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Economic Intelligence Report

OUTLOOK FOR DEVELOPMENT
OF THE NATURAL GAS INDUSTRY
IN THE USSR
1959-65



CIA/RR ER 62-35

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CENTRAL INTELLIGENCE AGENCY

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FOREWORD

Since the beginning of the Seven Year Plan (1959-65), Soviet officials have placed great emphasis on the contribution to economic growth expected from changes in the structure of production of energy in the USSR. Increased allocation of productive factors to the oil and natural gas industries is expected to result in rates of growth in output for these industries that substantially exceed rates of growth in gross national product (GNP).

The purposes of this report are to assess the prospects for fulfillment of plans for development of the Soviet gas industry and to estimate the over-all saving that will result from the substitution of gas for solid fuel in the USSR during 1959-65.

- iii -

C-O-N-F-I-D-E-N-T-I-A-L

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CONTENTS

| | <u>Page</u> |
|--|-------------|
| Summary and Conclusions | 1 |
| I. Introduction | 3 |
| II. Seven Year Plan (1959-65) for the Gas Industry | 8 |
| A. Production | 8 |
| B. Reserves and Exploration | 8 |
| C. Transmission | 14 |
| 1. Compressors | 14 |
| 2. Construction of Pipelines | 16 |
| 3. Underground Storage | 21 |
| D. Consumption | 21 |
| E. Anticipated Economies | 24 |
| III. Prospects for the Performance of the Gas Industry, 1962-65 | 26 |

Appendixes

| | | |
|---|----|------|
| Appendix A. Soviet Gas Reserve Categories | 29 | 50X1 |
| Appendix B. Methodology | 31 | |



Tables

| | |
|---|---|
| 1. USSR: General Level of Development of the Natural Gas Industry, 1940, 1958, and 1965 Plan | 6 |
| 2. USSR: Estimated Production of Primary Energy, by Source, 1958-61 and 1965 | 7 |

C-O-N-F-I-D-E-N-T-I-A-L

| | <u>Page</u> |
|--|-------------|
| 3. USSR: Change in the Targets for 1965 for the Extraction of Natural Gas, by Republic | 9 |
| 4. USSR: Control Figures of the Seven Year Plan for Exploratory Drilling for Natural Gas, by Republic, 1959-65 . . . | 10 |
| 5. USSR: Exploratory Drilling for Natural Gas and Additions to Proved Reserves of Nonassociated Natural Gas, 1955-61 | 11 |
| 6. USSR: Effectiveness of Exploratory Drilling for Natural Gas, by Republic, 1959 and 1960 | 12 |
| 7. USSR: Preparation of Structures for Exploratory Drilling for Natural Gas and Initial Exploratory Drilling of Structures, by Region, 1959 and 1960 | 13 |
| 8. USSR: Planned and Actual Additions to Proved Reserves of Nonassociated Natural Gas, by Region, 1959 and 1960 . . . | 14 |
| 9. USSR: Pipelines for Transmission of Oil and Natural Gas Available and Commissioned for Use, Estimate for 1955-61 and Plans for 1962 and 1965 | 18 |
| 10. USSR: Planned Construction of Pipelines for Crude Oil and Oil Products, 1959-65 | 19 |
| 11. USSR: Construction of 40-Inch Diameter Pipelines for Transmission of Oil and Natural Gas During the Period 1959-65 | 20 |
| 12. USSR: Estimated Structure of Consumption of Natural Gas, 1958-60 and 1965 Plan | 22 |
| 13. USSR: Summary Calculation of Estimated Savings in Operating Expenses Resulting from the Substitution of Natural Gas for Coal, 1959-65 | 32 |
| 14. USSR: Calculation of Planned Savings in Operating Expenses Resulting from the Substitution of Natural Gas for Coal, 1959-65 | 33 |
| 15. USSR: Index of All-Union Average Extraction Costs for Coal and Natural Gas, 1958-60 and 1965 | 36 |

C-O-N-F-I-D-E-N-T-I-A-L

| | <u>Page</u> |
|--|-------------|
| 16. USSR: Capital Savings Resulting from the Substitution of Natural Gas for Coal, 1959-65 . . | 39 |
| 17. USSR: Planned Percentage Reduction in Energy Requirements Resulting from the Substitution of Natural Gas for Other Fuels, 1959-65 | 39 |
| 18. USSR: Planned and Estimated Reduction in Energy Requirements Resulting from the Substitution of Natural Gas for Other Fuels, 1959-65 | 40 |

Illustrations

| | <u>Following Page</u> |
|---|-----------------------|
| Figure 1. USSR: Production of Natural Gas, 1958-65 (Chart) | 8 |
| Figure 2. USSR: Proved Reserves of Nonassociated Natural Gas, by Selected Geographic Area, as of 1 January 1959 and Plan for 1 January 1966 (Map) | 10 |
| Figure 3. USSR: Estimated Oil and Gas Transmission Pipelines Available for Use, 1955-61 and Plans for 1962 and 1965 (Chart) | 18 |
| Figure 4. Western USSR: Natural Gas Transmission Pipelines, 1961 (Map) (UNCLASSIFIED) <u>inside back cover</u> | |
| Figure 5. Central Asiatic USSR: Natural Gas Transmission Pipelines, 1961 (Map) (UNCLASSIFIED) <u>inside back cover</u> | |

C-O-N-F-I-D-E-N-T-I-A-L

OUTLOOK FOR DEVELOPMENT OF THE NATURAL GAS INDUSTRY IN THE USSR*
1959-65

Summary and Conclusions

Production and consumption of natural gas** in the USSR will increase at an estimated average annual rate of about 25 percent from 28 billion cubic meters (cu m) in 1958 to about 135 billion cu m in 1965. By 1965, production of gas in the USSR probably will amount to more than 30 percent of production in the US compared with less than 10 percent in 1958. The share of gas in the total production of primary energy will increase from 5 percent in 1958 to 15 percent in 1965. During 1959-65, exploratory drilling for gas will be approximately six times as great as during the previous 7-year period to provide for approximately three times as much in proved reserves*** by the end of 1965 as by the end of 1958. The length of pipelines available for transmission of gas probably will increase from about 13,000 kilometers (km) by the end of 1958 to more than 40,000 km by the end of 1965. In spite of this increase in availability of transmission lines in the USSR, the total length of the transmission net will amount to only one-tenth of that forecast for the US in 1965. Consumption of gas by industry in the USSR is expected to account for about 90 percent of the total consumption. Users in the category Domestic and Communal Service are to account for 9 percent of the total consumption in 1965 compared with 11 percent in 1958. In contrast, users in a comparable category, Residential and Commercial Services, have consumed from 20 to 35 percent of the total in the US. It is anticipated that the increased investment required to accomplish the planned expansion of the industry will be well justified by the substantial savings to the economy resulting from the substitution of gas for more expensive forms of energy. It is estimated that the substitution of gas for other fuels during 1959-65 will result in a saving of about 4.3 billion rubles† -- an amount roughly equivalent to almost 90 percent of the total investment in the gas industry planned for the period.

* The estimates and conclusions in this report represent the best judgment of this Office as of 15 September 1962.

** Unless otherwise indicated, the term gas is used to mean natural gas throughout this report.

*** Reserve classifications are explained in Appendix A.

† Ruble values in this report are given in new rubles established by the Soviet currency reform of 1 January 1961. A nominal rate of exchange based on the gold content of the respective currencies is 0.90 ruble to US \$1. This rate, however, should not be interpreted as an estimate of the equivalent dollar value of similar US goods or services.

C-O-N-F-I-D-E-N-T-I-A-L

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In spite of the 3.8-fold increase, output will fall about 10 percent short of the original goal of the Seven Year Plan of 150 billion cu m. Underfulfillment of plans for production during 1959-61 leaves little doubt that the target for cumulative extraction -- 633 billion cu m -- during 1959-65 will not be met. The major factors contributing to underfulfillment of production goals probably will be the following:

1. Shortages of transmission equipment,
2. Shortages of consuming equipment and inadequate development of city distribution systems, and
3. Lags in additions to proved reserves in some regions.

Shortages of line pipe, although relatively unimportant at present, could be of greater consequence during 1963-65. Production goals have not been met in many instances, because the designated consumers have not made the necessary preparations to receive gas. Equipment for residential consumption of gas has been in short supply. In the RSFSR, for example, it appears probable that less than one-half of the requirements for gas stoves, water heaters, space heaters, and the like will be met during 1959-65. The failure to develop and manufacture satisfactory compressors has resulted in underutilization of existing pipelines and in underfulfillment of production plans in each of the 3 initial years of the Seven Year Plan (1959-65).

Partly as the result of the estimated underfulfillment of the plan for production, savings accruing from the substitution of gas for solid fuels probably will amount to about 60 percent of the original plan of 7.0 billion rubles. The estimated total saving of 4.3 billion rubles, however, represents a substantial release of productive services for allocation to other sectors of the economy.

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I. Introduction

In order to make a maximum contribution to Soviet economic growth, the industries producing primary energy should be organized to minimize their requirements for labor, capital, and materials while simultaneously meeting the demands for energy* imposed by the over-all level of economic activity. The plan for extraction, processing, and transport of coal, oil, and gas should be chosen so that for the time period under consideration the total cost of their contribution to the demand for energy will be a minimum.

Ultimate reserves of all three basic sources of mineral energy are possessed in relative abundance by the USSR. According to the latest official Soviet evaluation completed in 1956, the total geological reserves of coal in the USSR amount to 8,670 billion tons,** or about 57 percent of the world total compared with similar reserves in the US of less than 2,000 billion tons. 1/*** Geologic appraisal of the USSR indicates that its total potential crude oil resources may exceed those of the US. In the US the total potential crude oil reserves have been estimated to be in the range of 27 billion to 34 billion tons. The 1955 Soviet estimate of 29 billion tons of potential petroleum resources in the USSR appears to be geologically reasonable. The Soviet estimate of the total recoverable reserves of gas is based on calculations for US reserves published in 1956 by the Bureau of Mines, which estimates the total recoverable reserves in the US at 28,000 billion cu m. The total area in the US that is geologically favorable for the occurrence of gas amounts to approximately 5 million square kilometers (sq km). The analogous territory within the boundaries of the USSR totals about 11 million sq km. Geologic evaluations indicate that the prospective petroliferous regions of the USSR are no less promising than those of the US. Therefore, Soviet geologists argue, the total recoverable reserves of gas of the USSR should amount to somewhat more than twice those of the US, or more than 56,000 billion cu m. 2/

In spite of this apparently enormous resource potential and the alleged cost advantages of gas, the Soviet gas industry remained a low-

* As a first approximation the fuels industries may be regarded as engaged in output of heat -- a homogeneous commodity measurable in physical units such as calories, tons of standard fuel, British thermal units, and the like. In spite of some areas of limited substitutability, the approximation is particularly appropriate in problems involving energy coal and gas.

** Tonnages are given in metric tons throughout this report.

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priority appendage of the oil industry until 1956. In general, exploration for gas took place only incidentally to the search for oil, and it was not until World War II that drilling expressly for gas was authorized. The keeping of separate quantitative records of drilling for oil and gas was not begun until 1955. Similarly, production of gas took place largely in connection with the extraction of oil.*

During the 1930's, output of gas was concentrated in the oilfields of Azerbaydzhan SSR -- the site of almost 80 percent of the total extraction of gas. Nonassociated gas was obtained primarily in Dagestan SSR, where a mere 8.3 million cu m were produced in the 1937-39 period. By the end of the decade, associated gas accounted for approximately 90 percent of the total production of gas in the USSR. The low level of development of the Soviet gas industry by 1940 is shown in Table 1.**

In the postwar period, in spite of the low priority given to the gas industry, proved reserves continued to grow, and by 1955 the ratio of proved reserves of nonassociated gas to annual extraction had mounted to 66 to 1. At the same time, the share of gas in the fuel production balance advanced from a negligible 1.9 percent in 1940 to a mere 2.3 percent in 1950 and 2.4 percent in 1955. The situation was aggravated by the economically untenable policy of encouraging production of manufactured gas. For example, under the Fifth Five Year Plan (1951-55), fully one-half of the investment of 440 million rubles in the gas industry was allocated to obtaining capacity for production of relatively expensive manufactured gas. ^{3/} Thus output of low-cost gas was expanded much more slowly than the rate required for minimizing the cost of meeting the demand of the national economy for fuel.

On the one hand, the resulting fuel balance structure as shown in Table 2*** has been acknowledged as a mistake ^{4/} that retarded economic growth in the past, and, on the other, it is viewed as a "reserve" that can contribute toward more rapid economic growth under the Seven Year Plan and in the more distant future.

Khrushchev himself has spelled out the problem in general and has outlined the economies to be achieved by the restructuring of the fuel balance:

* Previously, geologic methods were not sufficiently accurate to forecast whether a successful well would yield oil or nonassociated gas. Gas obtained from deposits where oil also is extracted is called associated gas. Nonassociated gas is extracted independently of oil.

** Table 1 follows on p. 6.

*** Table 2 follows on p. 7.

C-O-N-F-I-D-E-N-T-I-A-L

At one time we adopted decisions forbidding the use of gas and oil fuel at powerplants and at industrial enterprises using boilers.

We looked to coal to ensure the growing fuel needs of industry. Yet gas and oil fuel, as is known, are several times cheaper than coal. If we were to continue meeting the fuel needs of power, transport, and industry with costly coal while the leading capitalist states developed their own power system and industry on the basis of gas and oil, it would be difficult for us to overtake them.

Therefore, in working out a long-range plan for the development of the national economy, we are providing for the extensive use of natural gas and oil fuel for powerplants, industry, and transport, at the same time fully meeting communal and everyday needs of the public and the needs of the chemical industry for gas as a raw material in the production of synthetic materials. 5/

In his report to the 20th Party Congress in January 1959, Khrushchev claimed that "the total saving from the substitution of natural gas and oil fuel for coal will come to more than 12.5 billion rubles in the seven years" 6/ The anticipated saving in operating expenses connected with extraction and transportation of gas alone was expected to exceed 5.0 billion rubles. 7/ In addition, expansion of the gas industry was expected to require 2.0 billion rubles less in capital investment than would have been required to attain the same addition to capacity in the coal industry. 8/

Savings of this magnitude are based on the assumption that production of gas will rise at an average annual rate of more than 25 percent per year from 28 billion cu m in 1958 to about 150 billion cu m in 1965. The growth in exploratory activity, in construction of transmission facilities, and in consumption of gas, which will be required to make the 4.3-fold growth in production of gas possible, is discussed in the following sections of this report. Performance of the Soviet gas industry during 1959-61 is taken as the basis for assessing prospects for developments during the remainder of the Seven Year Plan (1959-65).*

* Text continued on p. 8.

Table 1

USSR: General Level of Development of the Natural Gas Industry
1940, 1958, and 1965 Plan

| Indicator | Unit | 1940 <u>a/</u> | 1958 <u>b/</u> | 1965 Plan |
|---------------------------------------|----------------------|----------------|----------------|------------------|
| Extraction of gas | Billion cubic meters | 3.2 | 28.1 | 149.8 <u>c/</u> |
| Proved reserves of non-associated gas | Billion cubic meters | 15.1 <u>d/</u> | 988 <u>d/</u> | 4,185 <u>e/</u> |
| Share of gas in total output of fuel | Percent | 1.9 | 5.3 <u>f/</u> | 15.2 <u>f/</u> |
| Length of gas transmission lines | Kilometers | 139 | 13,239 | 42,700 <u>g/</u> |

a. 9/

c. 11/

d. As of 1 January.

e. As of 1 January 1966. 12/

f. Estimated. 13/

g. See Table 9, p. 18, below.

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Table 2

USSR: Estimated Production of Primary Energy, by Source a/
1958-61 and 1965

| Source of Energy | 1958 | | 1959 | | 1960 | | 1961 | | 1965 | |
|------------------------|---|---------------------|---|---------------------|---|---------------------|---|---------------------|---|---------------------|
| | Million Metric Tons of Standard Fuel <u>b/</u> | Percent of Total | Million Metric Tons of Standard Fuel | Percent of Total | Million Metric Tons of Standard Fuel | Percent of Total | Million Metric Tons of Standard Fuel | Percent of Total | Million Metric Tons of Standard Fuel | Percent of Total |
| Coal | 362.1 | 56.7 | 370.0 | 54.3 | 373.1 | 52.1 | 372.3 | 48.8 | 423.8 | 39.6 |
| Crude oil | 161.9 | 25.3 | 185.3 | 27.2 | 211.4 | 29.5 | 237.4 | 31.1 | 379.0 | 35.5 |
| Gas | 33.9 | 5.3 | 42.5 | 6.2 | 54.4 | 7.6 | 70.8 | 9.3 | 162.0 | 15.2 |
| Peat | 21.1 | 3.3 | 23.0 | 3.4 | 20.4 | 2.8 | 21.7 | 2.8 | 27.0 | 2.5 |
| Shale | 4.5 | 0.7 | 4.6 | 0.7 | 4.8 | 0.7 | 5.0 | 0.7 | 7.5 | 0.7 |
| Fuelwood | 32.9 | 5.2 | 34.0 | 5.0 | 28.7 | 4.0 | 28.7 | 3.8 | 25.7 | 2.4 |
| Hydroelectric power | 22.3 | 3.5 | 21.8 | 3.2 | 23.9 | 3.3 | 26.7 | 3.5 | 41.0 | 3.8 |
| Nuclear electric power | Negl. | Negl. | Negl. | Negl. | Negl. | Negl. | Negl. | Negl. | 3.0 | 0.3 |
| Total | <u>638.7</u> | <u>100.0</u> | <u>681.2</u> | <u>100.0</u> | <u>716.7</u> | <u>100.0</u> | <u>762.6</u> | <u>100.0</u> | <u>1,069.0</u> | <u>100.0</u> |

a. 14/

b. Standard fuel has a calorific value of 7,000 kilocalories per kilogram.

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II. Seven Year Plan (1959-65) for the Gas Industry

A. Production

According to the original Seven Year Plan, production of gas was expected to increase at an average annual rate of about 25 percent from about 28 billion cu m in 1958 to almost 150 billion cu m by 1965. Cumulative extraction of associated and nonassociated gas was expected to amount to 633 billion cu m during 1959-65. If this goal were achieved, production of gas in the USSR would rise from about 9 percent of the level in the US in 1958 to approximately 35 percent of production forecast for the US by 1965.

In view of the persistent nature of the difficulties with exploration, transmission, distribution, storage, and consumption encountered by the gas industry in the first 3 years of the Seven Year Plan, the production goal of 150 billion cu m set for 1965 now appears to be the maximum achievable. It is estimated as more probable, however, that during 1962-65 annual increments to production will average about 18.5 billion cu m, an average annual rate of about 23 percent, and that in 1965 the total production of gas will amount to approximately 135 billion cu m, or more than 30 percent of production in the US.

The data in the chart, Figure 1,* show the relation between planned and actual production of gas in the USSR during 1958-61 and the plans for 1962 and 1965.

Regional extraction targets set for 1965 have been modified in accordance with the varying success experienced in obtaining additions to reserves. Faster-than-anticipated development of reserves in the Shebelinka field of the Ukrainian SSR and the Gazli field of Uzbek SSR has permitted an increase in the goals for 1965 set for these republics. A corresponding reduction in planned extraction, largely in the Urals-Volga region of the RSFSR, has been announced. The change in the targets for 1965 for regional extraction of gas in the USSR is shown in Table 3.**

B. Reserves*** and Exploration

Reserves of gas were expected to increase from 988 billion cu m as of 1 January 1959 to 3,469 billion cu m[†] as of 1 January 1966. The

* Following p. 8.

** Table 3 follows on p. 9.

*** Only reserves of nonassociated gas are discussed in this report. Reserves of associated gas can be estimated only with a large margin of error.

† Probably basing their estimates on the substantial overfulfillment of the plan for additions to reserves during 1959, Soviet planners now estimate that reserves of gas will reach [footnote continued on p. 9]

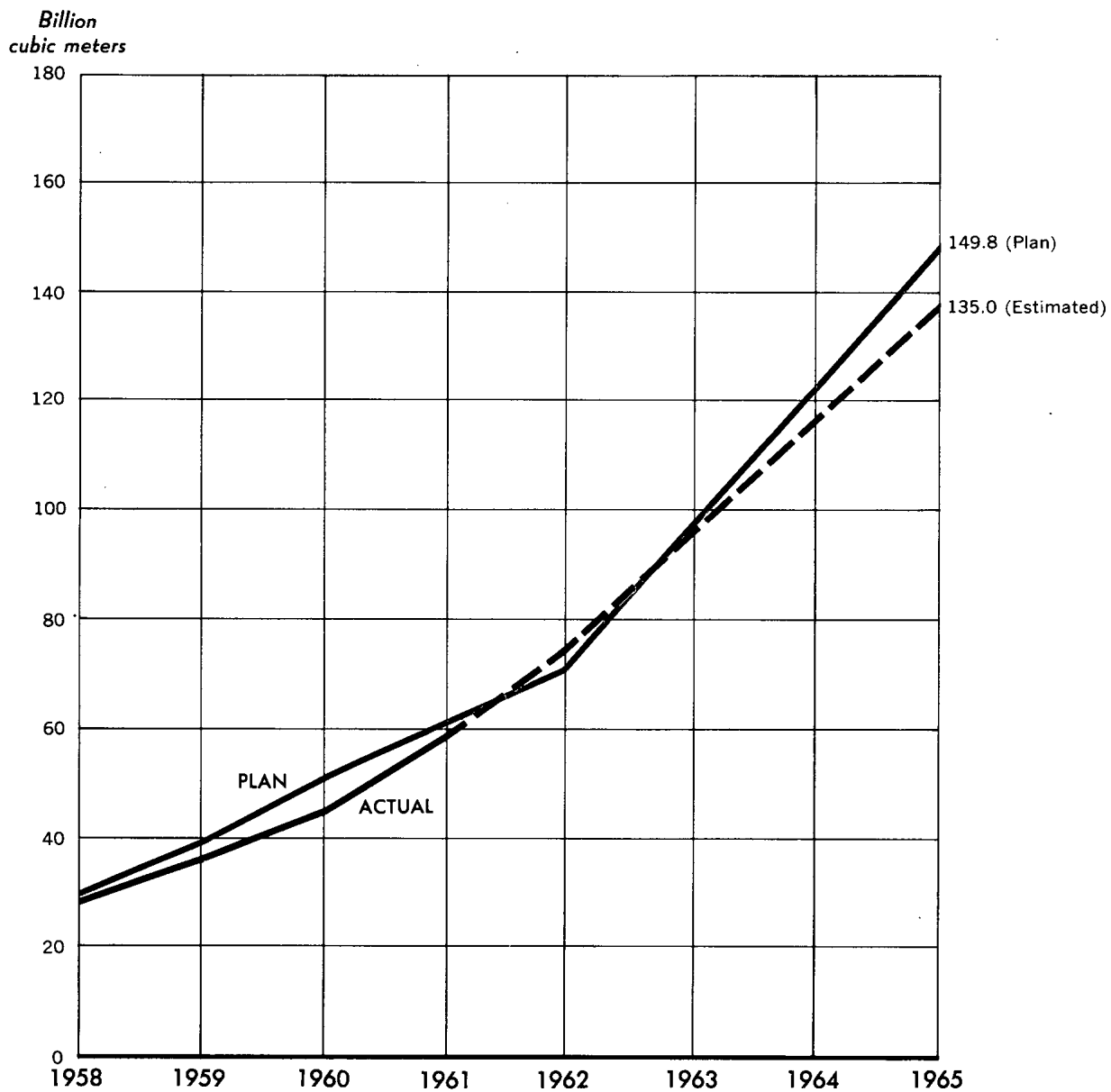
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Figure 1

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USSR PRODUCTION OF NATURAL GAS 1958-65



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AND DECLASSIFICATION

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Table 3

USSR: Change in the Targets for 1965
for the Extraction of Natural Gas, by Republic

Billion Cubic Meters

| <u>Republic</u> | <u>Original Plan a/</u> | <u>Revised Plan b/</u> |
|-------------------|-------------------------|------------------------|
| RSFSR | 83.750 | 75.930 |
| Ukrainian SSR | 31.450 | 36.000 |
| Azerbaijdzhan SSR | 11.600 | 11.600 |
| Uzbek SSR | 18.300 | 21.580 |
| Turkmen SSR | 1.050 | 1.400 |
| Kirgiz SSR | 2.070 | 2.070 |
| Kazakh SSR | 0.060 | 1.210 |
| Total USSR | <u>148.280</u> | <u>149.790</u> |

a. 15/

50X1

map, Figure 2,* shows planned regional changes in proved reserve patterns.

It has been a target of Soviet planners -- arbitrarily adopted from recent experience in the US -- that the ratio of proved reserves to extraction should not be permitted to descend below 20 to 1. If the plan is fulfilled the ratio will decline from 44 to 1 in 1958 to 26 to 1 in 1965.

The program for transformation of possible reserves into proved reserves was expected to require large increases in expenditures on geologic fieldwork and deep exploratory drilling. Achievement of the goal for additions to reserves by 1965 would require an increase in the amount of exploratory drilling for gas from about 1.1 million meters in 1959 to about 3.4 million meters in 1965. Investment by the gas industry

4,185 billion cu m by 1 January 1966. Performance of the Soviet industry in exploratory drilling and in additions to reserves during 1960-61, however, raises some doubt concerning fulfillment of even the original, more moderate plan.

* Following p. 10.

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in predrilling exploratory activities such as geologic surveying, structural-prospecting drilling, and geologic fieldwork is to amount to 770 million rubles. Expenditures on deep exploratory drilling for gas are to amount to a total of 1.58 billion rubles during 1959-65. The amount of exploratory drilling for gas is to attain a total of 15 million meters, or about six times the amount of the previous 7-year period. The planned distribution of exploratory drilling for gas is shown in Table 4.

Table 4

USSR: Control Figures of the Seven Year Plan
 for Exploratory Drilling for Natural Gas, by Republic a/
 1959-65

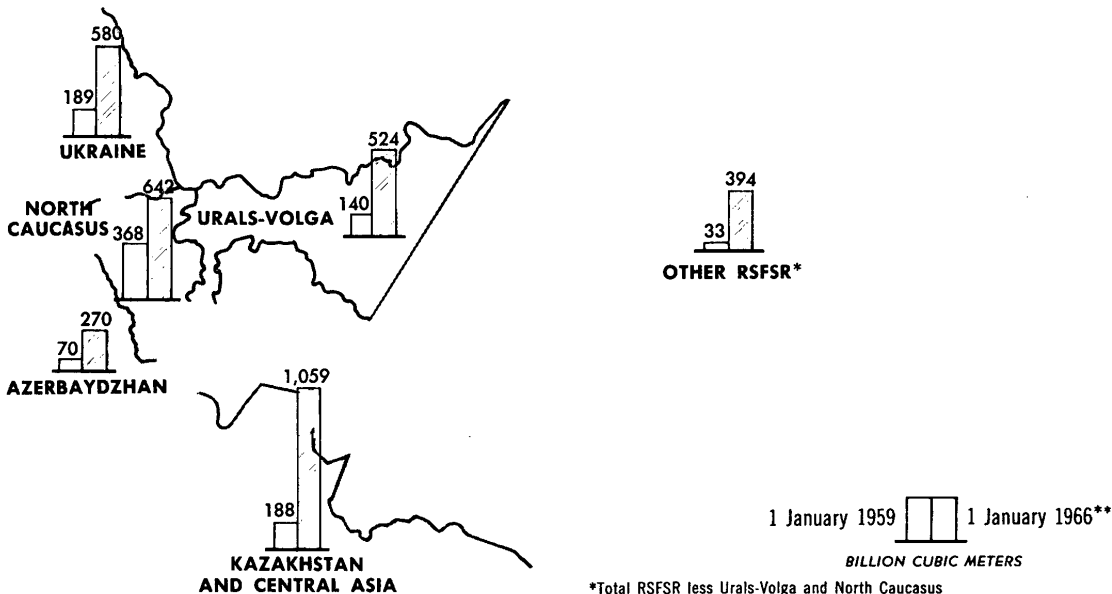
| Republic | Thousand Meters | | | | | | | Total 1959-65 |
|-------------------|-----------------|--------------|--------------|--------------|--------------|--------------|--------------|------------------|
| | 1959 | 1960 | 1961 | 1962 | 1963 | 1964 | 1965 | |
| RSFSR | 585 | 735 | 905 | 1,105 | 1,270 | 1,455 | 1,645 | 7,700 |
| Ukrainian SSR | 215 | 240 | 290 | 325 | 375 | 570 | 725 | 2,740 |
| Azerbaijdzhan SSR | 110 | 110 | 110 | 105 | 105 | 105 | 105 | 750 |
| Uzbek SSR | 120 | 150 | 200 | 230 | 270 | 300 | 340 | 1,610 |
| Turkmen SSR | 30 | 50 | 70 | 100 | 130 | 150 | 170 | 700 |
| Georgian SSR | N.A. | N.A. | N.A. | 10 | 10 | 20 | 20 | 60 |
| Tadzhik SSR | N.A. | 5 | 10 | 15 | 20 | 25 | 25 | 100 |
| Kazakh SSR | 40 | 50 | 60 | 80 | 110 | 150 | 210 | 700 |
| Kirgiz SSR | 10 | 10 | 20 | 25 | 35 | 45 | 55 | 200 |
| Lithuanian SSR | N.A. | N.A. | N.A. | N.A. | 5 | 10 | 15 | 30 |
| Latvian SSR | N.A. | N.A. | N.A. | N.A. | N.A. | 3 | 7 | 10 |
| Unspecified b/ | 30 | 40 | 45 | 55 | 65 | 75 | 90 | 400 |
| Total USSR | 1,140 | 1,390 | 1,710 | 2,050 | 2,395 | 2,908 | 3,407 | 15,000 |

a. 17/. Control figures refer to annual goals set forth as guidelines at the outset of a medium-range or long-range plan. Modifications are frequently required when the actual annual plan is drawn up.

b. Part of the total drilling for gas is to be accomplished by the Main Administration of the Soviet Gas Industry (Glavgaz) in unspecified regions of the USSR.

As a result of the greatly expanded volume of exploration, geologically less favorable structures will be drilled. Therefore, Soviet authorities anticipated that the effectiveness of exploratory drilling will decline from 290,000 cu m added to reserves per meter drilled during

USSR: PROVED RESERVES OF NONASSOCIATED NATURAL GAS, BY SELECTED GEOGRAPHIC AREA AS OF 1 JANUARY 1959 AND PLAN FOR 1 JANUARY 1966



36634 9-62

*Total RSFSR less Urals-Volga and North Caucasus

**Plan for 1 January 1966 as herein presented calls for total reserves of 3,469 billion cubic meters. A revised plan for this period calls for total reserves of 4,185 billion cubic meters.

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1951-55 to 200,000 cu m to be added to reserves per meter drilled during 1959-65. 18/

Consistent lags in the volume of exploratory drilling as yet have not resulted in chronic underfulfillment of annual plans for additions to proved reserves, as shown in Table 5. Developments to date, however, suggest that the plan for additions to proved reserves may not be met during 1962-65. Continuation of substandard performance in exploratory efforts may contribute to underfulfillment of the Seven Year Plan for increments to proved reserves. During 1959-61, only 85 percent of the planned exploratory drilling for gas was actually accomplished. It appears unlikely, therefore, that the much higher goals for the later years will be met.

Table 5

USSR: Exploratory Drilling for Natural Gas
 and Additions to Proved Reserves of Nonassociated Natural Gas
 1955-61

| Year | Exploratory Drilling <u>a/</u> (Thousand Meters) | | | Additions to Reserves (Billion Cubic Meters) | |
|------|---|-------------|--------|---|------------------|
| | Seven Year Plan Control Figures | Annual Plan | Actual | Planned <u>b/</u> | Actual <u>c/</u> |
| 1955 | N.A. | N.A. | 235 | 75 | 107 |
| 1956 | N.A. | N.A. | N.A. | 84 | 106 |
| 1957 | N.A. | 640 | 602 | 116 | 126 |
| 1958 | N.A. | 901 | 746 | 202 | 310 |
| 1959 | 1,140 | 1,130 | 985 | 359 | 710 |
| 1960 | 1,390 | 1,295 | 959 | 411 <u>d/</u> | 281 <u>e/</u> |
| 1961 | 1,710 | N.A. | N.A. | N.A. | 260 <u>f/</u> |

a. 19/



50X1

e. 23/
 f. 24/

Shortfalls in the volume of exploratory drilling would have had a more detrimental effect had they not been offset by greater-than-anticipated additions to reserves per meter drilled. During 1959-60 the

C-O-N-F-I-D-E-N-T-I-A-L

effectiveness of exploratory drilling amounted to 0.5 million cu m of additions to reserves per meter drilled, or more than double the figure anticipated by Soviet officials. Additions to proved reserves, however, declined from 721,000 cu m per meter drilled in 1959 to 293,000 cu m per meter drilled in 1960. The data in Table 6 demonstrate that the decline in additions to reserves per meter drilled was apparent in all the gas-producing union republics except Turkmen SSR, which possesses a negligible portion of the total Soviet proved reserves of gas. Furthermore, the exceptional performance in 1959 was primarily the consequence of more detailed exploration of the Gazli, Shebelinka, and Krasnodarskiy Kray fields, which are the largest in the USSR. 25/ Thus the majority of additions to reserves were accomplished at large fields that were discovered before 1959. In the past a few large fields have provided the major part of the total proved reserves. Soviet planners have calculated that in 1959-60 two fields with reserves of 50 billion to 100 billion cu m and one with more than 100 billion cu m should have been discovered. As a matter of fact, only one field with possibilities for reserves of this magnitude was discovered during the first 2 years of the Seven Year Plan -- at Darvazsk in the western portion of Turkmen SSR. 26/

Table 6

USSR: Effectiveness of Exploratory Drilling for Natural Gas
by Republic a/
1959 and 1960

Thousand Cubic Meters of Additions to Reserves per Meter Drilled

| <u>Republic</u> | <u>1959</u> | <u>1960</u> | <u>1959-60</u> |
|-------------------|---------------|---------------|----------------|
| RSFSR | 600 | 240 | 320 |
| Ukrainian SSR | 900 | 380 | 660 |
| Azerbaijdzhan SSR | 280 | 52 | 155 |
| Uzbek SSR | 3,400 | 775 | 2,200 |
| Turkmen SSR | N.A. | 1,100 | 1,100 |
| Kirgiz SSR | 265 | 136 | 195 |
| USSR | 721 <u>b/</u> | 293 <u>b/</u> | 510 <u>b/</u> |

50X1

b. Calculated from data in Table 5, p. 11, above.

Apparently geologic fieldwork has not proceeded at the rate hoped for by Soviet officials. As a result, the preparation of geologic structures for deep exploratory drilling has not kept pace with lagging exploratory drilling plans. In 1960 the number of structures prepared for

C-O-N-F-I-D-E-N-T-I-A-L

exploratory drilling, as well as the number of structures on which ex-
 ploratory drilling was begun, actually declined from the level of 1959,
 as shown in Table 7.

Table 7

USSR: Preparation of Structures for Exploratory Drilling for Natural Gas
 and Initial Exploratory Drilling of Structures
 by Region a/
 1959 and 1960

| Region | Preparation of Structures | | Initial Drilling of Structures | | Units |
|-------------------|------------------------------|------------|-----------------------------------|------------|-------|
| | 1959 | 1960 | 1959 | 1960 | |
| Urals-Volga | 48 | 34 | 41 | 30 | |
| North Caucasus | 23 | 22 | 16 | 11 | |
| Other RSFSR | 40 | 43 | 27 | 29 | |
| Total RSFSR | <u>111</u> | <u>99</u> | <u>84</u> | <u>70</u> | |
| Ukrainian SSR | <u>23</u> | <u>16</u> | <u>19</u> | <u>11</u> | |
| Azerbaijdzhan SSR | <u>5</u> | <u>7</u> | <u>3</u> | <u>0</u> | |
| Uzbek SSR | <u>12</u> | <u>13</u> | <u>17</u> | <u>14</u> | |
| Turkmen SSR | <u>20</u> | <u>22</u> | <u>8</u> | <u>7</u> | |
| Tadzhik SSR | | | | | |
| Kirgiz SSR | | | | | |
| Total USSR | <u>171</u> | <u>157</u> | <u>131</u> | <u>102</u> | |

a. 28/. Data pertain to both the oil and the gas industries.

In spite of the lags in the exploratory program, the extent of
 proved reserves should be more than adequate to meet requirements of
 the Soviet gas industry during 1962-65. Fulfillment of plans for pro-
 duction of gas and for additions to reserves would result in mainte-
 nance of a 26 to 1 reserve-extraction ratio, or well above the 20 to 1
 ratio deemed appropriate by Soviet planners. Moreover, there are in-
 dications that the target of 20 to 1 may not be applicable in all cases.
 For example, the Gazli field may be exploited at a rate that will deplete
 it in 15 years. 29/ Nevertheless, additions to proved reserves have
 lagged substantially behind plans in Azerbaijdzhan SSR, in the Urals-Volga

C-O-N-F-I-D-E-N-T-I-A-L

region, and in other regions of the RSFSR, as shown in Table 8. Minor underfulfillments of goals for 1965 may result from a continuation during 1962-65 of the experience of shortfalls in planned additions to reserves in these regions.

Table 8

USSR: Planned and Actual Additions to Proved Reserves
 of Nonassociated Natural Gas, by Region a/
 1959 and 1960

| Region | Billion Cubic Meters | | | |
|-------------------|----------------------|------------|------------|------------|
| | 1959 | | 1960 | |
| | Planned | Actual | Planned | Actual |
| Urals-Volga | 51 | 53 | 76 | 23 |
| North Caucasus | 65 | 150 | 85 | 106 |
| Other RSFSR b/ | 29 | 7 | 39 | 11 |
| Total RSFSR | <u>145</u> | <u>210</u> | <u>200</u> | <u>140</u> |
| Ukrainian SSR | <u>50</u> | <u>180</u> | <u>64</u> | <u>64</u> |
| Azerbaijdzhan SSR | <u>26</u> | <u>22</u> | <u>27</u> | <u>5</u> |
| Uzbek SSR | <u>130</u> | <u>293</u> | <u>103</u> | <u>53</u> |
| Turkmen SSR | <u>8</u> | 5 | <u>17</u> | <u>19</u> |
| Tadzhik SSR | | | | |
| Kirgiz SSR | | | | |
| Kazakh SSR | | | | |
| Total USSR | <u>359</u> | <u>710</u> | <u>411</u> | <u>281</u> |

a. 30/

b. Probably accounted for largely by Komi ASSR.

C. Transmission

1. Compressors

In order to insure operation of transmission lines at planned throughput volume, construction of 150 compressor stations with a total capacity of approximately 3.5 million horsepower (hp) was to be accomplished during 1959-65. Demand for gas turbine-powered compressors was to increase from 40 per year in 1958 to about 100 per year later in the

C-O-N-F-I-D-E-N-T-I-A-L

plan. 31/ Production of a total of almost 1,000 gas turbine compressors for gas transmission was planned for the 7-year period. 32/

In recent years the inability to develop and produce a satisfactory gas turbine compressor for operation on trunk transmission lines probably has been the most significant single problem encountered by the Soviet gas industry. By the end of 1960 the decision had been reached to convert* more than 20 stations to electric drive. 33/ Because construction of compressor stations has lagged substantially relative to construction of pipelines and because only compressors are needed to attain potential transmission capacities, Soviet authorities estimate that the conversion will result in an increase in annual transmission capacity of about 25 billion cu m. 34/

Although development of all types of compressors for use on gas transmission lines has proceeded slowly in the USSR during the entire postwar period, much of the difficulty in transmission encountered by the industry during 1959-61 may be ascribed to deficiencies in the program for production and operation of a 5,000-hp gas turbine-driven centrifugal compressor -- the GT-700-4. In the first place, it remained in the design and development stages longer than had been planned. Operational use of the GT-700-4 showed that it had a low coefficient of efficiency, insufficient capacity, and a complicated mechanism that required excessive downtime. Thus this compressor could not satisfactorily meet requirements for trunk line transmission. 35/

Electric drive has been successfully substituted for gas turbines at a substantial number of stations, and, as noted above, the conversion of more than 20 stations to electric drive was planned. However, plans for and actual accomplishment of acquisition of electric power equipment will be a disrupting factor. By the second quarter of 1961, schedules for construction of electric power lines and for procurement of electrical equipment were not being met. Furthermore, the substitution of electric drive will not be feasible in all regions, as an existing system providing inexpensive electric power is required. 36/ Certain stations, where no such supply of electric power exists, will need gas turbines. To meet this need, several new compressors are being prepared.

The GT-700-5, merely an improved version of the GT-700-4, was to undergo a testing program in 1960. 37/ In spite of claims that the GT-700-5 is the world's foremost compressor of its type, that assembly line production had begun, and that installation on trunk transmission

* The word convert is used to indicate (1) the actual removal of gas turbines and the substitution of electric motors at existing stations and (2) a change in plans whereby stations originally slated to receive gas turbines were to be equipped with electric motors.

C-O-N-F-I-D-E-N-T-I-A-L

lines had been successfully accomplished, testing probably had not been completed by the fourth quarter of 1961. 38/

Manufacture of 12,000-hp gas turbine-driven compressors, GTN 9-750's, for use primarily on 40-inch gas lines has been claimed. 39/ Tests of the GTN 9-750, however, are to continue throughout 1962. 40/ Soviet experience gives reason for doubt concerning possibilities of meeting the schedule for installation of GTN 9-750's on the dual Gazli-Urals line -- the major gas transmission construction project under the Seven Year Plan. As possible substitution of GT-700-5's for GTN 9-750's on the Gazli-Urals line has been considered, 41/ Soviet planners may be apprehensive concerning the outcome of the tests.

Mass procurement of satisfactory gas turbine-driven compressors is a necessary condition for successful implementation of the Seven Year Plan of the Soviet gas industry. As of November 1961, requirements for such compressors continued to significantly exceed the quantities being delivered. 42/ Thus the available evidence suggests that domestic capability for manufacture of gas turbine-driven compressors may continue to lag. If suitable compressors cannot be imported, underutilization of pipeline throughput capacity is quite likely to persist.

2. Construction of Pipelines

During the period of the Seven Year Plan, 26,000 km of gas trunk transmission lines were to be constructed and put into service. The total length of gas transmission lines in operation was expected to increase from 13,200 km at the end of 1958 to about 39,000 km by the end of 1965.* In the US, where 262,300 km of gas transmission lines were in existence by the end of 1958, construction of 90,000 additional km has been forecast for the 1959-65 period, bringing the total to about 350,000 km. Thus by 1965 the total length of transmission lines available in the US will be on the order of 8 to 9 times the length of such lines in the USSR. Soviet writers claimed, however, that in 1960 more than 40 percent (about 8,000 km) of all gas transmission lines in the USSR were of 720 millimeters (28 inches) or more in diameter, while lines of comparable diameter in the US constituted but 1.1 percent of the total.

As oil and gas pipeline laying operations are essentially quite similar and as Glavgaz has been charged with construction of both oil and gas lines, prospects for fulfillment of the program for construction of gas transmission lines can be meaningfully considered only in conjunction with the program for oil lines. Changes in availability

* The revised plan calls for 42,700 km by the end of 1965.

C-O-N-F-I-D-E-N-T-I-A-L

for use of Soviet oil and gas pipelines* are summarized in the chart, Figure 3,** and in Table 9.*** Figures 4 and 5† show the status of the Soviet gas transmission net as of the end of 1961.

Through 1961, additions to availability of Soviet gas lines proceeded at a pace easily consistent with achievement of the original goal of the Seven Year Plan of 26,000 km.†† In fact, commissioning of gas lines during 1959-61 exceeded the amount that would have had to occur to achieve the simple arithmetic average required to meet the original Seven Year Plan. Thus it appears probable that in 1959-61 additions to the total amount of line pipe in service were more than adequate for transmission of the increments to gas production actually achieved. Even the delay in construction of the Krasnodarskiy Kray - Serpukhov line, caused by lack of capability for the domestic production of 40-inch pipe, probably did not seriously contribute to underfulfillment of plans for gas extraction. Relying solely on imports of 40-inch pipe, Soviet planners apparently chose to construct a 240-km line from Shebelinka to Ostrogozhsk by the end of 1960 even though it may have meant diverting 40-inch line pipe from the 1,045-km Krasnodarskiy Kray - Serpukhov line. 44/ This decision probably was based on the fact that the latter 40-inch pipe would duplicate the service provided by the existing 28-inch and 32-inch Stavropol'-Moscow lines, which in 1960 operated at only 65 to 70 percent of capacity because of insufficient compression equipment.

In 1959-61 the use of imported pipe enabled the Soviet gas industry to make substantial progress on the construction of its gas transmission net. However, the brunt of any failures in pipe supply or pipeline construction during 1962-65 probably would be borne by the gas

* In any given year a summation of the length of line laid in place compared with the length of line placed into service may show a substantial disparity. Over a period of years, however, either figure is likely to be a good approximation of the other. [redacted] system- 50X1
atic and apparently comparable data on availability for use of both oil and gas pipeline. Such fragments as are available on actual laying of line in place are roughly consistent with the data on additions to availability.

** Following p. 18.

*** Table 9 follows on p. 18.

† Inside back cover.

†† [redacted] the plan for construc-50X1
tion and commissioning of transmission lines during 1959-65 may have been increased from 26,000 km to about 30,000 km. Furthermore, a summation of the length of individual gas transmission pipelines apparently planned for construction during the period of the Seven Year Plan yields a result in excess of 35,000 km. 43/

Table 9

USSR: Pipelines for Transmission of Oil and Natural Gas
 Available and Commissioned for Use a/
 Estimate for 1955-61 and Plans for 1962 and 1965

| Year | Thousand Kilometers | | | | | |
|-----------|--------------------------------|--------------------------|--------------------------------|--------------------------|--------------------------------|--------------------------|
| | Oil | | Gas | | Total | |
| | Available at End of Year | Commissioned Annually | Available at End of Year | Commissioned Annually | Available at End of Year | Commissioned Annually |
| 1955 | 10.4 | N.A. | 5.9 | N.A. | 16.3 | N.A. |
| 1956 | 11.6 | 1.2 | 7.9 | 2.0 | 19.5 | 3.2 |
| 1957 | 13.2 | 1.6 | 10.1 | 2.2 | 23.3 | 3.8 |
| 1958 | 14.4 | 1.2 | 13.2 | 3.1 | 27.6 | 4.3 |
| 1959 | 16.7 | 2.3 | 17.1 | 3.9 | 33.8 | 6.2 |
| 1960 | 17.3 | 0.6 | 21.5 | 4.4 | 38.8 | 5.0 |
| 1961 | 20.9 | 3.6 | 25.7 | 4.2 | 46.6 | 7.8 |
| 1962 Plan | 22.9 | 2.0 | 28.7 <u>b/</u> | 3.0 <u>c/</u> | 51.6 | 5.0 |
| 1965 Plan | 45.4 | 7.5 <u>d/</u> | 42.7 | 4.7 <u>d/</u> | 88.1 | 12.2 <u>d/</u> |

b. Computed from the plan for additions to availability in 1962.

c. 46/

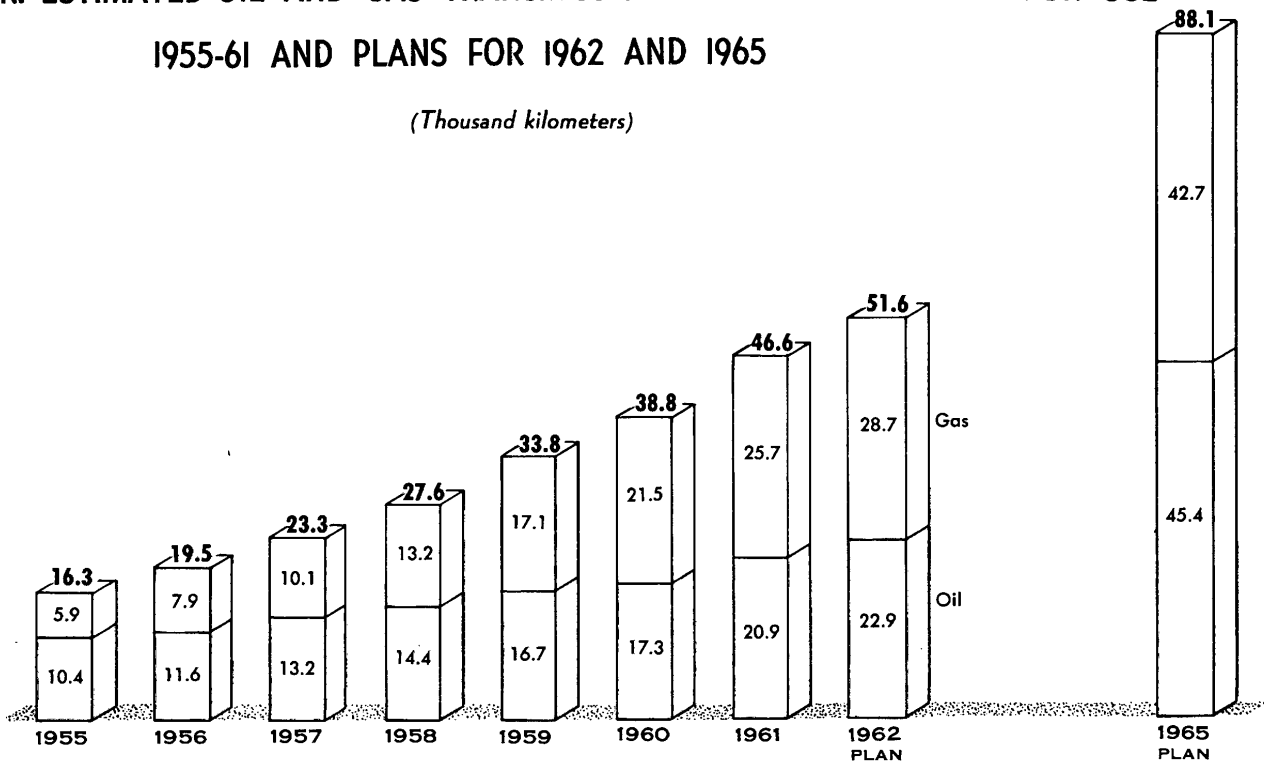
d. Average annual addition to availability required during 1963-65 to meet the target for 1965.

Figure 3

50X1

USSR: ESTIMATED OIL AND GAS TRANSMISSION PIPELINES AVAILABLE FOR USE 1955-61 AND PLANS FOR 1962 AND 1965

(Thousand kilometers)



50X1

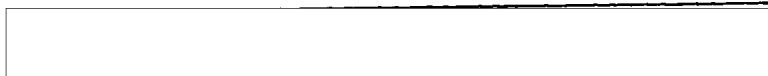
C-O-N-F-I-D-E-N-T-I-A-L

industry. Any such failure could significantly affect the ability of the USSR to meet the goal for extraction of gas for 1965. Although the original Seven Year Plan for construction of oil lines substantially exceeds that for construction of gas lines, annual plans and actual achievements in the first three years of the Seven Year Plan indicate that priority was given to construction of gas lines. The plans for 1961 showed a step toward a redress in the imbalance, however, and if plans for construction of oil lines as shown in Table 10 are fulfilled, movement in this direction will continue in the future. In 1960 the gas industry received only 94 percent of the amount of pipe procured in 1959, and in 1961 the allocation to the gas industry had fallen to 80 percent of the level in 1959. 47/ Requirements of the gas industry for 20-inch pipe were expected to be fulfilled by only 50 percent in 1961. 48/

Table 10

USSR: Planned Construction of Pipelines
for Crude Oil and Oil Products
1959-65

| <u>Year</u> | <u>Kilometers a/</u> |
|-------------|----------------------|
| 1959 | 1,907 <u>b/</u> |
| 1960 | 2,056 <u>c/</u> |
| 1961 | 2,775 |
| 1962 | 3,408 |
| 1963 | 5,480 |
| 1964 | 7,085 |
| 1965 | 8,090 |



50X1

b. 50/
c. 51/

Although indigenous production of line pipe in general has not been sufficient to meet the demands of Soviet industry, until late in 1961 the most prominent deficiency was the total lack of capacity to manufacture 40-inch line pipe. Requirements of the Soviet oil and gas industry for 40-inch pipe are shown in Table 11.* As of 1 January 1962, approximately 14 percent of the program had been completed, an

* Table 11 follows on p. 20.

C-O-N-F-I-D-E-N-T-I-A-L

Table 11

USSR: Construction of 40-Inch Diameter Pipelines
 for Transmission of Oil and Natural Gas
 During the Period 1959-65

| Pipeline | Kilometers | |
|---|-----------------|---------------------|
| | Planned | Completed <u>a/</u> |
| Kanevskaya-Novopskov-Ostrogzhsk-Serpukhov No. 1 | 1,045 <u>b/</u> | 760 <u>c/</u> |
| Kanevskaya-Novopskov No. 2 | 400 <u>d/</u> | 0 |
| Ostrogzhsk-Serpukhov No. 2 | 495 <u>e/</u> | 0 |
| Shebelinka-Ostrogzhsk | 240 <u>f/</u> | 240 <u>g/</u> |
| Krasnodarskiy Kray and Shebelinka system | <u>2,180</u> | <u>1,000 h/</u> |
| Gazli-Urals system (2 pipelines) | <u>4,465 i/</u> | <u>150 j/</u> |
| Gas pipeline total | <u>6,645</u> | <u>1,150</u> |
| Kuybyshev-Mozyr' oil pipeline | <u>1,350 k/</u> | <u>0</u> |
| Gas and oil pipeline total | <u>7,995</u> | <u>1,150</u> |

a. As of 1 January 1962.

b. 52/

c. Residual.

d. 53/

e. 54/

f. 55/

g. 56/

h. 57/

i. 58/

j. Estimated. 59/

k. 60/

achievement made possible largely by imports of line pipe from West Germany. As only token quantities of domestically produced 40-inch pipe became available by the fourth quarter of 1961 and as future availability of domestically produced pipe is extremely uncertain, completion of the program on schedule undoubtedly will require further imports of 40-inch pipe. Existing contracts call for the delivery of about 500,000 tons (about 1,650 km) of 40-inch line pipe to the USSR from West Germany,

C-O-N-F-I-D-E-N-T-I-A-L

Italy, and Sweden before the end of 1964. In spite of the sizable program for import of line pipe, construction of the Gazli-Urals line was being delayed in mid-1961 because of insufficient stocks of pipe, 61/ and construction planned for 1961 was reduced from 200 km to 150 km. Construction of the 40-inch oil line from Kuybyshev to Mozyr' probably will receive priority over 40-inch gas lines. Any future shortage of 40-inch line pipe probably will result in a delay in construction of transmission lines.

3. Underground Storage

Operation of natural gas pipelines at near capacity is required for efficiency, and in order to achieve such operation, some allowance for variable seasonal demands must be made. Underground storage of gas is the most effective method to meet the variable seasonal demands and still maintain uniform operation of the pipelines the year round. Experience of the US industry indicates that underground storage is best accomplished in exhausted oil and gas structures. As the USSR has few such structures in major consuming regions, a total capacity of only 2 billion cu m 62/ of underground storage was planned for 1965 compared with the 81.3 billion cu m available in the US by the end of 1960. 63/ Because of the predominant industrial load in the USSR, however, seasonal demand for gas probably is less pronounced there than it is in the US, and the relatively small amount of underground storage planned may be nearly adequate for the gas industry.

D. Consumption

As the USSR imports no gas and exports less than 1 percent of its production, consumption has differed little from production. No major expansion in exports of gas is expected before 1965. The distribution of consumption of gas by consumer category in 1958-60 and that expected by 1965 are shown in Table 12.* It was anticipated that industrial enterprises would continue to account for about 90 percent of the total consumption of gas; that the electric power industry would remain a major consumer, accounting for about 20 percent of the total consumption in 1965; and that ferrous and nonferrous metallurgy together would account for approximately 25 percent of the total consumption by 1965 compared with less than 10 percent in 1958.

The pattern of consumption of gas in the USSR differs strikingly from that in the US. In the US, Residential and Commercial consumption has varied from 20 to 35 percent of the total, while the most nearly comparable Soviet category Domestic and Communal Services according to plan was expected to decline slightly from 11 percent in 1958 to about

* Table 12 follows on p. 22.

Table 12

USSR: Estimated Structure of Consumption of Natural Gas a/
1958-60 and 1965 Plan

| Consumer | 1958 | | 1959 | | 1960 | | 1965 Plan | |
|-------------------------------------|-------------------------|--------------|-------------------------|--------------|-------------------------|--------------|-----------------------------------|--------------|
| | Billion Cubic Meters | Percent | Billion Cubic Meters | Percent | Billion Cubic Meters | Percent | Billion Cubic Meters <u>b/</u> | Percent |
| Electric power <u>c/</u> | 9.9 | 35.6 | 10.4 | 29.6 | 12.8 | 28.4 | 28.8 | 21.4 |
| Mines and quarries <u>d/</u> | 6.5 | 23.4 | 6.6 | 18.9 | 7.5 | 16.7 | 10.4 | 7.7 |
| Ferrous metals | 1.8 | 6.3 | 2.7 | 7.6 | 5.3 | 11.7 | 24.1 | 17.9 |
| Nonferrous metals | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | 9.7 | 7.2 |
| Engineering | 1.9 | 6.8 | 2.8 | 7.9 | 3.5 | 7.9 | 10.8 | 8.0 |
| Chemicals | 0.3 | 1.0 | 1.0 | 2.7 | 2.0 | 4.4 | 7.7 | 5.7 |
| Glass, ceramic, and construction | 0.9 | 3.2 | 1.4 | 4.0 | 1.6 | 3.6 | N.A. | N.A. |
| Cement | 1.6 | 5.6 | 2.0 | 5.8 | 3.1 | 6.8 | 7.5 | 5.6 |
| Food | 0.6 | 2.2 | 1.0 | 2.9 | 1.3 | 2.8 | N.A. | N.A. |
| Other industry | 1.4 | 5.1 | 2.9 | 8.2 | 2.0 | 4.5 | 23.1 | 17.2 |
| Total industry | <u>24.9</u> | <u>89.2</u> | <u>30.8</u> | <u>87.6</u> | <u>39.1</u> | <u>86.8</u> | <u>122.1</u> | <u>90.7</u> |
| Residential and communal service | <u>3.0</u> | <u>10.8</u> | <u>4.4</u> | <u>12.4</u> | <u>5.9</u> | <u>13.2</u> | <u>12.5</u> | <u>9.3</u> |
| Total consumption | <u>27.9</u> | <u>100.0</u> | <u>35.2</u> | <u>100.0</u> | <u>45.0</u> | <u>100.0</u> | <u>134.6</u> | <u>100.0</u> |

b. Based on estimated total consumption of 134.6 billion cubic meters of gas in 1965 and on planned structure of consumption in source 65/.

c. Consumption by electric powerplants of the electric power industry only. Does not include electric powerplants subordinate to other enterprises.

d. Including consumption by the oil and gas industries and losses. Data for 1965 include consumption by the gas industry only. A part of the category "other industry" probably should be included for 1965.

C-O-N-F-I-D-E-N-T-I-A-L

9 percent in 1965. In spite of the slight diminution in the relative importance of the residential consumer, it was planned that the number of cities and towns serviced with gas will rise from 150 in 1958 to 500 in 1965, and the number of individuals housed in quarters supplied with gas was to increase from about 16 million in 1958 to 50 million in 1965. 66/

The estimated shortfall in production of gas will be reflected in a corresponding shortfall in consumption, but there is no indication that the underfulfillment of the production plan will appreciably affect the sectoral distribution of consumption planned for 1965. The pattern of consumption in 1959-60, as indicated by the data presented in Table 12,* suggests general consistency with achievement of the pattern planned for 1965.

In recent years the chronic lack of preparation on the part of consumers has been a serious obstacle to even more rapid growth in production of gas in the USSR. During 1958, only 36 enterprises began using gas rather than 325 as was originally planned, largely because necessary preparations by consumers had not been made. 67/ In 1959 the plan for capital investment in urban gasification was fulfilled by only 92 percent in the RSFSR -- the most important gas-consuming republic. 68/ In the same year, rural areas in the RSFSR fulfilled the plan for supplying gas to apartments by only 82 percent. 69/ In 1960, hundreds of industrial enterprises were to receive gas, but conversion of plants, including electric power stations, proceeded at an "extraordinarily" slow rate. 70/ These difficulties arose partly as the result of faulty planning on the part of the RSFSR State Planning Commission, which had not allocated sufficient quantities of pipe and gas-consuming apparatus. 71/ In the third quarter of 1961 the lack of preparation on the part of consumers continued to impede development of the gas industry. 72/

The outlook is for continued difficulty of this type. In the RSFSR the existing capacity for production of residential gas-consuming equipment may be able to satisfy less than one-half of the requirements placed on it under the Seven Year Plan. 73/ In 1958-59, factories of the RSFSR produced 370,000 gas ranges annually, although requirements amounted to 840,000 units. 74/ In Azerbaydzhan SSR, achievement of the capacity for the manufacture of gas refrigerators, dryers, water heaters, and the like was delayed because of the low priority given it by the Administration for Machine Construction. 75/

In addition to the lack of equipment, consumers may be discouraged by the high price charged for gas, and the possibility of lowering prices has been considered. 76/ By bearing the conversion charges, the state has

* P. 22, above.

C-O-N-F-I-D-E-N-T-I-A-L

already given enterprises some financial incentive to convert furnaces and boilers to gas. 77/

In addition to financial incentives, other measures have been suggested for stimulating consumption of gas. In Uzbek SSR the creation of a Main Administration of Gasification was recommended. The Main Administration would be responsible for a wide range of activities including project planning, construction, and the manufacture of gas equipment, as well as for all other aspects in the operation of the gas industry. The organization was expected to exercise strict and systematic control over the progress in the development of the gas industry in Uzbek SSR. 78/

In view of the major shortfalls in achievement of capacity to consume gas during 1959-61, financial and/or organizational measures probably will not be adequate to eliminate similar shortfalls during 1962-65. Furthermore, there have been no indications of significant increases in priority given to supplying equipment for consumption of gas or for construction of distribution systems. Even if the Soviet gas industry proved capable of delivering 150 billion cu m of gas by 1965, it appears that consumers would be unable to make use of it.

E. Anticipated Economies

The total savings anticipated by Soviet planners from the development of the gas industry during the Seven Year Plan period were expected to amount to approximately 7.0 billion rubles (5.0 billion rubles saved in operating expenses and 2.0 billion rubles saved on capital expenditures) -- approximately 1.5 times the total investment in the gas industry planned for 1959-65. According to estimates published in 1959, the saving on the delivered cost of fuel in major gas-consuming regions was to be 1.2 billion rubles in 1965 alone. In the Urals region in 1965 the saving on operating expenses was to reach 0.16 billion rubles. The reduced capital investment made possible by the use of gas in the Urals during 1959-65 was to amount to about 0.44 billion rubles. 79/

The use of gas as a chemical raw material also was to result in an annual saving of 0.13 billion rubles by 1965, while capital economies in 1959-65 were to amount to 0.65 billion rubles.* 80/ Conversion to gas was to permit production of an additional quantity of 4.5 million tons of cement in 1965 without any greater investment than would have been required with the old technological process. 81/ When gas is used in place of solid fuels, certain other plants such as textile mills 82/ and particular types of electric power stations also require less investment for a given capacity.** 83/

* Probably including investment in the chemical industry only.

** In Soviet practice the combination of economies in both operating expenses and capital expenditures is an [footnote continued on p. 25]

C-O-N-F-I-D-E-N-T-I-A-L

Other benefits that Soviet planners hoped to realize from the increased share of gas in the total consumption of energy are reduced requirements for labor and fuel and improved conditions in employment and quality of product. The claim was made that by 1965 productivity of labor in gas extraction would amount to about 50 times that in coal extraction. Productivity of labor in gas transport was to amount to about 16 times that in coal transport. Increases in thermal efficiency and reductions in losses were expected to reduce fuel requirements per unit of GNP. As a result of these factors it was expected that 300,000 fewer workers would be required by the fuels industries in 1965. 84/ Furthermore, the quality of output of the cement, brick, and textile 85/ industries was expected to rise with the introduction of gas.

In spite of the estimated underfulfillment of plans for production of gas and for decreases in delivered costs of gas, adjustments for these expected shortfalls, for estimated shortfalls in reduction of coal costs, and for peculiarities of Soviet computational and accounting procedures suggest that during 1959-65 savings accruing from substitution of gas for solid fuels probably will amount to about 4.3 billion rubles compared with 7.0 billion rubles originally announced. It is estimated that savings of fuel in physical terms will amount to 83.2 million tons of standard fuel during 1959-65, falling short of the plan in proportion to the shortfall in production of gas.*

Inclusion in the accounts of the gas industry of expenditures for exploration, which have been omitted in official cost-of-production calculations, may diminish the widely acclaimed cost advantage. The use of amortization norms that do not accurately reflect lengths of service of capital equipment and capital structures contributes to an understatement of the relative cost advantage of gas over coal. In the gas industry, as elsewhere in the economy, no charge is made for the productive services of capital. To the extent that the gas industry

unusual case. Ordinarily -- at higher planning levels as well as at the level of the individual project -- a saving of operating expenses has been compared with the increment in investment required to achieve it. The result indicates how many years are required to recoup the additional investment. The shorter the recoupment period, the more effective is the incremental investment. The gas industry is a peculiar case in that the increment to investment (compared with the alternative of investing in further capacity for producing coal) required to achieve the diminution in operating costs was thought to be negative by Soviet planners. The resulting negative recoupment period suggests that investment in this direction is long overdue.

* For the methodologies used in making the estimates of 4.3 billion rubles and 83.2 million tons of standard fuel, see Appendix B.

C-O-N-F-I-D-E-N-T-I-A-L

is capable of producing the standard commodity -- heat -- at a saving in capital, the lack of a capital charge results in an understatement of the cost advantage that gas exhibits.*

Incomplete regional coverage of consumption of gas probably results in a tendency toward understatement of the savings actually achieved. Computation on the basis of average rather than incremental costs also contributes to an understatement of the advantage to be gained from the use of gas.

Underfulfillment of the plan for production of gas and differential underfulfillment of the plans for cost reduction in the coal and gas industries will cause deviations of actual from planned economies. A shortfall in production will mean that less high-cost solid fuel can be replaced by gas than was planned, and this would contribute toward less saving than is planned. Underfulfillment of the plan for reduction of delivered costs of coal will be of greater consequence than the underfulfillment of the plan for reduction of the delivered cost of gas, and the differential in the delivered costs of coal and gas would contribute toward greater-than-planned savings.

Adjustments for computational and accounting peculiarities where possible and for the consequences of plan underfulfillment indicate that during 1959-65 savings in operating expenses may be on the order of 3.3 billion rubles rather than the 5.0 billion rubles originally cited. Capital savings probably will amount to about 1.0 billion rubles rather than the 2.0 billion rubles initially claimed by Soviet authorities.

III. Prospects for the Performance of the Gas Industry, 1962-65

During 1962-65, production of gas in the USSR probably will grow at an average annual rate of about 23 percent from 59 billion cu m in 1961 to 135 billion cu m in 1965. During this period, almost 40 percent of the increase in the total consumption of primary energy in the USSR will be accounted for by the increased consumption of gas. As a result, the share of gas in the total consumption of primary energy will increase from about 10 percent in 1961 to about 17 percent in 1965.

In spite of the outstanding rate of growth that will be achieved by the gas industry, output probably will average about 10 percent below

* Revisions in accounting procedures affecting the calculated costs of coal and gas have been discussed in the issue of Finansy SSSR for December 1961. Prices based on the new cost schedules are to be instituted during 1962.

C-O-N-F-I-D-E-N-T-I-A-L

the plan for the period. As operations in the gas industry are highly interdependent, failure at any stage has an almost immediate effect on final output. In any given year, lags in the installation of consuming equipment in one region, a shortage of compression equipment or line pipe in another, and insufficient reserves in still a third could contribute to underfulfillment of the annual plan for the gas industry. Thus persistence -- at various times and places -- of any one or a combination of the above-mentioned difficulties would be sufficient to cause underfulfillment of annual plans during 1962-65.

During the first 3 years of the Seven Year Plan the goals for the manufacture of equipment necessary for the consumption of gas and plans for construction of city distribution systems have been consistently underfulfilled by substantial margins. It seems quite likely that these same difficulties will continue to contribute to underfulfillment of production plans during 1962-65.

Construction of gas transmission lines has proceeded at planned rates only because the USSR has been able to import substantial quantities of large-diameter line pipe almost exclusively from non-Bloc countries. Line pipe could become a bottleneck for the gas industry in the period 1962-65 only if Soviet planners do not avail themselves of relatively plentiful supplies from non-Bloc countries. It is doubtful that production of domestic pipe will be adequate to meet the requirements for 40-inch pipe for both the gas and the oil industries. Consequently, it is anticipated that heavy demand probably will continue to be made on Free World suppliers of pipe. Any delays in deliveries of 40-inch pipe -- which could result from overoptimistic expectations of increases in the domestic capacity to manufacture it -- probably would cause delays in construction of the gas transmission lines and would cause underfulfillment of the plan for production.

During the entire postwar period and particularly in 1959-61 the inability to develop and mass-produce satisfactory prime movers for use at compressor stations on transmission lines probably has been the most serious single obstacle to even faster growth of the gas industry in the USSR. Deficits in installation of compressors that developed during 1959-61 probably will not be made up during 1962-65. As a result, pipelines will continue to be used at less than potential throughput capacities, and extraction of gas will be retarded.

Annual plans for exploratory drilling for gas were fulfilled by only 85 percent during 1959-61. Furthermore, annual plans were set even lower than the original control figures of the Seven Year Plan. Thus it seems extremely doubtful that the volume of exploratory drilling for gas set in the original plan will be achieved. In

C-O-N-F-I-D-E-N-T-I-A-L

certain regions, shortfalls in drilling volumes combined with continued relatively small additions to reserves per meter drilled have resulted in gross shortfalls in additions to reserves. In Komi ASSR and the Urals-Volga region of the RSFSR, as well as in Azerbaydzhan SSR, lags in additions to proved reserves could result in failure to meet original extraction targets for 1965. On the other hand, other regions, in spite of lags in exploratory drilling, have exceeded plans for additions to reserves. In Uzbek SSR, for example, reserves sufficient to sustain levels of extraction planned for 1965 are already available.

As indicated above, certain bottlenecks have developed that have retarded the growth of production of gas in the USSR. As a result the substitution of gas for other fuels has not proceeded as rapidly as was originally anticipated, and it probably will not. Moreover, it is estimated that the potential saving in rubles resulting from the substitution of gas for other fuels was substantially overstated in original Soviet calculations. Even after allowing for the overstatement, however, the saving in rubles will be substantial. In 1962-65 as in 1959-61 the substitution of gas for other fuels will make a significant contribution to increasing efficiency in the Soviet economy.

C-O-N-F-I-D-E-N-T-I-A-L

APPENDIX A

SOVIET GAS RESERVE CATEGORIES

The following is a summary description of the Soviet classification proved reserves, which is the sum of A_1 , A_2 , and B reserves. A_1 reserves include those that can be extracted from wells that were drilled in fields where there is great confidence that the geology of the beds is relatively well understood. The condition of the beds and their pressures and structures have been studied on the basis of producing wells. A_2 reserves are calculated for fields that have been contoured with wells. The character of the producing horizons, the condition of the beds, and the structure of the fields have been studied on the basis of exploratory wells. The quality of the gas has been studied on the basis of laboratory tests. B reserves are calculated for an area where the presence of wells with favorable characteristics has been shown and at least two wells of commercial capacity exist. The structure of the field is established, and the extent of the productive horizons has been approximately determined. Analysis of the extracted material has been made. The sum of A and B reserves usually is called proved reserves. 86/

C-O-N-F-I-D-E-N-T-I-A-L

C-O-N-F-I-D-E-N-T-I-A-L

APPENDIX B

METHODOLOGY

As stated in the body of this report, the substitution of gas for coal in the USSR during 1959-65 will result in an estimated saving of capital and labor valued at about 4.3 billion rubles -- 3.3 billion rubles in operating expenses and 1.0 billion rubles on capital expenditures. The procedures used for deriving this estimate are presented below.

1. Estimation of Planned Savings of Operation Expenses

A summary calculation of estimated savings in operating expenses is presented in Table 13.* A calculation of resource savings that would be appropriate if no modification of Soviet delivered cost and consumption data were made is presented in columns 5 and 6 of Table 14.** This calculation indicates a reduction in operating expenses of 1.13 billion rubles in 1965 and about 5.17 billion rubles during the period 1959-65. This latter figure is compatible with the 5.0 billion rubles cited in December 1958 by A.K. Kortunov, Chief of Glavgaz. These calculated savings, however, required adjustment to compensate for a number of computational and accounting deficiencies and for deviations from planned consumption and delivered cost.

a. Modifications for Inappropriate Amortization Norms

In general, Soviet amortization norms do not reflect full depreciation of the capital stock. The rates are frequently based on overoptimistic estimations of productive life and, therefore, result in incomplete amortization of capital items that are to be retired. Errors of this type have been made in estimating the service lives of equipment and structures used in the coal and gas industries. It is estimated that the reported cost of extraction in the coal industry would have been about 18 percent higher, and in the petroleum industry 4 percent higher, if adequate depreciation were charged. 87/ The adjustment refers only to extraction, but in the case of coal about 75 percent of delivered cost is due to costs of extraction. The delivered cost of coal, therefore, would have been about 14 percent higher if adequate depreciation were charged in the coal extracting industry and if depreciation charges associated with the transport of coal are assumed to have been completely adequate.***

* Table 13 follows on p. 32.

** Table 14 follows on p. 33.

*** Text continued on p. 34.

C-O-N-F-I-D-E-N-T-I-A-L

C-O-N-F-I-D-E-N-T-I-A-L

Table 13

USSR: Summary Calculation of Estimated Savings in Operating Expenses
Resulting from the Substitution of Natural Gas for Coal
1959-65

| | Billion New Rubles | |
|---|--------------------|---------|
| Savings | 1965 | 1959-65 |
| Planned savings <u>a/</u> | 1.13 | 5.17 |
| Modifications for: | | |
| Inappropriate amortization norms <u>a/ b/</u> | 1.41 | 6.33 |
| and | | |
| Estimated shortfalls in plans for reduction of delivered costs <u>a/ c/</u> | 1.54 | 7.03 |
| and | | |
| Complete regional coverage <u>d/</u> | 1.75 | 7.73 |
| and | | |
| Underfulfillment of consumption plans and for use of incremental consumption <u>e/</u> | 1.05 | 3.86 |
| and | | |
| Amortization charges on investment in exploration <u>f/</u> | | |
| Yields: Estimated savings | 0.94 | 3.31 |

a. Based on consumption in regions that were expected to account for 88 and 91 percent of the total gas consumption in 1965 and 1959-65, respectively. See Table 14, p. 33, below.

b. See p. 31, above.

c. See p. 35, below.

d. Previous results increased by 13.6 and 9.9 percent, respectively. See p. 35, below.

e. Previous results multiplied by 60 and 50 percent, respectively. See p. 36, below.

f. See p. 36, below.

C-O-N-F-I-D-E-N-T-I-A-L

Table 14

USSR: Calculation of Planned Savings in Operating Expenses
Resulting from the Substitution of Natural Gas for Coal a/
1959-65

| Region | Planned Consumption of Gas (Million MT/SF) <u>b/</u> | | Delivered Cost in 1965 <u>c/</u> (Rubles per MT/SF) | | Reduction in Operating Expenses (Billion New Rubles) | | | | | |
|------------------------|---|-------------------|--|------|---|---------|--|---------|--------------------------|---------|
| | 1965 <u>d/</u> | 1959-65 <u>e/</u> | Coal | Gas | No Modification <u>f/</u> | | Realistic Depreciation Schedule <u>g/</u> | | Delivered Cost <u>h/</u> | |
| | | | | | 1965 | 1959-65 | 1965 | 1959-65 | 1965 | 1959-65 |
| I. North and Northwest | 7.2 | 34.6 | 13.04 | 3.20 | 0.07 | 0.34 | 0.09 | 0.43 | 0.10 | 0.47 |
| II. West | 5.4 | 15.2 | 10.92 | 2.50 | 0.05 | 0.13 | 0.06 | 0.16 | 0.06 | 0.18 |
| III. South | 33.4 | 175.7 | 8.47 | 1.30 | 0.24 | 1.26 | 0.29 | 1.51 | 0.32 | 1.68 |
| IV. Southeast | 15.5 | 64.7 | 8.25 | 1.30 | 0.11 | 0.45 | 0.13 | 0.54 | 0.14 | 0.60 |
| V. Transcaucasus | 13.8 | 72.4 | 10.49 | 1.70 | 0.12 | 0.64 | 0.15 | 0.77 | 0.16 | 0.85 |
| VI. Volga | 15.8 | 74.2 | 9.70 | 1.30 | 0.13 | 0.62 | 0.16 | 0.74 | 0.18 | 0.83 |
| VII. Central | 33.1 | 149.1 | 11.29 | 1.70 | 0.32 | 1.43 | 0.38 | 1.72 | 0.42 | 1.91 |
| VIII. Urals <u>i/</u> | 32.9 | 104.4 | 6.28 | 3.42 | 0.09 | 0.30 | 0.15 | 0.46 | 0.16 | 0.51 |
| Total | 157.1 | 690.3 | | | 1.13 | 5.17 | 1.41 | 6.33 | 1.54 | 7.03 |

a. The conclusions regarding planned savings in operating expenses are based on 88 and 91 percent of the total consumption of gas in 1965 and 1959-65, respectively. Consumption of gas including Regions IX through XII would total 178.3 million metric tons of standard fuel for 1965 and 757.5 million metric tons of standard fuel for 1959-65. The substitution of gas for coal in Central Asia -- the major gas-consuming region not covered individually -- probably will result in some saving in operating expenses, as the cost of extracting gas is 4.1 rubles per metric ton of standard fuel less than the cost of extracting coal. 88/

b. Metric tons of standard fuel.

c. 89/. Average cost rather than incremental cost is used, and, therefore, the savings implied by the difference between the delivered cost of coal and the delivered cost of gas probably are understated.

d. 90/

e. Estimated on the basis of available data for 1959-61 and 1965.

f. Derived by multiplying the planned consumption of gas times the savings implied by the difference between the delivered cost of coal and the delivered cost of gas.

See p. 31, above.

g. Derived by increasing the delivered cost of coal by 14 percent and decreasing the delivered cost of gas by 20 percent. The new adjusted unit savings implied by the utilization of gas was then multiplied by the planned consumption of gas. The delivered cost of coal was adjusted to reflect a more realistic depreciation schedule in the coal extraction industry, and the delivered cost of gas was adjusted to reflect a more realistic depreciation schedule for gas transmission lines. See p. 31, above.

h. Modifications for estimated shortfalls in plans for reduction of delivered cost, derived by further adjusting the delivered cost of both coal and gas, including the initial adjustment noted in footnote g, above, and then multiplying the adjusted savings implied by the utilization of gas times the planned consumption of gas. See p. 35, below.

i. The use of the coal cost figure for the Urals probably understates the savings, as gas may be used, at least in part, in place of a more expensive, higher quality of coal.

C-O-N-F-I-D-E-N-T-I-A-L

C-O-N-F-I-D-E-N-T-I-A-L

Inappropriate depreciation norms actually may result in an overstatement of the delivered cost of gas. It has been argued that the service life of gas transmission lines probably is closer to 35 to 40 years than to the 16 to 17 years now used for accounting purposes. 91/ If it is conservatively estimated that the probable life of gas transmission lines is twice the period now allowed for depreciation, the transportation costs of gas can be adjusted to allow for a more realistic depreciation schedule. This adjustment is made by the following formula:

$$\frac{C_a}{C_b} = \frac{C_o + (a)(D)}{C_o + D} = \frac{1 + \frac{aD}{C_o}}{1 + \frac{D}{C_o}}$$

where C_a = average cost after the reform

where C_b = average cost before the reform

where C_o = cost other than amortization charges

a = factor by which the amortization charges
change as a result of more appropriate
amortization norms -- equivalent to 0.5

and D = amount of amortization charges

A value for $\frac{D}{C_o}$ of $\frac{12.38}{9.90}$ is given in source 92/.

Substitution of values yields: $\frac{C_a}{C_b} = \frac{1 + 0.5 \left(\frac{12.38}{9.90} \right)}{1 + \left(\frac{12.38}{9.90} \right)} = 0.72$

Applying this factor to the 75 percent of the total delivered costs represented by transportation costs and allowing for a 4-percent increase in the 25-percent share in delivered costs represented by extraction costs results in an estimate of delivered costs that is about 80 percent of the present level [effect on delivered cost = $(0.72)(0.75) + (0.25)(1.04) = 0.80$].*

The data shown in Table 14 for delivered costs were adjusted by using the factors derived above (a 14-percent increase for coal and a 20-percent decrease for gas) to allow for more realistic depreciation schedules. The results of this adjustment are presented in columns 7 and 8 of Table 14, which show the reduction of costs in



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C-O-N-F-I-D-E-N-T-I-A-L

1965 as 1.41 billion rubles and the reduction over the 1959-65 period as 6.33 billion rubles.

b. Modifications for Estimated Shortfalls in Plans
for Reduction of Delivered Costs

The delivered cost data adjusted for more realistic depreciation schedules required further adjustment to compensate for shortfalls in the plans for reduction of delivered costs.

The delivered costs of coal and gas shown in columns 3 and 4 of Table 14 probably are based on projected cost trends. At the time that Soviet officials made these projections -- and savings calculations -- it was expected that by 1965 the extraction costs for coal would be reduced to 17 percent below the level of 1958. Actually the All-Union average extraction costs for coal both in 1959 and in 1960 exceeded the level of 1958, as shown in Table 15.* It has been estimated that by 1965 the average cost of coal may be reduced to about 98 percent of the level of 1958, or to about 18 percent above the plan. Adjusted for an expected rise in calorific value, extraction costs of energy from coal will be about 15 percent above the plan. Rail freight costs are expected to decline at very close to planned rates during the Seven Year Plan. As the allocation of productive services to the gas industry probably will not be reduced below planned amounts, and as the production goal probably will not be achieved, the anticipated reduction in average delivered costs of gas also will not be achieved. It is estimated that the delivered costs of both coal and gas will exceed the plan by about 11 percent during 1959-65. The absolute difference between them, however, will increase significantly. Thus deviations from planned trends in delivered costs of coal and gas will contribute to larger-than-planned savings of productive services.

As shown in columns 9 and 10 of Table 14, the adjustment for failure to achieve planned reduction in delivered costs brought the estimated reduction in operating expenses up to 1.54 billion rubles in 1965 and 7.03 billion rubles for the Seven Year Plan period.

c. Modifications for Complete Regional Coverage

Calculations on estimated savings have been on the basis of Economic Regions I through VIII** and have amounted to only a part of the total.*** The results of the computations thus far

* Table 15 follows on p. 36.

*** See footnote a, Table 14, above.

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C-O-N-F-I-D-E-N-T-I-A-L

C-O-N-F-I-D-E-N-T-I-A-L

Table 15

USSR: Index of All-Union Average Extraction Costs
for Coal and Natural Gas a/
1958-60 and 1965

| | 1958 = 100 | |
|-------------|----------------|----------------|
| <u>Year</u> | <u>Coal</u> | <u>Gas</u> |
| 1958 | 100.0 | 100.0 |
| 1959 | 106.8 | 92.0 |
| 1960 | 104.4 | 90.7 |
| 1965 Plan | 83.0 | 37.9 <u>b/</u> |
| 1965 | 98.0 <u>c/</u> | 41.6 <u>c/</u> |

b. 95/
c. Estimated.

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are, therefore, increased by 13.6 percent for 1965 and 9.9 percent for 1959-65 to provide for complete regional coverage (Regions I through XII).

d. Modifications for Underfulfillment of Consumption Plans and for Use of Incremental Consumption

At this point the calculation of savings is based on the total consumption of gas anticipated by Soviet planners. Savings accruing during 1965 and 1959-65 should be based only on consumption of gas in excess of an estimated 53.2 million tons of standard fuel and 310.8 million tons of standard fuel, respectively. These are the amounts that would be consumed if gas should account for only 5.5 percent of the total consumption of primary energy during 1965 and 1959-65, as it did in 1958. Estimated consumption in excess of 53.2 million tons of standard fuel and 310.8 million tons of standard fuel will amount to about 60 and 50 percent of planned consumption in 1965 and 1959-65, respectively. These percentages are applied to the previous results to obtain 1.05 billion rubles for 1965 and 3.86 billion rubles for 1959-65.

e. Modifications for Amortization Charges on Investment in Exploration

Operating expenses of the Soviet gas industry should be adjusted for the lack of amortization charges on investment in

C-O-N-F-I-D-E-N-T-I-A-L

exploration. Capital expenditures normally charged to the coal and gas industries are counted first as capital expenditures and then as amortization charges included in the cost of production. Investment in predrilling activities and exploratory drilling probably should be treated in the same way.

During 1959-65, about 1.02 billion rubles in predrilling activities probably will not be included in investment in the gas industry. In addition, about 0.89 billion rubles of investment in exploratory drilling will not be amortized by the gas industry. The official system of accounting for oil and gas extraction requires writing off the cost of unsuccessful exploratory wells as losses that do not add to capital assets. Exploratory wells that later become producing wells are entered on the books at the same rate as a comparable developmental well, even though the cost in general for an exploratory well exceeds that of a comparable developmental well by approximately 50 percent. ^{96/} About one-half of all exploratory wells now become producing wells. ^{97/} If it is assumed that this rate continues to be true in the future, about one-half of the 1.33 billion rubles of investment will be amortized but at a rate sufficient to cover only two-thirds of the actual outlays. Thus 0.89 billion rubles in addition will be charged to the state budget for a total of about 1.9 billion rubles during the period 1959-65.

It is estimated that charges for amortization of investment in predrilling activities and in drilling of unsuccessful exploratory wells would amount to about 0.11 billion rubles in 1965 and to 0.55 billion rubles during 1959-65. Consequently, the 1.05 billion rubles shown for reduction in costs in 1965 and the 3.86 billion rubles shown for reduction in costs during the Seven Year Plan period were reduced to 0.94 billion rubles in 1965 and 3.31 billion rubles for the entire period. These reductions in cost constitute savings in operating expenses estimated at about 0.94 billion rubles for 1965 and 3.31 billion rubles for the period 1959-65.

2. Estimation of Capital Savings

Capital savings are significantly overstated because of the failure to charge exploration expenditures to the gas industry. Predrilling fieldwork, which is regarded as being of such long-range character that it is financed directly from allocations in the state budget, ^{98/} nevertheless requires substantial resource allocation for optimal operation of the industry. Some Soviet writers have suggested that all expenditures connected with the search for gas should be charged to the industry. Such a procedure, it is argued, would provide a better basis for minimizing the allocation of resources required for satisfaction of the demand for energy.

C-O-N-F-I-D-E-N-T-I-A-L

C-O-N-F-I-D-E-N-T-I-A-L

The total expenditure for exploration for gas during the Seven Year Plan period is to amount to 2.35 billion rubles -- 0.77 billion rubles on fieldwork, 1.33 billion rubles on deep exploratory drilling, and 0.25 billion rubles on exploration support activities. The expenditure of 1.02 billion rubles on fieldwork together with exploration support activities probably was not included in investment in the gas industry. No great error will be involved if the entire 1.02 billion rubles are deducted from the total expected savings, for sums that are to be expended by the coal industry for such purposes are very small in comparison with those to be expended by the gas industry. The calculations are summarized in Table 16.*

3. Estimation of Savings Due to Increases in Thermal Efficiency and to Reductions in Fuel Losses

Not only will capital and current costs required per unit of thermal output be reduced, but also requirements for primary energy per unit of GNP will diminish as the consequence of the substitution of gas for other fuels. Several factors contribute to produce this result. Transportation and storage losses are lower for gas than for coal. In many processes, thermal efficiency is considerably higher when gas is consumed. In other processes the need for energy-consuming transformation of coal into gas, electric power, or coke is eliminated. 99/ Increases in thermal efficiency and expected savings of fuel are shown in Tables 17** and 18.*** If the production plan is fulfilled by only 90 percent, as is now estimated, savings accruing from the reduction in losses and from increases in thermal efficiency probably also will be only about 90 percent as large as those originally planned.

* Table 16 follows on p. 39.

** Table 17 follows on p. 39.

*** Table 18 follows on p. 40.

C-O-N-F-I-D-E-N-T-I-A-L

Table 16

USSR: Capital Savings
 Resulting from the Substitution of Natural Gas for Coal
 1959-65

| | | Billion New Rubles |
|--------------------------------|----------------|--------------------|
| Planned capital savings | | 2.0 <u>a/</u> |
| Less: | | |
| Expenditures on fieldwork | 0.77 <u>b/</u> | |
| Exploration support activities | 0.25 <u>b/</u> | |
| Total | <u>1.02</u> | |
| Estimated capital savings | | <u>0.98</u> |
| a. | <u>100/</u> | |
| b. | <u>101/</u> | |

Table 17

USSR: Planned Percentage Reduction in Energy Requirements
 Resulting from the Substitution of Natural Gas for Other Fuels a/
 1959-65

| Branch of Industry | Technological Process | Reduction in Energy Requirements (Percent) |
|-------------------------|---|---|
| Ferrous metallurgy | Substitution of gas for coke | 18 to 20 |
| Cement | Substitution of gas for solid fuel in rotary kilns | 4 to 4.5 |
| Brick | Substitution of gas for solid fuel in annular kilns | 10 to 20 |
| Glass | Substitution of gas for generator gas | 35 to 40 |
| Machine building | Equipping of mazut furnaces with gas burners | 2 to 3 |
| Machine building | Substitution of gas for mazut furnaces | 20 to 25 |
| Machine building | Substitution of gas for electric furnaces | 15 to 20 |
| Food | Substitution of gas for coal in boilers | 10 to 15 |
| Food | Substitution of gas for coal to heat ovens | 15 to 20 |
| Electric power stations | Substitution of gas for coal to heat boilers | 4 to 8 |
| Industrial boilers | Substitution of gas for coal | 7 to 25 |
| a. | <u>102/</u> | |

Table 18

USSR: Planned and Estimated Reduction in Energy Requirements
Resulting from the Substitution of Natural Gas for Other Fuels
1959-65

Million Metric Tons of Standard Fuel

| Sector of Substitution | Reduction in Energy Requirements | | | |
|----------------------------------|----------------------------------|-------------|----------------|-------------------|
| | Planned | | Estimated | |
| | 1965 <u>a/</u> | 1959-65 | 1965 <u>b/</u> | 1959-65 <u>c/</u> |
| Ferrous metallurgy | 2.3 | 9.6 | 2.1 | 8.7 |
| Cement | 0.5 | 1.8 | 0.4 | 1.6 |
| Engineering | 2.4 | 9.1 | 2.2 | 8.3 |
| Electric power stations | 2.4 | 11.8 | 2.2 | 10.7 |
| Industrial boilers | 4.5 | 19.3 | 4.0 | 17.6 |
| Other industry | 2.0 | 8.8 | 1.8 | 8.0 |
| Residential and communal service | 7.0 | 31.0 | 6.3 | 28.3 |
| Total | <u>21.1</u> | <u>91.4</u> | <u>19.0</u> | <u>83.2</u> |

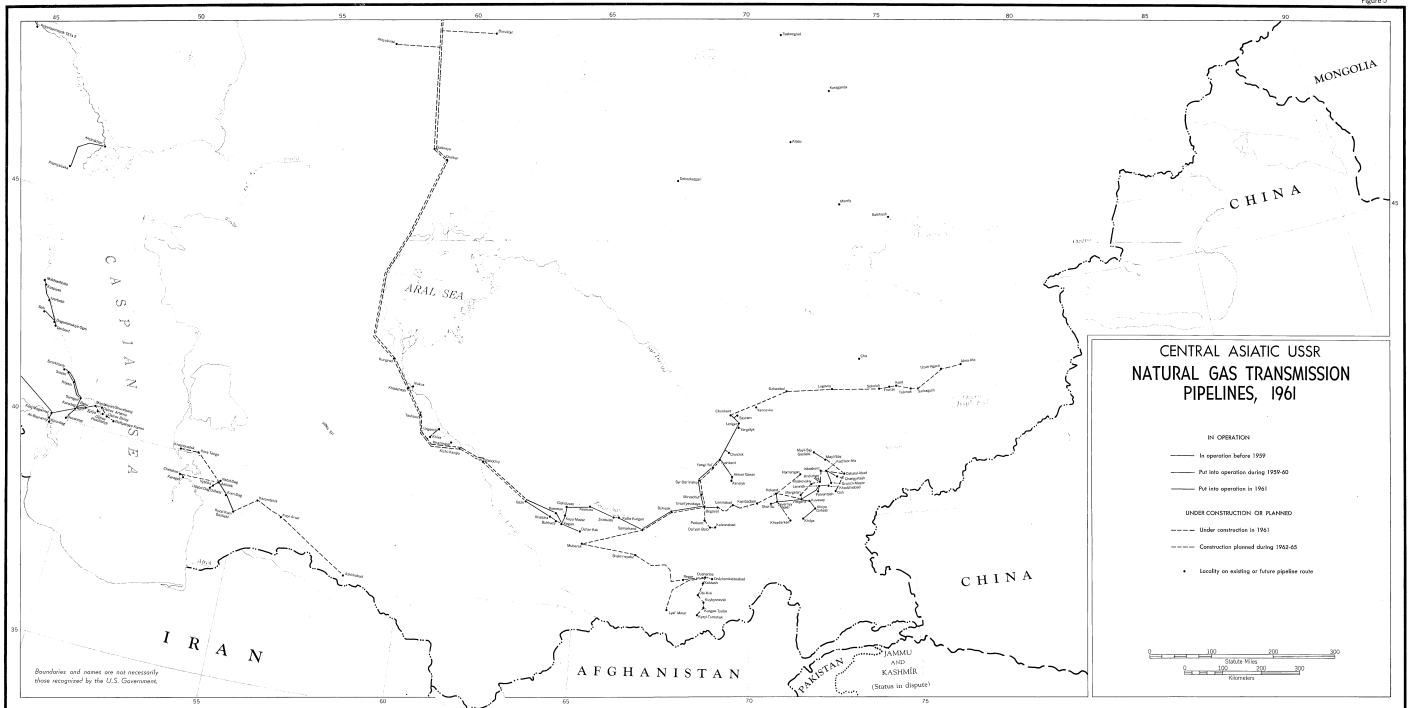
a. 103/

b. Planned reduction in energy requirements adjusted by the extent of the expected shortfall in production.

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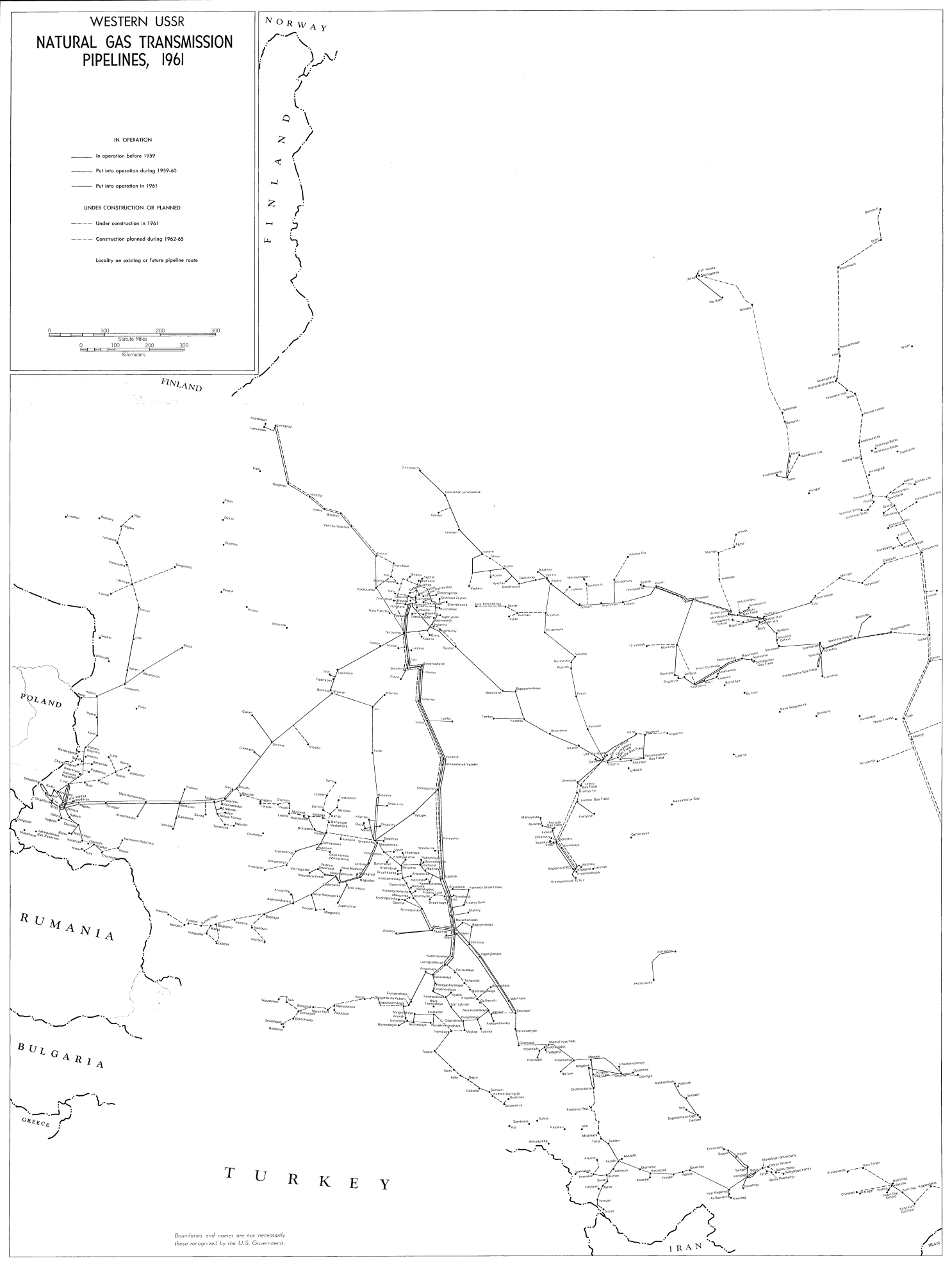
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WESTERN USSR NATURAL GAS TRANSMISSION PIPELINES, 1961

- IN OPERATION**
- In operation before 1959
 - Put into operation during 1959-60
 - Put into operation in 1961
- UNDER CONSTRUCTION OR PLANNED**
- - - Under construction in 1961
 - - - Construction planned during 1962-65
- Locality on existing or future pipeline route



Boundaries and names are not necessarily those recognized by the U.S. Government.

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