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MEMORANDUM FOR:

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FROM :

SUBJECT : Recent Improvement in the Derivation from Open Source
Materials of an Estimate of Soviet Expenditures on
Military/Space Hardware, 1958-67

1. Over the past decade there have been numerous investigations of open source materials by CIA and others directed at obtaining measures of Soviet outlays for defense. This effort has been spurred by the uncertainty surrounding the procedures used by the intelligence community to estimate Soviet military expenditures and the belief that official statistical aggregates must include in their totals the concealed defense expenditures.

2. One line of investigation has sought to uncover the value of those durables included in the Soviet statistical aggregate "gross value of output of machine building and metal working" that are purchased by the defense sector. Because of possible errors inherent in the approaches employed, however, the results to date have been of only limited value. The attached memorandum summarizes the results of a recent exercise that appears to establish a firm benchmark value for 1959 using official source material. Although many problems remain with respect to the determining of the appropriate index for moving this value, at least one major step has been made in improving the estimate.

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23 August 1967

The "Machinery Purchase Residual" as an Indicator of Outlays
on Military Hardware by the USSR -- New Findings

1. Several attempts have been made in recent years to derive a measure of ruble outlays for military hardware in the Soviet Union by computing an "unexplained residual" from official statistical aggregates -- Gross Value of Output of Machine Building and Metal Working (GVO of MBMW) and the State Budget.* One of these approaches has centered on the derivation of a ruble value of purchases of machinery by the defense establishment. This series was obtained by deducting estimates of machinery used for nondefense purposes -- consumption, investment, and export -- from an adjusted value of GVO of MBMW. But because of possible error inherent in the procedure for deriving the time series of ruble values, the Machinery Purchase Residual (MPR) approach was thought to be the least reliable of the several "residual" methods.** This method required an extraordinary number of adjustments in the GVO of MBMW in a benchmark year to derive an estimate of the net value of output of MBMW available for final use. More specifically, extraneous elements included in the GVO of MBMW in any given year included (a) intra-branch purchases of intermediate product which led to double counting, (b) value of capital repair activity, (c) value of materials in work performed for customers when those materials were supplied by the customers, (d) increase in enterprise stocks of special tools and finished semifabricates, and (e) increase in value of unfinished production.

2. This memorandum gives the derivation of a revised series for the MPR. The revision is made possible through the direct availability of a benchmark value of final product (net output) for MBMW, thus avoiding the intermediate steps previously required in obtaining a net measure. The benchmark datum for 1959 of 18.46 billion rubles in net

* A guide to the literature and a description of the general approaches employed can be found in ORR Project 14.4580, Alternative Measures of Production and Procurement of Military and Space Hardware in the USSR, dated 27 August 1965 (unpublished).

** The other principal residual methods were the Machine Output Residual, based on sector-of-origin or output, and the Budgetary Funds Residual, based on unexplained residuals in the State Budget. Additional evidence that has come to light during the past year, however, has seriously eroded the degree of reliability of these two methods.

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output is obtainable from Vladimir Treml's "reconstructed" version of the Soviet 1959 input-output table. Fortunately, the concomitant publication in an authoritative official source of a ruble value of net output for MBMW of 18.1 billion rubles provided an independent check of Treml's estimate.* By deducting sales of machinery to non-defense users, a residual magnitude of sales of machinery to the defense sector of 5.52 billion rubles for 1959 can be derived. The residual value was obtained by adding the value of net imports of machinery to domestic output and deducting the value of sales of consumer durables, producer durables and net changes in inventories of uninstalled equipment for investment purposes (see Table 1).**

3. The residual value of 5.52 billion rubles only roughly approximates the OSR estimate for acquisition of military hardware in 1959 of 6.52 billion rubles. The latter excludes the value of research and development (R&D).*** The OSR estimate covers outlays for

In his book Mezhotraslevoy balans obshchestvennogo proizvodstva, (Moscow, 1966), M. R. Eydell'man, a Soviet authority on inter-industry studies, provided the evidence needed for derivation of a "final product" (i.e., value of shipments).

The difference of 0.4 billion rubles between the estimates can be attributed in large part to the differences in prices. The estimate by Treml is expressed in current year prices (1959); the value obtainable from Eydell'man is expressed in constant 1963 prices. The implied price index for 1963 (1959=100) of 98 is roughly in keeping with trends in official price indexes. The official wholesale price index (f.o.b. factory and including excise taxes) came to 96 in 1963 (1960=100) (Narodnoye khozyaystvo v 1963 g. Moscow 1964, p. 137; official statistical yearbooks are hereafter abbreviated N.kh. plus the year), and the implicit retail price index for consumer durables was 97 (1959=100) (N.kh. 1964, pp. 582, 583, 589). Both aggregates, 18.1 and 18.46 billion rubles, are expressed in purchase prices, i.e., cost of acquisition to end user, including transportation, storage, and other costs of distribution.

** The overall results are summarized in Table 1 and detailed computations are shown in Tables 4 to 8.

*** Disagreement remains as to the inclusion or exclusion in the official Soviet measure -- GVO of MBMW -- of the value of machinery generated in R&D programs.

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machinery uniquely military in use (tanks, aircraft, naval vessels) plus common-use durables (trucks, vehicles, office equipment) purchased by the defense establishment. Unfortunately, the improved reliability in the 1959 benchmark value of purchases of military hardware does not extend to other years. In addition to the types of biases inherent in the level of the ruble aggregate of the GVO of MBMW for any given year (see paragraph 1, above) the official index exaggerates the growth of output because of the change over time in the degree of multiple counting and because of the introduction of new products at inflated prices (the so-called "new product" pricing problem). Nevertheless, under alternative assumptions concerning the degree of overstatement in this index, several hypothetical series of MPR's can be derived.

4. To test the sensitivity of the growth of the residual value of MBMW to alternative discounts of the official GVO index of MBMW, three ratios were applied -- 0.9, 0.8, and 0.7. The ruble values and the implied index numbers resulting from the use of these ratios are shown in Tables 1 and 2, respectively. The results are based on the assumption that production ("final product") in any given year is "purchased" in the same year. Though not affecting the overall configuration of trends (e.g., turning points in growth) in the acquisition of military hardware, the several variants for discounting do, of course, have considerable impact on absolute ruble magnitudes and annual rates of change (see Table 2). Finally, to test the impact of a time differential between production and purchase of machinery, lags of one-half and one full year were introduced.* By lagging purchases by one-half year the rather erratic behavior in year-to-year changes observed in the unlagged MPR were dampened and the turning points in the QSR series were at least reasonably matched (see Table 3).

5. What can be said about the reliability of the revised MPR? Some of the major sources of error have been eliminated or narrowed but others remain, as identified below:

a. In estimating the MPR in the benchmark year 1959, the additions to domestic production due to net imports of machinery were available only in dollars and were converted to ruble "purchase prices" by use of a rather arbitrary ratio of 0.4 rubles to 1 dollar. However, the small magnitude of net machinery imports relative to total machinery output precludes this problem as a major source of error.

* For example, under the assumption of a full year's lag between output and final use, the MPR in Period 1 depends upon the value of production in Period 1 plus net imports in Period 1 minus the value of consumer and producer durables used in Period 2.

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b. The several hypothetical discount rates (10, 20, and 30 percent) applied to the official indexes for the GVO of MBMW probably bracket the "true" required adjustment but it is not at all clear that any one discount is stable over time.

c. The series for producer and consumer durables are expressed in 1955 transfer prices (including transportation costs and turnover taxes) whereas the series for uninstalled equipment is in current transfer prices and could diverge appreciably from 1955 prices.

d. The 1959 benchmark value for machinery output is based on a commodity classification of output whereas the official index for the GVO of MBMW used to obtain estimates for other years is based on an establishment classification.* For technical reasons, the rate of growth between the output measured by the two accounting concepts may diverge over time.

e. As noted on p. 2 (third footnote), there is a lack of agreement as to how much, if any, of the R&D effort is included in the official GVO of MBMW. On balance, the evidence suggests that at least part of the value of R&D activity is included.** Given the nature of official instructions to enterprises for reporting on value of "experimental" (i.e., R&D) production, it is conceivable that the proportion of R&D effort included in the official GVO varies over time. If the share included were to have substantially increased during the period under review, the high average annual rates of growth reflected in all the MPR series become more "reasonable".

* The essential difference between these two classifications is that under a commodity classification an enterprise's secondary product is included in the output of the branch of industry which produces it as a primary product. For example, the value of production of electrical machinery is aggregated from all the branches of industry which produce electrical machinery regardless of whether or not it is the primary or secondary product of an enterprise; in this case, the output of electrical machinery classified by the establishment method would have included only electrical machinery produced by enterprises whose primary product was electrical machinery. The output of electrical machinery as a secondary product would be included in the output of enterprises classified under other categories.

** For a discussion of the evidence on official procedures for accounting of R&D activity, see the following:

, op. cit., pp. 13-14.

r, Is R&D Hardware in Soviet Official GVO? (undated memorandum).

[Footnote cont. p. 5.]

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** Footnote continued from page 4

W. T. Lee and Sally Anderson, Potential of Economic Data for Verification of an Arms Control Agreement with the USSR (draft), SRI Project 5536, Stanford Research Institute, Menlo Park, California, August 1967, Chapter VI.

The above list does not pretend to be exhaustive. These sources happen to be readily accessible and do provide an adequate survey of the literature.

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Table 1

USSR: Machinery Purchase Residual
Under Alternative Assumptions
of Required Discounts a/
1958-67

Year	Value of Final Output of MBMW b/			Plus Value of Net Imports	Minus Sales of Consumer Durables	Minus Sales of Producer Durables		Billion rubles Equals		
	(1)	(2)	(3)			Investment in Equipment	Change in Uninstalled Equipment	(1)	(2)	(3)
1958	16.26	16.48	16.71	0.11	3.41	8.40	0.10	4.46	4.68	4.91
1959	18.46	18.46	18.46	0.07	3.81	9.10	0.10	5.52	5.52	5.52
1960	20.98	20.76	20.39	0.21	4.23	9.70	0.10	7.16	6.94	6.57
1961	23.90	23.40	22.73	0.31	4.46	10.70	0.56	8.49	7.99	7.32
1962	27.24	26.37	25.48	0.43	4.84	12.10	0.43	10.30	9.43	8.54
1963	30.57	29.33	28.24	0.41	5.26	13.20	0.35	12.17	10.93	9.84
1964	33.33	31.97	30.41	0.42	5.77	14.99	0.36	12.63	11.27	9.71
1965	36.26	34.61	32.75	0.42	6.51	15.88	(+)0.20	14.49	12.84	10.98
1966	40.41	38.23	36.01	0.42	7.55	16.60 - 16.90	0.60	15.78-16.08	13.60-13.90	11.38-11.68
1967	45.37	42.68	39.94	0.42	8.36	17.60 - 17.90	0.20	19.33-19.63	16.64-16.94	13.90-14.20

a/ Source Notes follow on p. 7.

b/ Col. 1: 10 percent discount in growth of MBMW GVO.

Col. 2: 20 percent discount in growth of MBMW GVO.

Col. 3: 30 percent discount in growth of MBMW GVO.

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Source Notes to Table 1.

Value of Final Output of MBMW:

1958, 1960-67: 1959 datum moved by index series in Cols. 2-4 of Table 4.

1959: Summation of sales (lines 12-20) to "total final demand" in table in Vladimir G. Treml, "The 1959 Soviet Input-Output Table" (as reconstructed),

New Directions in the Soviet Economy, Joint Economic Committee, US Congress, 1966, Part IIA, Face p. 269 - No. 1. Table labelled Reconstructed 1959

Soviet Input-Output Table, Part a.

Value of Net Imports:

Col. 2 of Table 5.

Sales of Consumer Durables:

Col. 1 of Table 6.

Investment in Equipment:

Col. 1 of Table 7.

Change in Uninstalled Equipment:

Col. 2 of Table 8.

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Table 2
USSR: Indexes of the Machinery Purchase Residual

	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967
10 Percent Discount of Growth in GVO of MBMW Index 1958 = 100	100.0	123.8	160.5	190.4	230.9	272.9	283.2	324.9	353.8-360.5	433.4-440.1
Percent over preceding year		23.8	29.7	18.6	21.3	18.2	3.8	14.7	8.9-11.0	22.5-22.8
20 Percent Discount of Growth in GVO of MBMW Index 1958 = 100	100.0	117.9	148.3	170.7	201.5	233.5	240.8	274.4	290.6-297.0	355.6-362.0
Percent over preceding year		17.9	25.7	15.1	18.0	15.9	3.1	13.9	5.9-8.3	22.4-21.9
30 Percent Discount of Growth in GVO of MBMW Index 1958 = 100	100.0	112.4	133.8	149.1	173.9	200.4	197.8	223.6	231.8-237.9	283.1-289.2
Percent over preceding year		12.4	19.0	11.4	16.7	15.2	-1.3	13.1	3.6-6.4	22.1-21.6

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Source Note:

All line items computed from ruble values of "Residual Output" in Table 1.

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Table 3

USSR: The Machinery Purchase Residual With One-Half Year and One Year Lags Between Production and Utilization and the OSR Estimate of Expenditures on Hardware a/ 1958-67

Billion rubles

	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967
20 percent discount in GVO of MBMW										
a. One-half year lag	4.13	5.01	6.10	7.16	8.71	9.76	10.73	11.41-11.56	12.89-13.19	NA
Index 1958 = 100	100.0	121.3	147.7	173.4	210.9	236.3	259.8	276.3-279.9	312.1-319.4	NA
Percent over preceding year		21.3	21.8	17.4	21.6	12.1	9.9	6.3-7.7	13.0-14.1	NA
b. One year lag	3.58	4.50	5.25	6.34	7.99	8.62	10.20	9.98-10.28	12.19-12.49	NA
Index 1958 = 100	100.0	125.7	146.6	177.1	223.2	240.8	284.9	278.8-287.2	340.5-348.9	NA
Percent over preceding year		25.7	16.7	20.8	26.0	7.9	18.3	(-2.8)-0.8	22.1-21.5	NA
OSR estimates of expenditures on hardware for defense use, <u>excluding R&D</u>	6.15	6.52	6.94	7.10	7.33	7.08	6.54	6.45	7.25	7.85
Index 1958 = 100	100.0	106.0	112.8	115.4	119.2	115.1	106.3	104.9	117.9	127.6
Percent over preceding year		6.0	6.4	2.3	3.2	-3.4	-7.6	-1.4	12.4	8.3
OSR estimates of expenditures on hardware for defense use, <u>including R&D</u>	7.69	8.29	9.10	9.64	10.26	10.56	10.47	10.79	12.26	13.35
Index 1958 = 100	100.0	107.8	118.3	125.4	133.4	137.3	136.2	140.3	159.4	173.6
Percent over preceding year		7.8	9.8	5.9	6.4	2.9	-0.9	3.1	13.6	8.9

a/ Source notes follow on p. 10.

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Source Notes to Table 3:

A. Machinery Purchase Residual

1. When non-defense purchases are lagged one-half year:

$$R_t = O_t + M_t - \frac{(CD_t + CD_{t+1})}{2} - \frac{(I_t + I_{t+1})}{2} - \frac{(\Delta UE_t - \Delta UE_{t+1})}{2}$$

2. When non-defense purchases are lagged one full year:

$$R_t = O_t + M_t - CD_{t+1} - I_{t+1} - \Delta UE_{t+1}$$

The variables are defined as follows:

R_t = Residual value of MBMW output available for defense purposes in year t .

O_t = Output of MBMW when the benchmark value for 1959 is moved over time with the official index of GVO of MBMW discounted by 20 percent.

M_t = Net imports of machinery.

CD_t = Sales of consumer durables.

I_t = Investment in equipment.

ΔUE_t = Change in inventory of uninstalled equipment to be used for investment purposes.

- B. The basic data for deriving the actual estimates are from Table 1.

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Table 4

USSR: Index of Value of Output of Machine Building and Metal Working Under Alternative Assumptions of Required Discounts in the Official Index, 1958-67

1958 = 100

Year	Discount of Growth in MEMW GVO			
	0 Percent (1)	10 Percent (2)	20 Percent (3)	30 Percent (4)
1958	100	100	100	100
1959	115	113.5	112	110.5
1960	132	129	126	122
1961	152	147	142	136
1962	175	167.5	160	152.5
1963	198	188	178	169
1964	217	205	194	182
1965	237	223	210	196
1966	265	248.5	232	215.5
1967	299	279	259	239

Source Notes to Table 4:

Col. 1:

1958-65: N.kh. 1965, p. 194.

1966: Cumulative index for 1965 times annual rate of growth of 12 percent (Izvestiya, 29 January 1967, p. 1).

1967: Extrapolated from 1966 by assuming the rate of growth of 13 percent for the first half of 1967 over the corresponding period in 1966 will be maintained for the balance of the year. (Pravda, 16 July 1967, p. 1).

Cols. 2 - 4:

Cumulative growth from the base year (1958) to the given year minus the discount indicated in each column plus 100.

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Table 5
USSR: Net Imports of Soviet Machinery
1958-67

<u>Year</u>	<u>Dollars (millions)</u> (1)	<u>Rubles (millions)</u> (2)
1958	269.8	107.9
1959	183.8	73.5
1960	534.0	213.6
1961	769.9	308.0
1962	1,076.5	430.6
1963	1,030.9	412.4
1964	1,052.1	420.8
1965	1,051.9	420.8
1966	N.A.	420
1967	N.A.	420

Source Notes to Table 5:

Col. 1:

1958-59: Economic Intelligence Statistical Handbook 1965, A.ERA 65-1, p.65-66.

1960-65: Economic Intelligence Statistical Handbook 1967, RR H 67-1, p.60-61.

1966-67: Net imports assumed to be approximately same level as in 1964-65.

Col. 2:

1958-67: Dollar values converted to rubles by use of a ruble-dollar ratio of R 0.4/\$1. Average ratio for producer durable equipment for industrial investments (1 July 1955 prices), from A Comparison of Capital Investment in the US and the USSR, 1950-59, ER 61-7, p. 52.

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Table 6

USSR: Sales of Consumer Durables to Individuals
and Public Organizations
1958-67

Million rubles, 1959 prices

<u>Year</u>	<u>Gross Sales</u> (1)	<u>Sales Net</u> <u>of Mark-Up</u> (2)	<u>Sales Net of</u> <u>Turnover Tax</u> (3)
1958	3,411	3,155	2,101
1959	3,814	3,528	2,350
1960	4,234	3,916	2,608
1961	4,462	4,127	2,749
1962	4,844	4,481	2,984
1963	5,263	4,868	3,242
1964	5,765	5,333	3,552
1965	6,512	6,024	4,012
1966	7,552	6,986	4,653
1967	8,360	7,733	5,150

Source Notes to Table 6:

Col. 1:

1958, 1964-66: Official series of ruble values for 1959-63 extrapolated by use of the OER index of consumer durables (minus furniture and musical instruments). The OER index appears to be a reasonable surrogate for the official series. For the period 1959-63, comparative indexes were as follows:

	<u>1959</u>	<u>1963</u>
OER	100	142
Official	100	138

1959-63: Sales to "nonproductive consumption" (individuals, "institutions serving the population" and "scientific institutions and administrations") for 1959 expressed in current purchase prices moved over time by a volume index of

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Source Notes to Table 6 (continued)

sales expressed in "constant" purchase prices (N.kh. 1964, pp. 582, 589). The base year number, 3,814 million rubles, on p. 582 of the source is moved by the volume index found on p. 589.

1967: 1966 moved forward by index of production of sample included in mid-1967 plan fulfillment report (Pravda, 16 July 1967, p. 2). Sample includes 94 percent of the ruble value in the OER index.

Col. 2:

1958-67: $92\frac{1}{2}$ percent of Col. 1. An assumed $7\frac{1}{2}$ percent retail mark-up on consumer durables based on an average of mark-up rates on individual items (unpublished estimate of Barbara Severin).

Col. 3:

66.6 percent of Col. 2. Vladimir Treml has computed a turnover tax element of 1.2 to 1.3 billion rubles for 1959 as the contribution of MBMW to total turnover tax (TOT) receipts. It is assumed all the TOT burden on products of MBMW would be reflected in sales to "private consumption" and to institutions and organizations in Quadrant 2 of the official input-out matrix for 1959. In 1959 total sales of MBMW products to "Consumption" came to 3,814.2 million rubles. Hence, Treml's estimate of TOT receipts from sale of MBMW products comes to approximately one-third of the value of sales (including TOT). (Treml's estimate of TOT receipts from MBMW products obtained by telephone, March 1966).

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Table 7
USSR: Investment in Equipment
1958-67

<u>Year</u>	<u>Billion rubles (1 July 1955 prices, as adjusted)</u>	
	<u>Investment Expressed</u>	
	<u>Purchase Prices</u>	<u>FOB Values</u>
	<u>(1)</u>	<u>(2)</u>
1958	8.40	7.39
1959	9.10	8.01
1960	9.70	8.54
1961	10.70	9.42
1962	12.10	10.65
1963	13.20	11.62
1964	14.99	13.19
1965	15.88	13.97
1966	16.60-16.90	14.61-14.87
1967	17.60-17.90	15.49-15.75

Source Notes to Table 7

Col. 1:

1958-63: Equipment component in state investment (N.kh. 1965, p. 529)--- plus equipment component in collective farm investment (worktable of Scot Butler, dated 12 April 1966). Data in source are expressed in billions of rubles rounded to one decimal place.

1964-65: Economic Intelligence Statistical Handbook 1967, RR H 67-1, p. 12.

1966: Worktable dated 10 August 1967. Because of uncertainty in the absolute size of the equipment component of collective farm investment in 1966, a range is estimated.

1967: Investment in equipment for year as a whole assumed to increase by 6 percent, the rate of growth for total investment (state centralized only) in first half of 1967 over the corresponding period in 1966. Thus the relative shares of construction, equipment, and "other outlays" are assumed to remain the same as in 1966 (Pravda, 16 July 1967, p. 1).

Col. 2:

1958-67: 88 percent of Col. 1. To obtain a series of values expressed in prices f.o.b., an allowance of 12 percent was made to cover the differential between prices charged by the producing enterprises and the prices used to value equipment used in investment. The differential is comprised of cost of storage, handling, transportation, and the like (unpublished estimat

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Table 8

USSR: Change in Stocks of Uninstalled Equipment 1958-67
(End of Year)

Million rubles (current prices)

<u>Year</u>	<u>Total Stocks</u> (1)	<u>Change from</u> <u>Previous Year</u> (2)
1957	1,400	--
1958	1,500	+ 100
1959	1,600	+ 100
1960	1,700 ^{a/}	+ 100
1961	2,260	+ 560
1962	2,690	+ 430
1963	3,040	+ 350
1964	3,400	+ 360
1965	3,200	- 200
1966	3,800 ^{a/}	+ 600
1967	4,000	+ 200

^{a/} As of 1 October.

Source Notes to Table 8:

1957-64: Unpublished tabular material dated 15 July 1965).

1965-66: Finansy SSSR, no. 5, 1967, p. 67.

1967: Notional addition of 200 million rubles to stocks assumed. A relatively small increase over the previous year is assumed because of the effect of the new incentives -- under the reform statutes -- that will encourage enterprise managers to reduce stocks of uninstalled equipment.

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