	1,433	1,926	1,788
Transport (Units)	72,000	681	364	515	403	1,599
Other (Units)	10,000	3,723	2,478	2,994	4,000	2,884
Armored Vehicles (Thousand US $)		1,125,500	1,088,900	1,142,500	1,142,500	1,101,100
Medium (Units)	89,000	7,109	6,698	7,300	7,300	7,300
Heavy (Units)	135,000	3,650	3,650	3,650	3,650	3,650
Artillery (Thousand US $)		328,800	303,600	252,900	252,900	252,900
Under 76-mm (Units)	3,200	500	500	500	500	500
76-mm and up (Units)	13,400	9,371	9,997	9,800	9,800	9,800
Antiaircraft (Units)	48,000	4,200	3,500	2,500	2,500	2,500
Small Arms (Thousand US $)		11,100	11,100	111,100	11,100	11,100
Small Arms (Units)	35	317,500	317,500	317,500	317,500	317,500
Mortars (Thousand US $)		16,200	16,200	16,200	16,200	16,200
Mortars (Units)	2,700	6,000	6,000	6,000	6,000	6,000

* Footnotes for Table 51 follow on p. 122.

Table 51

Production of Munitions in the USSR in Units and Dollars
1949-53
(Continued)

Class of Munitions	Cost per Unit a/* (US $ 1945)	Production 48/ b/ 1949	1950	1951	1952	1953
Naval Vessels (Thousand US $)		117,800	205,600	325,900	468,080	468,080
Cruiser (Units)	30,000,000	11	2	4	5.7	5.7
Destroyer (Units)	9,560,000	55	10	15	18	18
Submarine (Units)	2,500,000	16	20	25	50	50
Ammunition (Thousand US $)		314,200	314,200	314,200	314,200	314,200
Small Arms (Tons)	2,200	17,500	17,500	17,500	17,500	17,500
Mortars (Tons)	1,460	37,800	37,800	37,800	37,800	37,800
Artillery (Tons)	930	237,100	237,100	237,100	237,100	237,100
Trucks (Thousand US $)		101,100	141,000	155,100	159,800	164,500
Trucks (Units)	2,350	43,000	60,000	66,000	68,000	70,000
Total (Thousand US $)	2,874,900	2,874,900	2,633,440	3,313,500	3,717,180	3,806,480
Index (1940 = 100)		119	109	127	153	157
Adjusted Index (1940 = 100) c/		87	109	131	153	157

a. Estimated 1945 dollar costs are from Appendix C. Average artillery prices are based on proportions from CIA. 47/ The price for submarines is for average weight of coastal and long range submarines. Artillery ammunition prices are from the following proportions, similar to the proportions for 1952:

Table 51

Production of Munitions in the USSR in Units and Dollars
1949-53
(Continued)

Ammunition	Proportion		Dollar Price per Ton
Light artillery ammunition (23-57-mm)	33		1,630
Medium artillery ammunition (76-100-mm)	181		840
Heavy artillery ammunition (122-mm and up)	23		620
		Average cost per ton	930

b. Conversion to tons is as follows:

Ammunition	Average Weight (Pounds)	Rounds (Thousand)	Total Weight (Tons)
Light Artillery((23-57-mm)	1.4	48,340	32,733
Medium Artillery (76-100-mm)	36.3	10,000	181,300
Heavy Artillery (100-mm and up)	76.3	605,000	23,070
Total			237,000
Mortar	25.2	3,000	37,800
Small Arms	.07	500,000	17,500

Trucks are estimated at 20 percent of Soviet truck production. Truck production for each year is estimated by CIA as follows:

1949	212,700
1950	301,000
1951	330,000
1952	342,000
1953	350,000

c. The 1949 to 1951 values are interpolations using 1948 = 66 from Appendix A.

Table 52

Capacity Estimates and Dollar Values of Soviet Items and Munitions a/* 49/

Class of Munitions (Units)	Cost per Unit (US $ 1945)	Capacity Production (Units)	Total Value (Thousand US $)
Aircraft			
Fighter	90,000	20,000	1,800,000
Ground Attack	117,000	2,000	234,000
Bombers	417,000	6,000	2,502,000
Transport	72,000	3,000	216,000
Trainer	14,000	5,000	70,000
Other	10,000	7,000	70,000
Total			4,892,000
Armored Vehicles			
Medium	89,000	45,000	4,005,000
Heavy	135,000	15,000	2,025,000
Total			6,030,000
Artillery			
Light (20-75-mm)	3,200	4,000	12,800
Medium (76-100-mm)	10,600	45,000	477,000
Heavy (122-mm and up)	15,400	25,500	392,700
Antiaircraft	48,000	31,000	1,488,000
Total			2,371,000
Small Arms	35	10,000,000	350,000

* Footnotes for Table 52 follow on p. 125.

Table 52

Capacity Estimates and Dollar Values
of Soviet Items and Munitions a/ 49/
(Continued)

Class of Munitions (Units)	Cost per Unit (US $ 1945)	Capacity Production (Units)	Total Value (Thousand US $)
Mortars	2,700	200,000	540,000
Naval Vessels			
Cruisers	30,000,000	18	540,000
Destroyers	10,600,000	68	720,800
Submarines	2,500,000	170	425,000
Other	N.A.	N.A.	758,600 c/
Total			2,444,000
Ammunition (Tons)	820	13,000,000	10,660,000
Trucks and Jeeps	2,200	200,000	440,000
Other Munitions b/			(9,096,000 to 14,693,000)
Total			(36,382,000 to 41,980,000)

a. Estimates are assumed to apply to 1956.
b. Other munitions are 25 to 35 percent of total.

APPENDIX G

METHODOLOGY

This appendix sets forth the conceptual aspects of munitions-producing potential and outlines the specific method employed to obtain estimates given in the text. Alternative methods for estimating munitions-producing potential that have been used in the past are also discussed.

Munitions-producing potential is one important element of a nation's war potential. Unfortunately, the literature on the determinants and different aspects of munitions-producing potential is wholly inadequate for present purposes. Studies of war economics or economics of war potential are generally concerned with such problems as monetary and fiscal policies, military manpower and other demographic factors, the availability of certain materials, capital goods, minerals and fuels, and institutional problems. All of these factors are related to a nation's war effort. They must, however, be ordered and evaluated in some fashion if magnitudes representing the various components of war production are to be determined.

Munitions-producing potential may be defined as the maximum quantity of military hard goods a particular country could produce during a specific period of time if the state of mobilization readiness, the type of war expected to be fought, and the location and duration of the conflict were properly anticipated. In order to proceed directly to a measure of potential, assumptions are necessary with respect to each of these variables. Such a process would yield a series of values representing the maximum amount and optimum distribution of munitions output during the relevant years; the sum of this series, appropriately discounted,* would represent the munitions-producing potential of the nation for the given period of time.

* By discounting is meant taking cognizance of the fact that the military value of munitions will vary with the time period when they come into use, that is, a tank has a greater value if produced during the first year of war than if produced shortly before the war is over.

Such a procedure would involve an incredibly complex calculation even if all relevant data could be assembled. Among other things, it would involve complete knowledge of the opposing strategy, or at least a probability estimate of strategy, complete knowledge of the uses and costs of all weapons that might be involved in the conflict, and enough information covering the structure and size of the economy to permit accurate prediction of potential levels of output under the posited strategic parameter.* An attempt is made in this report to take one part of this problem and produce a quantitative estimate of its magnitude.

Specifically, an attempt is made to estimate maximum annual munitions output in the USSR during a select future year when full mobilization has been reached. No account is taken of potential munitions output during the period when the economy is being adjusted from a cold war status to full mobilization.** None but the crudest sort of account is taken of the impact of new weapons on munitions potential. It is assumed that the strategy of the opposing forces is known sufficiently well to enable the USSR to plan a definite munitions mix.

The following is a brief sketch of the procedure used to obtain an estimate of the maximum quantity of munitions that the USSR could produce during a future period such as is described above. Ideally, this estimate should consist of a specific number of different kinds of weapons, the total of which represents a maximum effort. The following steps are taken in order to arrive at this estimate.

1. An estimate of the relationship between the amount of resources used for munitions production during 1944 and the amount of resources that could be utilized for the same purpose during 1956 is obtained by means of an adjusted index of industrial

* The importance of knowing strategy lies not only in deciding which composition of weapons should be produced for maximum military effectiveness; it is equally important in determining the distribution of munitions output between present and future and between near future and distant future.

** By abstracting from the mobilization period, the more difficult problems connected with the distribution of munitions output between present and future are circumvented. Although this makes the problem manageable, given existing data and techniques, it has the obvious defect of disregarding the most interesting (and perhaps important) part of the war potential problem.

production. Since 1944 was in fact a year of maximum munitions production, given the magnitude of the 1944 economy, the relationship is thus a measure of the change in aggregate munitions-producing potential between 1944 and 1956.

2. An estimate of the aggregate value of the 1944 Soviet munitions effort is obtained by combining estimates of US $ 1945 prices for Soviet munitions with estimates of 1944 Soviet munitions output by types. This yields a US $ 1945 value for the Soviet 1944 munitions effort.

3. From the ratio in part 1 and the dollar value in part 2 an estimate is obtained of the quantity of resources -- in US $ 1945 -- that would be available to the USSR for munitions production during 1956 (or during any other future full mobilization year).

4. Estimates of the US $ 1945 costs per unit for current Soviet munitions (those that would be produced during full mobilization) are made.

5. Given the costs per unit from part 4 and the aggregate quantity of resources available for munitions production from part 3 (both in terms of US $ 1945) estimates of alternative bundles of munitions that could be produced during 1956 are obtained. It is clearly not possible via this procedure to estimate what quantities of munitions would be produced; it is possible only to indicate the magnitude of alternative sets of munitions, any of which could be produced if the USSR chose to do so. The aggregate limitation is the only constraint imposed.

The above five steps outline, in skeleton form, the procedure carried out in this report. For the reader who desires a more precise statement, an algebraic presentation is given below. This part may be passed over without loss of continuity.

Definitions:

1. E = Value of industrial output (aggregate value of final industrial products).

2. M = Value of munitions output.

3. K = Value of capital goods output.

4. C = Value of consumer goods output.

So defined that $E_i = M_i + K_i + C_i$, where i is any time period.

5. $x_1 x_2 \ldots x_n$ = number of units of output of World War II munitions $x_1 x_2 \ldots x_n$.

6. x'_1, x'_2, x'_n = number of units of output of current munitions $x'_1, x'_2 \ldots x'_n$.

7. $p_1, p_2 \ldots p_n$ = prices of munitions $x_1, x_2, \ldots x_n$.

8. $p'_1, p'_2 \ldots p'_n$ = prices of munitions $x'_1, x'_2 \ldots x'_n$.

9. $a = \frac{x_1 p_1}{M_{44}}$, $b = \frac{x_2 p_2}{M_{44}}$, $c = \frac{x_3 p_3}{M_{44}}$, ... $n = \frac{x_n p_n}{M_{44}}$ = relative value of class to total munitions.

10. $a' = \frac{x'_1 p'_1}{M_{56}}$, $b' = \frac{x'_2 p'_2}{M_{56}}$, $c' = \frac{x'_3 p'_3}{M_{56}}$, ... $n = \frac{x'_n p'_n}{M_{56}}$ = relative value of class to total munitions.

Procedure:

From definitions 1 through 4.

1.1 $E_{44} = M_{44} + K_{44} + C_{44}$, and

1.2 $E_{56} = M_{56} + K_{56} + C_{56}$

Neither E_{44} nor E_{56} is known; their ratio, $\frac{E_{56}}{E_{44}}$, is taken to be simply the index of industrial production with 1944 as a base, designated as a. No assumptions are involved in the use of this index to determine the $\frac{E_{56}}{E_{44}}$ ratio, since the index itself purports to be a net output index weighted by value added in each sector.

1.3 $$\frac{E_{56}}{E_{44}} = \frac{M_{56} + K_{56} + C_{56}}{M_{44} + K_{44} + C_{44}} = a$$

From equations 1.1 and 1.2

2.1 $$E_{44} - C_{44} = M_{44} + K_{44}$$

2.2 $$E_{56} - C_{56} = M_{56} + K_{56}$$

The left hand values of equation 2.1 and 2.2 are reformulated as:

2.3 $$E_{44} - C_{44} = E_{44} \left(1 - \frac{C_{44}}{E_{44}}\right)$$

2.4 $$E_{56} - C_{56} = E_{56} \left(1 - \frac{C_{56}}{E_{56}}\right)$$

The ratio C_{44}/E_{44} and C_{56}/E_{56} are the proportions of industrial output necessary for consumption purposes in the two years.

a' is defined as being equal to $$\frac{E_{56} \left(1 - \frac{C_{56}}{E_{56}}\right)}{E_{44} \left(1 - \frac{C_{44}}{E_{44}}\right)}$$

thus, from the above definition and equation 2.3 and 2.4

3.1 $$a' = \frac{E_{56}}{E_{44}} \frac{\left(1 - \frac{C_{56}}{E_{56}}\right)}{\left(1 - \frac{C_{44}}{E_{44}}\right)} = \frac{M_{56} + K_{56}}{M_{44} + K_{44}}$$

The a' expression is simply an adjusted industrial output index with 1944 as base, adjusted for the fact that the share of consumer goods output in industrial output would be proportionately lower during 1956 than it was during 1944.

It is clear from equation 3.1 that if

$$\frac{C_{56}}{E_{56}} = \frac{C_{44}}{E_{44}}, \quad \text{then } a' = \frac{E_{56}}{E_{44}} = a$$

Similarly, if $\frac{C_{56}}{E_{56}} \left\langle \frac{C_{44}}{E_{44}}, \right.$ then $a' \left. \right\rangle \frac{E_{56}}{E_{44}} = \ldots$

In order to eliminate the "K" term from equation 3.1, it is assumed that the proportion of capital goods output to total industrial output less consumer requirements is equal for the two years, that is:

4.1 $$\frac{K_{44}}{E_{44}\left(1 - \frac{C_{44}}{E_{44}}\right)} = \frac{K_{56}}{E_{56}\left(1 - \frac{C_{56}}{E_{56}}\right)}$$

combining 3.1 and 4.1,

4.2 $$\frac{K_{56}}{K_{44}} = \frac{M_{56} + K_{56}}{M_{44} + K_{44}}$$

$$K_{56} M_{44} + K_{56} K_{44} = M_{56} K_{44} + K_{56} K_{44}$$

$$\frac{K_{56}}{K_{44}} = M_{56}/M_{44}$$

Combining 4.1 and 4.2,

5.1 $$\frac{M_{56}}{M_{44}} = \frac{E_{56}\left(1 - \frac{C_{56}}{E_{56}}\right)}{E_{44}\left(1 - \frac{C_{44}}{E_{44}}\right)}$$

All terms on the right hand side of equation 5.1 can be estimated. The ratio $\frac{E_{56}}{E_{44}}$ is known. The ratio $\frac{C_{56}}{E_{56}}$ and $\frac{C_{44}}{E_{44}}$ are estimated as shown in Appendix A. The ratio $\frac{M_{56}}{M_{44}}$ is thus determined.

From the definitions.

6.1 $M_{44} = \sum x_1p_1 + x_2p_2 + x_3p_3 \ldots x_np_n$

6.2 $M_{56} = \sum x'_1p'_1 + x'_2p'_2 + x'_3p'_3 \ldots x'_np'_n$

In equation 6.1 only the "x" terms are known. Ruble prices are not obtainable, hence dollar prices for the "x" munitions are estimated. M_{44} becomes an estimate of the number of dollars required to produce the Soviet 1944 munitions program. Given M_{44} in dollars, M_{56} is given in dollars since the ratio $\frac{M_{56}}{M_{44}}$ is known. Prices of the "x'" munitions are estimated in dollars using the same procedure as for the "x" munitions. Thus, M_{56} in dollars and $p'_1, p'_2, p'_3 \ldots p'_n$ in dollars are obtained. The values $x'_1, x'_2, x'_3 \ldots x'_n$ are variables.

Equation 6.2 gives

$$M_{56} = \sum x'_1p'_1 + x'_2p'_2 + x'_3p'_3 \ldots x'_np'_n$$

The munitions mix is indicated by

$a' = \frac{x'_1p'_1}{M_{56}}$, $b' = \frac{x'_2p'_2}{M_{56}}$, ... $m' = \frac{x'_np'_n}{M_{56}}$: since, from equation 6.2 $\frac{x'_1p'_1}{M_{56}} + \frac{x'_2p'_2}{M_{56}} + \frac{x'_3p'_3}{M_{56}} \ldots \frac{x'_np'_n}{M_{56}} = 1$, it follows that

$a' + b' + c' \ldots n' = 1.$

The a, b, c terms are simply proportions indicating the share of X_1, X_2, X_3 kinds of weapons in total munitions output. Thus, X_1, X_2, X_3 .... X_n are determined when a, b, c ... n are determined. The only constraint is that a + b + c ... n = 1.

Rubles prices can be obtained indirectly from the dollar price estimates if desirable. Define p_1^r as ruble prices and p_1^d as dollar prices. Assume that

$$\frac{p_1^r}{p_1^d} = \frac{p_2^r}{p_1^d} = \frac{p_3^r}{p_3^p}$$ that is, that ruble prices are proportional to dollar prices.

Equation 6.1 states that $M_{44} = \sum x_1p_1 + x_2p_2 + x_3p_3 \ldots x_np_n$

If the prices are dollar prices, M_{44} is in dollars. If M_{44} is in rubles and the ratio of p_1: p_2: p_3: p_n is in dollars, rubles prices can be derived. Given from dollar prices and quantities,

$$a = \frac{x_1p_1}{M_{44}}, \quad b = \frac{x_2p_2}{M_{44}}, \quad c = \frac{x_3p_3}{M_{44}} \ldots n = \frac{x_np_n}{M_{44}}$$

M_{44} is expressed in dollars and a, b, c ... n are ratios. An estimate of M_{44} in rubles may be obtained from the Soviet defense budget, since M_{44} is simply the total value of munition procurement. Given M_{44} in rubles and the ratio a, b, c ... n, ruble prices are obtained provided that the proportions a, b, c ... n are the same in rubles is in dollars, that is, provided that ruble prices are proportional to dollar prices. A similar procedure can be carried out to obtain ruble prices for the "x'" (current) Soviet munitions.

The procedure described above will yield reasonably accurate answers to the problem posed provided that three conditions are met. First, the adjusted index of industrial production must serve as an accurate indicator of growth in munitions-producing potential. Inaccuracies in the index are translated directly into inaccuracies in the estimate of potential munitions output. Secondly, the relative costs of Soviet munitions in dollars must be similar to their relative costs in rubles. It must be noted that the dollar prices have no influence on the results -- they serve the functions of a numeraire only. If dollar prices are all too low or too high the results are not affected in any way, as can be seen from the preceding algebraic section. If some dollar prices are too high relative to others, then bias is introduced, although the magnitude of the error is difficult to determine. Some observations may be made along this line. If dollar costs for Soviet World War II munitions are low

relative to costs of current munitions, the result will be understatement of potential output.* Similarly, if dollar costs for current Soviet munitions are too low relative to World War II costs, the estimate of potential output would be high. In-between cases, where some 1944 costs are relatively low and some relatively high, would result in offsetting errors and an indeterminate bias.

The third major source of error is concealed in the estimate of the amount of resources used up by the n.e.c. categories. The reader will note that the dollar total of 1944 munitions output is greater than the sum of all specifically identified munitions multiplied by their prices. A considerable number of items, such as spare parts, transportation equipment, signal corps equipment, and others were produced by the USSR during 1944. An attempt has been made to estimate the amount of resources absorbed by these activities, largely on the basis of US experience. Similar problems were faced in making up the composition of the 1956 munitions effort. Again, some generalizations can be made. If the estimate of resources used in the n.e.c. category during 1944 is low relative to the estimate of what would be used during 1956, then the specific output estimates for 1956 will be understated.** Similarly, if the 1956 usage of resources in n.e.c. is low relative to 1944, then the estimates of potential output are overstated.

Of the problems discussed above, the most complex analytically is the use of an adjusted industrial output index to measure changes in aggregate munitions-producing potential. At least two kinds of

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* This would be caused in the following manner: relatively low 1944 dollar prices would mean a relatively low dollar total for the 1944 aggregate. This would mean a relatively low dollar for the 1956 aggregate, since the growth index is not affected. Having a relatively low 1956 dollar total and relatively high 1956 dollar costs for munitions would result in too low a quantity of munitions estimated for 1956.

** This may be illustrated as follows: suppose that the n.e.c category had been estimated as being 20 percent of the 1944 total whereas it really was 25 percent. In that event, the 1944 dollar total is lower than it should be, and the 1956 dollar total is similarly lower than it should be. Thus, if the proportion of resource used in n.e.c. during 1956 is accurate, a too low dollar total for categories other than n.e.c., is obtained, and the potential output estimates will come out to be understated.

problems arise here. Initially, the question is whether this industrial output index itself is the best general measure of growth for the purpose; in addition, it is necessary to consider adjustments in the index, both the one that was carried out and others that might have been made. With regard to the first point the reader is referred to Appendix A. With regard to the adjustments, the following comments seem appropriate.

In the first place, it is clear that in general the higher the level of total output in an economy the higher proportion of that total becomes available for military purposes. While it is undoubtedly true that minimum consumer requirements for goods and services are not necessarily based on physical subsistence levels, it is equally true that consumption standards in the USSR were drastically reduced during World War II with no apparent ill effects on productivity. What was done during World War II could and would be done during a future war. On the other hand, there is no particular reason why cuts in the consumption of industrial output should follow the same pattern as cuts in total consumption. The numerical adjustment made involved an assumption of this nature which cannot really be justified. It does not seem reasonable, however, that serious error could have been introduced in either direction, because the magnitude of industrial consumption compared to total industrial output is small in any case. Any moderate adjustment of the consumption percentage would not make very much difference in the size of the remaining position of industrial output.*

The other problem that arises here is one of possible omission. Should some adjustment have been made for the fact that a greater or smaller proportion of industrial resources might be used for capital goods production in 1956 than was the case during 1944? The assumption actually used was that the resources proportion used for the purpose would be the same during both years; the index was therefore unaffected.** This assumption posits, in effect, that roughly three times as many resources will be needed for capital goods production in a future full mobilization program than was the case during 1944, since

* To illustrate: if it had been assumed that no resources now being used for consumer goods production in industry could be transferred to other industrial sectors, the munitions-potential index for 1956 would have been about 10 percent less than the current estimate.
** See equation 4.1 above.

we have the same proportion of a total the magnitude of which has tripled. Considering the facts that (1) the USSR has a considerably larger capital stock that must be maintained, (2) modern munitions programs may well require more rapid technological changes in the characteristics of weapons, and (3) the USSR will have to break their own production bottleneck during a future war because Lend-Lease aid will obviously not be forthcoming, this assumption does not appear to be unreasonable. The most compelling argument in favor of this assumption is perhaps that no alternative seems to be available.

The second source of difficulty, use of dollar price relative as an approximation to ruble price relatives will probably have to be accepted on faith. Research is continuing in this area and some future dividends may be expected to accrue. It should be noted that this assumption is made only in regard to reasonably homogeneous area of production, namely, the munitions sector. The other factor to be noted is that the results will be seriously biased only if there is a persistent tendency for all World War II dollar prices to be relatively high or low compared to all current dollar prices. If the errors are randomly distributed in both directions, some bias is still present but probably not a serious cause for concern.*

The last problem discussed above, that of the magnitude of the residual categories, is purely a data problem. It is not believed that the numbers actually used are very far from the mark, but there is no way of demonstrating the proposition. It is sufficient to note again that in order for errors in these estimates to bias the result, they must be errors in the 1944 residual relative to the 1956 residual. If both are proportionally high or low, the results are not affected in the least.

One further comment as to the nature of this estimate. It has been pointed out above that it is possible only to make estimates of alternative sets of munitions, each set representing a possible

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* One possible source of difficulty for the reader should be pointed out. It may well be true that dollar prices for current Soviet models are understated because the models themselves are not the latest ones or the ones that would be produced during mobilization. The only remedy for that situation is to obtain different dollar prices for the models that are actually relevant. This presents no problems conceptually and would require only a simple recalculation of the data.

composition of a maximum effort.* The assumption involved here is that the composition of the mix is adequately foreseen by the Soviet planners, that is, that they have sufficient time during mobilization to plan a program designed to produce a particular mix when completed. The assumption has the effect of making the estimate an upper limit, one that would probably never be achieved in practice.** The particular set of munitions calculated in this paper is not completely arbitrary. Some rough notion of the probable limits to the munitions mix can be obtained from two sources: (1) distribution in the past and (2) estimated requirements for a future war fought under certain conditions. Data from both of these sources are shown in Appendix E. The future war requirements data are estimated for one of an infinite number of possible strategic circumstances. Data for the past war cannot be expected to apply to a future period without alteration. Within limits, the distributions of the two sets of data are similar. These limits are used as a basis for rough guide setting up the distribution of munitions among classes.

It would be useful to discuss briefly other procedures that have been used or that could be used to develop estimates similar to those contained in this report.

The simplest and most commonly used procedure is based on plant capacity estimates. Data on plant capacity for specific types of munitions can be assembled in various ways. What is usually meant by capacity in this context is the maximum output of plants that are, have been, or could be used to produce the particular munitions in question.*** In fact, of course, the capacity of the economy to

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* This amounts to saying that the size of the aggregate munitions program is independent of its composition, implying simply that munitions may be substituted for each other at their price ratios. A further assumption of complete flexibility within the industrial section of the economy is thus involved. This assumption is valid if sufficient time for adjustment is allowed; it is obviously not valid in shorter periods of time.

** If it is assumed that the data are accurate.

*** Serious problems arise even at this level:

a. The extent to which assembly plants have been or are now being built.
b. The extent to which plants can be converted from producing non-munitions to producing munitions, and the speed of such conversion.

produce munitions may be considerably larger or smaller than the sum of the capacities of particular munitions plants -- or potential ones -- known to exist. Most of the resources needed to produce, say the T-54 tank, are absorbed in the manufacture of the coal, iron ore, steel, electronic equipment, and engines that comprise the "raw" materials used by the munitions plant to produce a finished tank.

It may be asked why the USSR would have munitions plants totaling greater capacity than their economy would sustain simultaneously. Part of the answer is that a plant capable of building finished munitions does not necessarily have to be so engaged and is for more than one purpose. When new and modernized facilities are constructed, the older ones are still in existence and continue to be counted although they may be converted to different uses. In addition, it is quite possible that deliberate excess capacity is encouraged (as it is in the US to some extent) to prevent plant losses through enemy attacks from causing several temporary stoppages in production during wartime.

The difficulties involved in use of this procedure can perhaps be best illustrated in the following manner. An economy is composed of thousands of interrelated producing units, some making products that do not undergo additional processing, such as clothes, food, tanks, and wartime tools, but most producing items that require additional processing before going to final users. The plant capacity procedure concentrates primarily on these plants that turn out finished munitions, and exclude from consideration the underlying layers of supporting processing industries. Since many more plants are physically capable of being used as end-item producing units than could ever be actually used in this fashion, there may be a persistent and substantial bias toward overstatement inherent in the process.* Broadly speaking, it is probably reasonable to assume that the rate of build-up in the output of particular military goods will depend heavily upon present

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c. The relationship between the capacity of a plant to produce World War II type munitions and their capacity to produce the more complicated current munitions, and/or future munitions.

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* This situation makes such estimating particularly hazardous during peacetime, since it is necessary to estimate the number and capacity of plants that could be used for munitions production in a future wartime period. The process is simpler and more accurate during wartime itself, since information can usually be obtained as to which plants are actually producing finished items, which parts, and other information.

capacity to produce these munitions, while the achievable rate of production for particular military products depends upon more generalized factors.

Another possible procedure involves the analysis of inter-industry relationships for the USSR. Such a structure (matrix) would classify all Soviet economic activities into an exhaustive list of "industries" that produce an output, distribute this output to other industries and to final consumers, and consume inputs from other industries. The output (activity) levels for each industry, and the final "bill of goods" for the economy, consisting of all final or end products produced by the economy, could be determined. In this fashion a comprehensive structural picture of each Soviet industry for some given year is built up. The level of output, the distribution of that output among consuming industries, and the amounts of inputs required from other industries as well as the bill of goods, the set of final outputs available to the economy are known. After setting up this structural picture of a peacetime Soviet economy, the bill of goods could be varied in accordance with assumptions as to what activity levels might be desired in the munitions-producing industries and what cuts could be made in the nonmilitary goods sectors, in the event of mobilization. At the same time, adjustment could be made in the input structure of industries where a less scarce input could be completely or partially substituted for a more scarce input. After having made all the adjustments that are thought plausible in terms of the inter-industry structure and the final demand output of nonmunitions-producing industries, a hypothetical activity level for each industry can be generated. This would be the activity level that must be reached in every industry if the desired output levels in the munitions industries are to be attained.

The answer that would be obtained from this procedure is either a "yes" or a "no" for each industry in the input-output matrix. That is, the activity levels that would be needed in every industry in order to attain the desired military bill of goods either are or are not reasonable. The set of answers would usually consist of some "yes" and some "no," in terms of the generated activity level being plausible. As long as some answers come out "no," it would be necessary to go back and make more adjustments in the bill of goods, cutting back still further the output of the nonmunitions-producing industry, until finally a system that provides all "yes" answers results. It would then be necessary to inspect the resulting bill of goods and decide if the final outputs in the nonmunitions sectors are sufficient to maintain

civilian consumption and industrial capital at their minimum levels. It may be that the assumed munitions program is too large; it requires more resources than the economy can spare. It would then be necessary to go back and scale down the program until it was consistent with the size of the economy and the magnitude of competing demands.

One big advantage of this system is that the indirect repercussions of increasing output in one economic sector and decreasing it in another are explicitly brought out into the open. It identifies sectors where the peacetime output level is much too low to support a heavy munitions program, and shows by what amount output would have to be increased if this munitions program is to be feasible.

The deficiencies of the procedure are serious, however. A vast amount of data is required to obtain an answer by use of this method. These data have to be exhaustive in the sense that all economic activities must be estimated quantitatively either directly or by some imputation process. Data of this kind for the USSR are simply not available. In addition, a large amount of quantitative information must be available as to the possibilities of changing the peacetime input pattern so that output levels in some industries can be maintained or increased without the necessity of using as much or any of those inputs likely to be especially scarce in wartime. The difficulty here is that the peacetime input structure for an economy reflects the peacetime demand for the product and the relative prices of resources that can be combined to produce the product. A wartime situation results in a drastic change in the demand for all products, with military goods having relatively increased demand and nonmilitary goods relatively decreased demand. This change in demand will mean that the relative prices of resources will also change, with those resources more readily adaptable to making military products rising in price, and those more adaptable to nonmilitary products not rising as rapidly or even falling in price. Thus the most efficient wartime method of producing a commodity may be quite different from the most efficient peacetime method, and the input structure of industries may change radically.* It is, of course, possible to predict some of these changes and make allowances for them.

* The above description refers to what should happen in a competitive economy during wartime. In a planned economy, the same end result, that is, a shift in the input pattern away from relatively scarce resources, might come about due to changes in the physical allocation plan rather than from changes in the official prices. Either method would accomplish the same general results, although one or the other might be more efficient.

Generally speaking, this procedure is, in principle, the most promising available for making estimates of this nature. The data required for its successful application simply are not obtainable at present.

Several other procedures could be used, all similar in principle to the one used in this report. All require exhaustive and accurate Soviet price data for munitions, which is not obtainable. The first of these methods takes the gross national product as a starting point. The value of output required for civilian consumption and for investment is subtracted out, leaving a residual available for military purposes. An estimate of the portion of the residual that could consist of munitions procurement is then made (the procurement estimate would correspond conceptually to the estimate of the total value of resources available for munitions production). The aggregate is then broken down into specific types of munitions by means of prices and proportions of total resources used by different munitions classes, as was done above.

Alternatively, attention could be concentrated on industrial output instead of on GNP. An estimate could be made of the total "value added" in the durable goods sector of industry for all years of a mobilization period. This value added total may be calculated by estimating the quantity of labor that could be employed by the durable goods industries for each year of this period, and then estimating the industrial "value added" for each employee. An estimated maximum output of military hardware can be derived from this estimated total value of durable goods output. The simplest answer is that the two magnitudes are equal, that is, all durable goods produced are military goods. The total value of durable goods output is the munitions-producing capability. The total value estimate can then be split up into alternative sets of specific items, such as tanks and aircraft, by means of a set of prices for military end items and an estimate of the proportions in which different military goods are to be produced. A number of alternative sets of munitions that could be produced are thus derived.

A more sophisticated version of the latter procedure involves setting up a relationship between the total durable goods capacity in years X, X + 1, ... X + n, the quantity of military hardware produced in the same years, and the nonmilitary durable goods output of each year. Estimates could be made of the increase that would have taken place in the capacity of the durable goods industry between years X

and X + 1 due to some part of year X's durable goods output consisting of capital goods rather than munitions. In addition, estimates could be made of the decrease in the output of durables for years X + 1 to X + n if no capital goods were ever produced and worn out equipment were not replaced. In general terms a set of equations would be obtained relating the munitions-producing capacity of year X + 2, 3, ... n to the amounts of munitions produced in the preceding years. The same procedure as before could be used to break down the aggregate value of munitions into specific military items, that is, use of prices to derive alternative sets of munitions that could be produced.

The last two procedures work under the assumption that the sole factor limiting munitions output is aggregate capacity in the durable goods industries. The procedure used in this report involves a similar but slightly broader assumption. As noted, the only reason for not using any of the last three methods is that the required price data is almost totally lacking.

The attention of this Appendix has been directed mainly to the problem of measuring munitions-producing potential in quantitative terms, and particularly, of measuring this potential for a time period when full mobilization is assumed to exist. It is unfortunately the case that this sort of estimate is of limited usefulness for intelligence purposes. Estimates of potential munitions output would be of maximum value if they could be obtained for the period just after the outbreak of hostilities and the start of mobilization, that is, during the period of transition from cold war to hot war activity. This problem is not amenable to solution via the procedures developed in this report. Further, even if the procedure could be developed sufficiently well to handle the transition period problem, it would still be true that the validity of the estimate would depend upon the adequacy of assumptions relating to the strategic circumstances of the war, the development of and costs associated with new weapons, and immeasurable but important political, sociological, and chance factors. In fine, the measurement of munitions-producing potential in a thoroughly realistic sense would have to include factors that defy quantitative analysis; measurement of these aspects of the problem that are susceptible to quantification may lend an aura of precision that is wholly unjustified.

Next 5 Page(s) In Document Denied