PROVISIONAL INTELLIGENCE REPORT

SELECTED INPUTS FOR THE EXTRACTIVE PHASE OF THE PETROLEUM INDUSTRY IN THE URAL-VOLGA AREA OF THE USSR

CIA/RR PR-141
6 June 1956

CENTRAL INTELLIGENCE AGENCY

OFFICE OF RESEARCH AND REPORTS

WARNING

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

Approved For Release 1999/09/26 : CIA-RDP79-01093A001100050001-1

S-E-C-R-E-T

PROVISIONAL INTELLIGENCE REPORT

SELECTED INPUTS FOR THE EXTRACTIVE PHASE OF THE PETROLEUM INDUSTRY IN THE URAL-VOLGA AREA OF THE USSR

CIA/RR PR-141

(ORR Project 25.683)

NOTICE

The data and conclusions contained in this report do not necessarily represent the final position of ORR and should be regarded as provisional only and subject to revision. Comments and data which may be available to the user are solicited.

CENTRAL INTELLIGENCE AGENCY

Office of Research and Reports

S-E-C-R-E-T

Approved For Release 1999/09/26 : CIA-RDP79-01093A001100050001-1

FOREWORD

This report is a formal research effort to determine the quantity and cost of selected inputs for the Soviet petroleum industry. Although its scope is limited to an analysis of the inputs necessary to discover and develop the petroleum resources of the Ural-Volga area, the methodology provides a basis for similar input studies of the extractive phase of the industry in other areas of the USSR and in the USSR as a whole. On the basis of the techniques employed in this report, it may be possible to expand the scope of future reports to include related information on other phases of the Soviet petroleum industry.

The selection of the inputs covered in this report was governed by the relative importance of the specific inputs and the information available. Data on some relatively important inputs were unavailable or were too fragmentary to warrant inclusion.

To provide a means of evaluating the level of efficiency in the extractive phase of the petroleum industry in the Ural-Volga area, data on certain important inputs for the oilfields of Alberta, Canada, have been included in the report. Alberta was selected because of its similarity to the Ural-Volga area in climate, geology, and relative development of petroleum resources.

CONTENTS

Appendixes

Tables

CIA/RR PR-141
(ORR Project 25.683)

SELECTED INPUTS FOR THE EXTRACTIVE PHASE OF THE PETROLEUM INDUSTRY IN THE URAL-VOLGA AREA OF THE USSR*

Summary

Production of petroleum in the Ural-Volga area** of the USSR has increased much more rapidly since World War II than has production in other areas of the USSR. Before World War II the Ural-Volga area produced only 6 percent of total Soviet production of petroleum; in 1955 the Ural-Volga area accounted for 58 percent of the total. During the period between 1945 and 1955 the drilling operations of the petroleum industry in the Ural-Volga area, in terms of meters drilled, increased from about 275,000 to about 2.3 million.

The input requirements for the extractive phase of the petroleum industry in the Ural-Volga area have increased commensurately with the increase in exploratory and developmental drilling. The number of operating drilling rigs in the area increased from about 110 in 1946 to about 520 in 1954, and the number of workers employed in drilling crews increased from about 2,100 to about 8,500 during the same period. Inputs of tubular goods increased from about 22,000 metric tons*** in 1946 to about 149,000 tons in 1954, and inputs of oil well cement increased from about 5,500 tons to about 47,500 tons.

Comparison of the input requirements for the extractive phase of the petroleum industry in the Ural-Volga area with those of the industry in Alberta, Canada, a major petroleum area in the Free World in which climate and geology are similar to those in the Ural-Volga area, indicates that the industry in the Ural-Volga area has a relatively low level of efficiency. In terms of the quantity of inputs required for a given meterage of drilling, the Ural-Volga operations are much less efficient than those in Alberta. In the Ural-Volga

* The estimates and conclusions contained in this report represent the best judgment of ORR as of 1 April 1956.

** The Ural-Volga area includes parts of Economic Regions VI, VII, and VIII. (The term region in this report refers to the economic regions defined and numbered on CIA Map 12048.1 (First Revision, 7-52), USSR: Economic Regions.)

*** Except as noted, tonnages are given in metric tons throughout this report.

area, for example, a rig drills one-third as many meters of hole per year as does a rig in Alberta and consumes 5 times as much drill pipe and 70 percent more casing per meter drilled. Estimated inputs for the extractive phase of the petroleum industry in the Ural-Volga area in 1946, 1954, and 1960 are shown in Table 1,* and comparative data on operations in the Ural-Volga area and Alberta are shown in Tables 11, 12, 13, and 14.**

The difficulty of drilling in the Ural-Volga area and the inferior quality of the Soviet materials used make requirements for drill pipe and bits unusually large. Because Soviet drill pipe wears out less rapidly in turbine drilling than in rotary drilling, the emphasis has been on turbine drilling in the Ural-Volga area. In spite of this emphasis, drilling bits wear out much more rapidly in the Ural-Volga area than in other parts of the USSR, and about 70 percent of all the 3-cone rock bits consumed in the USSR in 1954 were used in the Ural-Volga area.

The use of water as a drilling fluid has reduced the requirements for clays and soda products in the Ural-Volga area; but where it is not feasible to use water alone, there is still a shortage of good-quality clays for drilling fluids.

The petroleum industry in the Ural-Volga area is using electric power in increasing amounts as the supply of electric power in the area increases. At the end of 1955, however, the supply was not sufficient to electrify all operations of the extractive phase of the industry, and much of the drilling was still powered by diesels. The anticipated increase in the supply of electric power in the area will result in an increase in the consumption of electricity for drilling and for pumping the water used in flooding operations.

Apparently there is an ample supply of labor in the Ural-Volga area, but poor management has resulted in considerable idleness and wasted man-hours, and there is a critical shortage of trained technicians to operate and repair the complex mechanized equipment that is beginning to be used in the oilfields.

---

* Table 1 follows on p. 3.

** Pp. 39, 40, 41, and 42, respectively, below.

Table 1

Estimated Inputs for the Extractive Phase of the Petroleum Industry
in the Ural-Volga Area
1946, 1954, and 1960

Inputs	1946	1954	1960
Drilling rigs	99 to 124	502 to 533	710 to 753
Drilling bits a/	N.A.	118,000 to 126,000	167,000 to 178,000
Tubular goods (metric tons) a/	20,000 to 24,000	144,000 to 154,000	204,000 to 217,000
Oil well cement (metric tons) a/	5,000 to 6,000	46,000 to 49,000	66,000 to 70,000
Electric power (million kilowatt-hours)	N.A.	550 to 650	780 to 920
Labor (workers in drilling crews only)	1,750 to 2,500	7,500 to 9,500	10,600 to 13,400

a. Figures have been rounded to the nearest 1,000.

Approved For Release 1999/09/26 : CIA-RDP79-01093A001100050001-1

The discovery and development of the petroleum resources in the Ural-Volga area require large expenditures of capital. It is estimated that between 2 billion and 3.8 billion rubles were spent in the extractive phase of the petroleum industry in the Ural-Volga area in 1954. Of this amount, from 800 million to 1.15 billion rubles, about 25 percent of the total investment in the Ural-Volga petroleum industry, were invested in the drilling of wells.

The construction of supply and repair bases and of power, water, and transportation facilities has not been adequate for the needs of the Ural-Volga oilfields. To continue the rapid development of the petroleum resources of the area, large capital expenditures for such construction will be necessary.

I. Introduction.

A. General.

The extractive phase of the petroleum industry includes all operations of geological and geophysical prospecting, the drilling of exploratory ("wildcat") wells and of developmental wells in discovered fields, the production of crude oil from the wells and its treatment in the oilfields, and the transport and storage of the crude oil within the oilfields. For the purposes of this report, the term drilling operations refers to the drilling of both exploratory wells and developmental wells, and the term producing operations refers to the production of crude oil from completed wells and the treatment, transport, and storage of crude oil within the oilfields.

Inputs for which estimates are given in this report were selected on the basis of relative importance and available information. About 75 percent of the total inputs into the extractive phase of the petroleum industry in the Ural-Volga area are discussed. Because of the lack of pertinent data, estimates of the inputs into the geological and geophysical prospecting operations and into the facilities for treating and storing crude oil in the oilfields are not included.

The Ural-Volga area, also known as the "Second Baku," covers about 475,000 square miles in the eastern European USSR. It includes the oilfields in the Kama valley in Molotovskaya Oblast, the important fields of the Bashkirskaya and Tatarskaya ASSR's, the Buguruslan fields in Chkalovskaya Oblast, the fields along the Volga River in Kuybyshevskaya Oblast, and the oil and gas producing areas of the Saratovskaya and Stalingradskaya Oblasts in the lower Volga area.

Since World War II the Ural-Volga area has developed rapidly. Production of petroleum in the Ural-Volga area has increased from 6 percent of the total petroleum produced in the USSR in 1940 to 58 percent of the total in 1955. 1/* Estimates of the potential petroleum resources in this area indicate that the importance of the Ural-Volga area will continue to increase during the next 10 to 15 years. 2/ According to Soviet estimates, about 75 percent of the total petroleum production of the USSR in 1960 will be obtained from the Ural-Volga oilfields. 3/

Since World War II the fields of the Bashkirskaya ASSR have produced more than two-thirds of the cumulative total production of the Ural-Volga area, 4/ and in 1955 the Bashkirskaya ASSR became the leading petroleum producing region in the USSR. 5/ Since 1950 the oilfields of the Tatarskaya ASSR have also been developed rapidly, 6/ and in 1955 the production of the Tatarskaya ASSR was reported to equal that of Baku. 7/ The Tatarskaya and Bashkirskaya ASSR's together probably produced from 80 to 85 percent of the total Ural-Volga production in 1955.

B. Comparison of the Ural-Volga Area with Alberta, Canada.

In order to evaluate the level of efficiency in the extractive phase of the petroleum industry in the Ural-Volga area, this report includes a comparison of the inputs required in that area and those required in a similar petroleum region in the Free World. The similarity of Alberta, Canada, to the Ural-Volga area in climate, geological conditions, and relative stage of development led to the selection of Alberta as the best available region to use for such a comparison.

* For serially numbered source references, see Appendix C.

The development of the petroleum resources of Alberta began to expand rapidly in 1946-47. The USSR began intensive development of the Ural-Volga area at about the same time. In both regions, production and drilling operations have increased at a rapid rate through 1955 and are expected to continue to increase. Production of crude oil in the Ural-Volga area increased from 3.7 million tons in 1946 to 22.1 million tons in 1954, and in Alberta, production increased from 960,000 tons in 1946 to 11.8 million tons in 1954.* Drilling operations in the Ural-Volga area during the same period increased about 8 times and in Alberta about 14 times.**

The climate in both areas complicates the development of the petroleum resources. The areas are located in approximately the same latitude. Both are bounded on the north by the 60th parallel; on the south, Alberta is bounded by the 49th and the Ural-Volga by the 48th parallel. Both areas have extremely cold winters, which last about 6 months. In Alberta, average winter temperatures are -3°F in the northern part and 18°F at Calgary. In the Ural-Volga area the average winter temperatures range from about -5°F to 15°F. The summer temperatures average about 75°F in the southern part of both areas. 8/ The severe winter cold in these areas requires the construction of boiler installations and steam pipelines to keep drilling fluid from freezing and to keep crude oil flowing in pipelines. 9/ In the Ural-Volga area, between October and May there is only one-third as much drilling as there is during the summer months, because of the difficulty of delivering supplies and completing construction work. 10/ In Alberta, on the other hand, drilling operations increase during the winter -- heavy equipment and supplies can be moved much more easily over frozen ground than over the wet muskeg in the summer months. 11/

Wells drilled in Alberta penetrate rocks of the same geologic age as those in the Ural-Volga area. In both areas the major part of production comes from the Devonian formations. 12/ The very hard rocks of these formations make drilling considerably more difficult

* The area of Alberta is only 225,000 square miles, less than half as large as the Ural-Volga area.

** The production of both areas is shown in Table 11, p. 39, below, and the drilling operations in Table 12, p. 40, below.

in both areas than in the southern and western areas of the USSR and on the Gulf coast of the US. Most of the wells drilled in both areas are of approximately the same depth.*

The lack of transportation facilities handicaps the development of the petroleum resources in the two areas. In Bashkirskaya ASSR, where the largest Ural-Volga oilfields are located, there were less than 10 kilometers of railroad per 1,000 square kilometers of area in 1950, 13/ and in 1947 there were only about 20,000 kilometers of dirt and improved roads. 14/ Because many of the roads in the Bashkirskaya ASSR are impassable to truck traffic in the winter, tractors provide the only means of transportation to many exploratory drilling sites. 15/ In Alberta there are only about 22 miles of railroad and 315 miles of highway for every 1,000 square miles of area, 16/ and there also tractors furnish the only transportation to many remote drilling sites.

The oilfields of both the Ural-Volga area and Alberta are at considerable distances from the source of supplies and equipment. Most of the supplies and equipment used in Alberta are shipped from US suppliers. The petroleum industry in Alberta has apparently had sufficient equipment available at all times, even during the Korean War. The Ural-Volga area receives its supplies and equipment from many parts of the USSR, and most of the basic types of equipment and supplies are generally available in adequate quantity to supply the needs of the oilfields. The distribution of these supplies to the drilling crews, however, is frequently badly organized and hampered by lack of transportation facilities. In some areas, equipment often is allowed to deteriorate in warehouses while in other areas drilling crews have to wait for deliveries. Supply bases are frequently at considerable distances from the drilling sites, and there are too few repair bases to keep equipment in operating condition. As a result, new equipment is frequently used to replace equipment that repair would make serviceable. 17/

One problem of the Ural-Volga area is the shortage of water for water-flooding operations. Water flooding (pressure maintenance) was first introduced in 1948, particularly in the oilfields of Bashkirskaya and Tatarskaya ASSR's. 18/ There is not enough water in these areas, however, to make flooding completely effective. 19/ Although

* See Table 12, p. 40, below.

the Karabash reservoir, under construction on the River Ik, will supply industrial water for flooding purposes to some of the oilfields of Tatarskaya ASSR, 20/ the shortage of water for flooding probably will continue to be a problem in much of the Ural-Volga area. In Alberta, water flooding has not been introduced.

In the Ural-Volga area, electric power is the most economical type of power and is widely used in all oilfield operations. Sufficient electric power is not available, however, for the complete electrification of all operations, and other types of power have had to be substituted for electricity -- particularly in drilling. 21/ The completion of the large hydroelectric power stations under construction in the Volga basin 22/ may help to alleviate this shortage. In Alberta, other types of power are more economical for drilling, and electric power is used much less than in the Ural-Volga area.

C. General Methodology.

Estimated annual drilling and wells completed in the Ural-Volga area in 1946 and 1954 are shown in Table 2.* Estimated annual drilling and wells completed in the Tuymaza oilfields of Bashkirskaya ASSR in 1946 and 1951-54 are shown in Table 3.** All input estimates in this report are based on these estimates of the volume of drilling operations.

In order to develop estimates of inputs into the extractive phase of the petroleum industry in the Ural-Volga area, it was necessary to determine the volume of the drilling operations in all of the oil producing fields and prospecting areas. Postwar statistics for annual drilling meterage and number of wells completed in the entire Ural-Volga area or in any significant part of it have not appeared in Soviet publications. The estimates made for the area as a whole, therefore, can be only rough approximations of the actual figures. Research revealed, however, that there was available some information which permitted fairly reliable estimates of annual drilling meterage and number of wells completed in the Tuymaza oilfields of Bashkirskaya ASSR. The margin of error for estimates of the drilling operations in the Tuymaza oilfields is, therefore, considerably smaller than for those of the Ural-Volga area as a whole.

The Tuymaza oilfields are the most important in Bashkirskaya ASSR and in the entire Ural-Volga area. Throughout the postwar period the Tuymaza oilfields have produced the major portion of the Bashkir crude oil and about 30 to 40 percent of the total Ural-Volga production. 23/ The Tuymaza fields are located in the central part of the

* Table 2 follows on p. 9.
** Table 3 follows on p. 10.

Table 2

Estimated Annual Drilling and Wells Completed in the Ural-Volga Area
1946 and 1954 a/

Oil Producing Areas	1946 Drilling (Thousand Meters)	1946 Number of Wells	1946 Average Depth of Wells (Meters) b/	1954 Drilling (Thousand Meters) c/	1954 Number of Wells	1954 Average Depth of Wells (Meters) b/
Bashkirskaya ASSR	105 to 120 d/	66 to 75	1,600	765	450	1,700
Tatarskaya ASSR	e/			750	430	1,750
Kuybyshevskaya Oblast	80 to 90 f/	73 to 82	1,100	335 to 345	186 to 192	1,800
Molotovskaya Oblast	25 to 30 g/	13 to 16	1,900			
Saratovskaya Oblast	20 to 25 h/	22 to 28	900			
Chkalovskaya Oblast (Buguruslan), Stalingradskaya Oblast, and others	20 to 35 i/	27 to 47	750	400 to 540	222 to 300	1,800
Total	250 to 300	200 to 250	1,225	2,250 to 2,400	1,290 to 1,370	1,750

a. Totals and averages have been rounded and do not always agree with actual sums or averages of the components. The estimated range of error for the estimates is plus or minus 20 percent.
b. The average well depths were estimated from the geological study of the Ural-Volga area 24/ and from source 25/. In 1954 the majority of wells in new producing regions were drilled to depths of 1,600 to 2,000 meters. 26/
c. Estimates for 1954 drilling meterage were derived from a study of the organization of the drilling offices operating in the Ural-Volga area, a study which is available in CIA files. These data are recognized to be incomplete, and allowances have been made for drilling organizations which are believed to exist but of which no positive identification has been made. Each drilling office is estimated to have had approximately 10 drilling crews, 27/ and each crew is estimated to have drilled 4,000 to 5,000 meters during 1954. 28/
d. The estimate includes some drilling by the Tuymaza Oil Trust in the Tatarskaya ASSR. 29/
e. Some drilling was done in Tatarskaya ASSR by the Bashkir Oil Association, and the meterage was included in the estimate for Bashkir (see note d).
f. Estimated on the basis of the plan to drill about 1 million meters in the Fourth Five Year Plan, (1946-50), which was 4.5 times as much as had been drilled in the previous 5 years. 30/
g. Estimated on the basis of a report that only 10 rigs were operating in Molotovskaya Oblast. 31/
h. There were 19 wells in January 1945, and it was planned to drill 35 developmental and 9 exploratory wells, a total of 40,000 meters. 32/ In 1947 the Saratov oil workers pledged to increase the total number of gas wells to 60. 33/
i. Estimated.

Approved For Release 1999/09/26 : CIA-RDP79-01093A001100050001-1

Table 3

Estimated Annual Drilling and Wells Completed in the Tuymaza Oilfields of Bashkirskaya ASSR 1946 and 1951-54

Year	Drilling (Thousand Meters)	Number of Wells a/	Percent of Total Ural-Volga Drilling b/
1946	99 c/	58	30.3 to 39.6
1951	137 d/	81	N.A.
1952	156 e/	92	N.A.
1953	260 f/	153	N.A.
1954	280 g/	165 b/	11.7 to 12.4

a. The number of wells drilled was computed on the basis of an average depth of 1,700 meters. 34/

b. Computed from data in Table 2, p. 9, above.

c. In January 1947, 22 percent of the drilling in the eastern areas was reported to be concentrated in Tuymaza. 35/ The total drilling meterage of the eastern areas is estimated to be about 450,000 meters because only about 340,000 meters had been drilled during the first 9 months. 36/

d. Drilling in 1954 was 204 percent of the 1951 drilling meterage. 37/ (See note g, below.)

e. Drilling in 1952 was 114 percent of the 1951 drilling meterage. 38/

f. Drilling in 1953 was 190 percent of the 1951 drilling meterage. 39/

g. The estimate of the drilling meterage for 1954 was derived in two ways. The annual drilling plan called for 170 new wells. 40/ The plan for drilling wells was apparently not met, 41/ although probably more than 160 wells were completed. 42/ It is estimated that about 165 wells with a total of about 280,000 meters were drilled. The majority of the drilling crews in the Bashkirskaya ASSR were reported to be drilling at the rate of 4,000 to 5,000 meters per year in 1954. 43/ The 56 crews of Tuymaza, 44/ averaging 5,000 meters each, could have drilled about 280,000 meters.

Ural-Volga area, and the geological and climatic conditions are fairly typical of all Ural-Volga oilfields. For these reasons and because of the greater reliability of input estimates based on the more reliable drilling data, estimates for the inputs in the Tuymaza oilfields have, in all cases, been included in the report. When data have been too fragmentary to permit estimates for certain input requirements for the Ural-Volga area as a whole, it has sometimes been possible to make such estimates for the Tuymaza oilfields, and these estimates have been included.

II. Inputs in the Ural-Volga Area.

A. Materials and Equipment.

1. Drilling Rigs.

The following types of rigs for developmental and deep exploratory drilling are being manufactured in the USSR 45/*:

Name of Rig	Type of Drilling	Maximum Depth of Drilling (Meters)
UZTM-1M (with group diesel drive and 2 U8-3 pumps)	Rotary, turbine**	3,500
Uralmash 3 D	Rotary, turbine	5,000***
Uralmash 4 E	Rotary, turbine	5,000***
Uralmash 6 D	Rotary, turbine	3,000
Uralmash 5 D	Rotary, turbine	3,000
BU-40	Rotary	1,200
BSShL-150 with electric drive	Rotary, turbine	2,500
BSShL-150 with SAL-III and SAN-I drive	Rotary	2,500
Godzhayev rig with electric drive	Rotary	3,000

* Complete specifications for the equipment used on each type of drilling rig are given in the same source.

** Rotary drilling is a method of drilling whereby a rotary table rotates the entire drilling string, which in turn rotates the bit. In turbine drilling, the drill string does not rotate, and the bit is rotated by a turbine at the bottom end of the drill string. Most types of rigs can drill by either the rotary or the turbine method, but some are not suitable for turbine drilling, as indicated in this tabulation.

*** A 200-ton block-and-tackle system was used in drilling to this depth.

The rigs most commonly used in the Ural-Volga area are those produced by the Ural Heavy Machine Building Plant (UZTM). 46/ The drilling rigs Uralmash 5 D and Uralmash 3 D are reported to be giving better service than are other types of rigs in use in the Ural-Volga area. 47/

Portable rigs also are manufactured and are used for shallow exploratory wells. These small rigs are used usually for the preliminary exploration of new areas in preparation for deep exploratory drilling. 48/

Steel derricks are now in general use. The "jack-knife" mast has not been adopted in the USSR as widely as it has in the US and is used mainly for shallow wells. The derricks are 28, 41, or 53 meters high and are made of "structural rolled iron" (sic) or used drill pipe. 49/ The 41-meter derrick, which is used for drilling to depths of 1,500 to 3,500 meters, 50/ probably is the size most commonly used in the Ural-Volga area, as the depths of most Ural-Volga wells are within that range.

The Tuymaza Oil Drilling Trust and the drilling trusts of the Tatarskaya ASSR probably have the most modern and efficient equipment of any oil producing regions in the USSR. By 1954, Tuymaza had replaced almost all of its obsolete equipment with modern equipment, 51/ and the Tatar oilfields, which have been developed since 1950, 52/ presumably have been supplied with the most modern drilling rigs.

Until 1954 the number of drilling rigs in operation in the Ural-Volga area had been increasing during the postwar period. In that year the number of rigs in operation was reduced in some parts of the area -- in the USSR as a whole the reduction amounted to 12 percent of the total. This trend continued in 1955. Drilling speeds have increased, however, so that more meterage is drilled with fewer rigs. 53/ Estimated drilling rigs in operation and wells drilled per rig in the Ural-Volga area as a whole and in the Tuymaza oilfields of the Bashkirskaya ASSR in 1946 and 1951-54 are shown in Table 4.* The number of rigs in operation given in Table 4 probably represents about 85 to 90 percent of the total number of rigs on hand. The remaining 10 to 15 percent probably are held in reserve or are undergoing capital repair. 54/

Although drilling speeds have been increasing in the USSR, the average speed is still far behind the US average, and the number of wells drilled per rig per year is still very small by US standards.**

* Table 4 follows on p. 13.

** In the US and western Canada an average of 18.2 wells were drilled by each rotary rig in 1954. 55/ In Alberta, 9.45 wells were drilled per rig compared with 2.57 in the Ural-Volga area (see Table 12, p. 40, below).

Table 4

Estimated Drilling Rigs in Operation and Wells Drilled per Rig in the Ural-Volga Area and in the Tuymaza Oilfields of Bashkirskaya ASSR a/ 1946 and 1951-54

	Ural-Volga Area		Tuymaza Oilfields	
Year	Rigs in Operation	Wells per Rig	Rigs in Operation	Wells per Rig b/
1946	99 to 124 c/	2.02 d/	40 e/	1.45
1951	N.A.	N.A.	43 f/	1.88
1952	N.A.	N.A.	52 g/	1.77
1953	N.A.	N.A.	68 f/	2.25
1954	502 to 533 c/	2.57 h/	56 f/	2.95

a. The estimates are for the maximum number of rigs in actual operation or in the state of being dismantled, moved, or constructed at any time during the year and do not include rigs in reserve or undergoing capital repair. The range of error for the estimates for the Ural-Volga area is plus or minus 20 percent and for Tuymaza, plus or minus 10 percent.

b. These estimates were computed from the data in Table 3, p. 10, above, and the third column of this table.

c. These estimates were computed from data in Table 2, p. 9, above, and from the data in the second column of this table.

d. This estimate was computed from the average meterage drilled per rig at Tuymaza (2,475 meters, derived from Table 3 and the third column of this table) and the estimated average well depth of 1,225 meters given in Table 2.

e. 56/

f. 57/ Each brigade is assumed to operate one rig.

g. 58/ Each brigade is assumed to operate one rig.

h. This estimate was computed on the basis of data from Table 2 and an average drilling meterage per rig of 4,500 meters, based on the statement that most crews in Bashkirskaya ASSR drilled 4,000 to 5,000 meters per year, 59/ an amount considered to be fairly typical of the entire Ural-Volga area. The Tuymaza average of about 5,000 meters and the Tatarskaya ASSR average of 5,333 meters 60/ are believed to be the highest in the Ural-Volga.

Although the hard-rock drilling in the Ural-Volga area requires that a large part of the drilling time be consumed in "trip"* operations for frequent bit changes, the greatest cause of the small output per rig appears to be the amount of time required to dismantle a rig, move it to a new location, and reassemble it for drilling the next well. Even the best drilling crew in the Tatarskaya ASSR, for example, had an average of 3 weeks of idle time between wells in 1953, 61/ and in many instances a month or more is required to construct the drilling rig. 62/ Although the USSR has developed a method of constructing movable foundations, which eliminates the necessity of dismantling the rig before moving it, this innovation has not been adopted generally. 63/ Because of a lack of mechanized equipment, much of the construction work is still done manually. 64/ Another reason for the small output of wells per rig is the amount of idle time that occurs during drilling as the result of organizational delays and shutdowns caused by accidents and repairs. 65/

2. Tubular Goods.

The types of tubular goods for which estimates have been made are drill pipe, casing, tubing, and field oil-gathering lines. Because of the lack of essential data, no estimates have been made for gas-gathering lines, water lines, or steam lines. Much of the gas produced is still being flared, however, 66/ and the meterage of gas lines is presumably much less than that of the oil-gathering lines. The severe winter climate requires the heating of pipelines, storage tanks, and other oilfield installations, so that the meterage of steam pipelines is probably equal to, or greater than, that of the oil-gathering lines. Estimated inputs of tubular goods in the Tuymaza oilfields of Bashkirskaya ASSR in 1946 and 1951-54 are shown in Table 5,** and estimated inputs of tubular goods in the Ural-Volga area in 1946 and 1954 are shown in Table 6.***

a. Drill Pipe.

Soviet drill pipe is made of rolled or cast open-hearth steel, mark D or mark E. The size of pipe**** ranges from a diameter

* A "trip" is the operation of pulling the entire drill string from the well, changing the bit, and lowering the drill string back into the hole to resume drilling.

** Table 5 follows on p. 16.

*** Table 6 follows on p. 17.

**** Soviet publications usually give pipe diameters in inches, as in the US, but use the metric system for other types of measurement.

of 2 7/8 inches to 6 5/8 inches, and the lengths range from 6 meters for pipe of the smallest diameter to 11.7 meters for pipe of the largest diameter. 67/

The average life of a string* of drill pipe in the Ural-Volga area is very short, according to US standards.** In turbine drilling in the USSR a string of drill pipe will be worn out after drilling only 4 or 5 wells. 69/ In rotary drilling, which causes greater stress on drill pipe, the life of a drill string is presumably shorter and may be only 1 or 2 wells. The poor performance of drill pipe in rotary drilling in the Ural-Volga area 70/ is certainly one of the chief reasons for the wide use of turbine drilling in that area. The new experimental electric drill,*** which has been tested at Tuymaza recently, has thus far proved to be more economical, for 8 to 10 wells can be drilled with 1 drill string. 71/ It is estimated that in 1954, 9.2 kilograms (kg) of drill pipe were used for every meter drilled in the Ural-Volga area; in Alberta, 1.8 kg of drill pipe were used per meter of drilling.**** The inferior quality of Soviet drill pipe, which

* A string is a column or series of pipe arranged with the necessary couplings for lowering into the hole.

** In the US a drill string drilled from 23 to 57 rotary wells in 1951, the number determined by the geological conditions. 68/

*** The electric drill consists of an electric motor installed at the bottom of the drill string to rotate the bit. As in turbine drilling, the drill string itself does not rotate.

**** See Table 13, p. 41, below.

Table 5

Estimated Inputs of Tubular Goods in the Tuymaza Oilfields of Bashkirskaya ASSR
1946 and 1951-54

Tubular Goods	1946		1951		1952		1953		1954	
	Meters	Metric Tons [a]	Meters	Metric Tons [a]	Meters	Metric Tons [a]	Meters	Metric Tons [a]	Meters	Metric Tons [a]
Drill pipe	65,725 [b]	1,900 [c]	34,425 [b]	1,000 [c]	39,100 [b]	1,100 [c]	61,200 [b]	1,800 [c]	65,450 [b]	1,900 [c]
Conductor casing	14,500 [d]	1,200 [e]	20,250 [d]	1,700 [e]	23,000 [d]	2,000 [e]	38,250 [d]	3,300 [e]	41,250 [d]	3,500 [e]
Production casing	99,000 [f]	3,900 [g]	137,000 [f]	5,300 [g]	156,000 [f]	6,100 [g]	260,000 [f]	10,100 [g]	280,000 [f]	10,900 [g]
Tubing	74,250 to 89,100 [h]	700 to 800 [i]	102,750 to 123,300 [h]	900 to 1,100 [i]	117,000 to 140,400 [h]	1,100 to 1,300 [i]	195,000 to 234,000 [h]	1,800 to 2,100 [i]	210,000 to 250,000 [h]	1,900 to 2,300 [i]
Oil-gathering lines	20,100 [j]	300 [k]	28,050 [j]	400 [k]	31,875 [j]	400 [k]	53,000 [j]	700 [k]	57,150 [j]	800 [k]
Total	273,575 to 288,425	8,000 to 8,100	322,475 to 343,025	9,300 to 9,500	366,975 to 390,375	10,700 to 10,900	607,450 to 646,450	17,700 to 18,000	653,850 to 693,850	19,000 to 19,400

a. Tonnage figures have been rounded. Weight is pipe only and does not include tool joints.
b. The estimates are based on the assumption that 4 wells were drilled with 1 drill string (1,700 meters) in turbine drilling, 1.5 wells per string in rotary drilling, and 8 wells per string in electric drilling. 72/ Because in 1946 less than 2 percent of the total drilling in Bashkirskaya ASSR was drilled by turbine drill, 73/ the drill pipe requirement was computed on the basis of 1.5 wells per drill string. In the years 1951-54, almost all wells were drilled by turbine drill. 74/ In 1953, 17 wells were drilled by electric drill and in 1954, 22 wells. 75/
c. Computed on the basis of 5 9/16-inch drill pipe weighing 29.3 kg per meter. 76/
d. Figures are derived by estimating the average length of the conductor string at 250 meters per well. 77/
e. Computed on the basis of 12 3/4-inch casing weighing 85.2 kg per meter. 78/
f. The production casing is estimated to be required for the entire meterage drilled.
g. Computed on the basis of 6 5/8-inch casing weighing 39 kg per meter. 79/
h. Tubing requirements are based on the estimate that from 75 to 90 percent of the total drilling results in productive wells requiring tubing.
i. Computed on the basis of 2 1/2-inch tubing weighing 9.16 kg per meter. 80/
j. The estimate is computed on the basis of 400-meter well spacing for which 25,000 meters of pipe are required for every 1,000 hectares. 81/ There is an average of 13.856 hectares per well with this spacing.
k. Computed on the basis of 4-inch pipe weighing 13.44 kg per meter. 82/

Approved For Release 1999/09/26 : CIA-RDP79-01093A001100050001-1

Table 6

Estimated Inputs of Tubular Goods in the Ural-Volga Area a/
1946 and 1954

Tubular Goods	1946		1954	
	Meters	Metric Tons b/	Meters	Metric Tons b/
Drill pipe	163,325 to 204,160 c/	4,800 to 6,000	705,825 to 749,575 d/	20,700 to 22,000
Conductor casing	30,000 to 37,500 e/	2,600 to 3,200	193,500 to 205,500 e/	16,500 to 17,500
Production casing	250,000 to 300,000 f/	9,750 to 11,700	2,250,000 to 2,400,000 f/	87,750 to 93,600
Tubing	162,500 to 195,000 g/	1,500 to 1,800	1,462,500 to 1,560,000 g/	13,400 to 14,300
Oil-gathering lines	69,275 to 86,600 h/	900 to 1,200	446,850 to 474,575 h/	6,000 to 6,400
Total	675,100 to 823,260	19,550 to 23,900	5,058,675 to 5,389,650	144,350 to 153,800

a. These estimates are derived on the basis of data in Table 2, p. 9, above. They are based on wells of average depth with two strings of casing. They do not include estimates for intermediate strings of casing.
b. Tonnage figures have been rounded. Weight is pipe only and does not include tool joints. The tonnage estimates were derived for all types on the same bases as were used in Table 5, p. 16, above.
c. The 1946 drilling was mainly by rotary method in which it is estimated that 1.5 wells were drilled with 1 drill string.
d. It is probable that about 85 percent of the drilling in the Ural-Volga area was by turbine drill in 1954. In the Bashkirskaya and Tatarskaya ASSR's, 95 to 100 percent was by turbine drill, 83/ and in the eastern regions as a whole, 75 percent was by turbine drill in 1953. 84/ In turbine drilling it was assumed that 4 wells were drilled with 1 drill string and 1.5 wells per drill string in rotary drilling, as shown in Table 5.
e. The average length of the conductor string was estimated to be 150 meters per well. 85/
f. The production casing is estimated to be required for the entire meterage drilled.
g. The meterage of tubing was based on the estimate that about 65 percent of the total drilling results in productive wells requiring tubing.
h. The estimate is computed on the basis of 400-meter well spacing, 13.856 hectares per well, for which spacing 25,000 meters of pipe are required for every 1,000 hectares. 86/

Approved For Release 1999/09/26 : CIA-RDP79-01093A001100050001-1

has not been greatly improved during the last 20 years, 87/ causes many accidents, particularly in rotary drilling. Even in the Baku region, where the rock formations are more easily drilled, in 1954 there were 241 accidents caused by failures of drill pipe. 88/*

b. Casing.

Soviet casing is either welded pipe or seamless pipe, made usually from carbon steels, mark A, mark S, or mark D, and sometimes from alloy steels, mark E or mark EM. 91/ The diameters of casing range from 4 3/4 inches to 20 1/2 inches, and pipe lengths range from about 6 meters to about 15 meters. 92/ Although there are 43 different sizes of casing listed in the Soviet GOST (Gosudarstvennyy obshchesoyuznyy standart -- All-Union State Standard), not all these sizes actually are produced, and the selection of casing is considerably smaller than it is in the US. 93/ Because of the small selection, casing of a larger diameter or with a greater wall thickness than is necessary or economical is sometimes used in Soviet oilfields.

In the Tuymaza oilfields the usual well construction consists of a conductor casing set to a depth of from 100 to 300 meters** and a production string set for the entire length of the well. The conductor string usually is of 10 3/4-, 12 3/4-, or 14 3/4-inch casing, and the production string is generally 6 5/8 inches in diameter. The more complicated deep exploratory wells may have 1 or 2 intermediate strings in addition to the conductor and production strings. 94/ The same type of well construction is employed throughout the Ural-Volga area, but in some regions a short length of surface casing, in addition to the conductor string, is set. 95/ Within the last year there has been a trend to conserve metal by the use of casing of smaller diameter and the elimination of the conductor and intermediate strings of casing. 96/ Although these steps are being taken in Stalingrad and Kuybyshev, there does not appear to have been much progress in the Ural-Volga area as a whole.

---

* Offshore exploratory drilling, more difficult than land drilling, is done usually by the rotary method, 89/ and in 1954 in the Baku area 27.3 kg of drill pipe were used for every meter drilled, three times as much as the permitted norm. 90/

** The conductor casing is set near the surface to prevent caving of the top soils and seepage of water.

An average Ural-Volga well, 1,750 meters deep with 2 strings of casing, is estimated to require 81 tons of casing, or 46.3 kg per meter.* The joints used to connect the casing together would bring the total amount of steel used in the casing strings to about 83.1 tons, as the joints add about 2 or 3 percent to the total weight of the casing strings.** In 1946 the Ural-Volga area used almost 70 percent more casing per meter drilled than did Alberta in that year.*** One reason for the greater casing inputs in the Ural-Volga area is that the Soviet industry apparently does not attempt to salvage casing from dry holes.**** It also seems to be standard practice in the Ural-Volga area to case all types of wells for the entire length of the hole instead of just to the production zone or to the degree that the geological conditions of the individual wells require.

The cost of casing is about 15 to 20 percent of the cost of drilling a well 99/ and 50 percent or more of the cost of materials for drilling. 100/ Some 1950 prices for casing indicate a wide variation in price, the degree of difference depending on the grade of steel and the thickness of the wall. For example, one type of 6-inch casing cost 56.74 rubles per meter, and another type cost 96.38 rubles per meter*****; and one type of 10-inch casing cost 94.04 rubles per meter, and a 16-inch casing cost 195.43 rubles per meter. 101/ If it is assumed that these prices were effective in

---

* In the offshore wells at Baku, where the geological conditions often require one or more intermediate strings of casing, the Neftyannyye Kamni Drilling Office consumed 65.8 kg of casing per meter drilled in 1954 instead of the planned 56.5 kg; and during the first quarter of 1955 the Artem Drilling Office consumed 62 kg of casing per meter instead of the 45 kg established by norm. 97/

** Computed from data in source 98/.

*** See p. 41, below.

**** This conclusion is based on the fact that although a number of references to salvage of surface equipment, such as water pipelines and electric lines, have appeared in Soviet publications, no reference to salvage of casing has been seen. There is no provision for salvage of casing in available examples of estimates for drilling and financing wells.

***** The prices quoted apparently include the joints.

the Tuymaza area in 1951, the cost of the 6-inch production casing in that trust alone may have been between 7.8 million and 13.2 million rubles. The only information on 1954 prices of casing is a statement that by saving 1,300 tons of 6-inch and 12-inch casing the Turkmen oilfields saved almost 2 million rubles, 102/ an indication that the price of casing may average about 1,500 rubles per ton. If it is assumed that this is also about the average price of casing in the Ural-Volga area, the cost of casing at the Tuymaza oilfields in 1954 may have been about 22 million rubles and in the Ural-Volga area as a whole, about 160 million to 170 million rubles.

c. Tubing.

Crude oil is produced through tubing varying in diameter from 1 1/2 to 4 inches. Although in some parts of the USSR, notably Baku, a double string of tubing is generally used, the well cemented rock formations of the Ural-Volga area probably make only one string of tubing necessary in most fields. 103/ Furthermore, the compressor method of production, which requires the double string of tubing, has been largely eliminated in the Ural-Volga area. 104/ Because of the paraffin problem at Tuymaza, it is improbable that anything smaller than 2 1/2-inch tubing is used in those oilfields. 105/ The 2 1/2-inch size probably is the most commonly used throughout the Ural-Volga area.

There are no available data to indicate the proportion of dry holes to the total number of wells drilled either in the Tuymaza oilfields or in any part of the USSR during the postwar period. In view of the very rapid increase in Tuymaza production, it has been assumed that a large percentage of the total wells drilled, possibly 75 to 90 percent, are productive and require tubing. The proportion of productive wells to the total wells drilled in the Ural-Volga area as a whole has been estimated at about 65 percent, the same proportion as in the US and western Canada in 1954. 106/

d. Field Oil-Gathering Lines.

Field oil-gathering lines from the wells to the individual or group storage point and from there to the central field tank farm range in diameter from 2 to 12 inches. The size most commonly used probably is the 4-inch pipe. 107/

In the early years of development, wells were spaced at 100 to 200 meters. 108/ It is probable that in most areas wells are now spaced at 400 meters. With the latter spacing, considerably less metal is required for gathering lines than with the closer spacing. With 400-meter spacing, 25,000 meters, or 336 tons, of 4-inch pipe are required for every 1,000 hectares. 109/

3. Bits.

The three-cone rock bits manufactured in the USSR are classified according to the type of rock formation they are designed to drill: soft, medium, hard, and well cemented. 110/ All but the first type are commonly used in the Ural-Volga area, and the latter two types are required for a large share of the drilling. 111/ The most frequently used size is the No. 10 bit, 9 3/4 inches in diameter, for drilling hole for the production string; and bits up to a No. 18, 17 3/4 inches in diameter, are used for drilling hole for the conductor string. 112/

In the hard-rock drilling conditions in the Ural-Volga area the expenditure of bits is considerably higher than the average for the USSR as a whole. In 1954 the average meterage per bit at Tuymaza was 21 meters, 113/ and in the USSR as a whole the average meterage per bit was 33.7 meters in developmental drilling and 18.7 meters in exploratory drilling. 114/ The 1954 average at Tuymaza is an improvement over the average in 1951, when each bit drilled an average of only 15.1 meters. 115/ A Tuymaza well (1,700 meters deep) requires between 65 and 100 bits. 116/* Although the actual

* In the US, wells as deep as 5,000 feet (1,524 meters) use an average of 16 bits, wells between 5,001 and 10,000 feet (1,525 to 3,049 meters) use an average of 28 bits, and wells more than 10,000 feet (more than 3,049 meters) use an average of 136 bits. 117/ The meterage per bit varies widely in the US, depending on the depth of wells and the geological formations. In the "West Texas chert," considered the most difficult to drill in the US, a bit can drill only 3 or 4 meters, whereas in some soft formations on the Gulf coast 1 bit may drill more than 3,000 meters. 118/ In the Mid-Continent region, each bit drills on the average 108 to 117 meters. 119/

meterage per bit for the Ural-Volga area as a whole is not available, it was reported in 1955 that the average was not yet 20 meters. 120/ Because of the great volume of drilling in the Ural-Volga area, it is evident that the low meterage per bit in that area has reduced the average for the USSR. Of a total of about 173,000 three-cone rock bits used in the USSR in 1954, 121/ the Ural-Volga area is estimated to have used 118,400 to 126,300 bits, 68 to 73 percent of the total. In spite of the large expenditure of bits, the supply was reported to be adequate in all areas in 1954. 122/ Estimated inputs of bits in the Ural-Volga area and in the Tuymaza oilfields of Bashkirskaya ASSR in 1951-54 are shown in Table 7.*

The poor quality of Soviet bits causes considerable concern to the Soviet oil industry.** Research to improve the quality of bits continues, and a number of new types were tested in the oilfields in 1954. 124/ The results of the tests have not been disclosed, and none of the new types has been produced for general use. 125/

The 1950 prices of 3-cone rock bits for a "theoretical Soviet well" were given as 848 rubles for a 9 3/4-inch bit and 2,396 rubles for a 15 3/4-inch bit. 126/ If the prices quoted are considered to be in the right order of magnitude for the Tuymaza oilfields, the cost of bits used in Tuymaza in 1951 was nearly 9.8 million rubles. In 1954 the average price of a Soviet 3-cone bit was approximately 725 rubles.*** At this average price the cost of bits used in the Tuymaza oilfields in 1954 may be estimated at about 9.64 million rubles and in the Ural-Volga area as a whole at about 85.84 million to 91.57 million rubles.

4. Cement.

For cementing wells, special "tamponage" cements are used. These are special types of hydraulic portland cement for wells

* Table 7 follows on p. 23.

** A comparison of bits of Soviet manufacture with bits imported to Soviet oilfields during World War II showed the great superiority of the imported bits. In 1945, imported bits drilled, on the average, 40 percent more meterage per bit than the bits of Soviet manufacture. 123/

*** In 1954 the USSR used about 173,000 three-cone bits at a cost of more than 125 million rubles. 127/

Table 7

Estimated Inputs of Bits in the Ural-Volga Area and in the Tuymaza Oilfields of Bashkirskaya ASSR 1951-54

	Ural-Volga Area		Tuymaza Oilfields	
Year	Number of Bits a/	Weight in Metric Tons a/	Number of Bits a/ b/	Weight in Metric Tons a/ c/
1951	N.A.	N.A.	9,100	550
1952	N.A.	N.A.	10,100	600
1953	N.A.	N.A.	13,300	800
1954	118,400 to 126,300 d/	6,650 to 7,050 c/	13,300	800

a. Figures have been rounded.
b. The average meterage per bit in 1951 was 15.1; in 1952, 15.4; in 1953, 19.5; and in 1954, 21.0. 128/
c. The weight is computed on the basis of 50 kg for a 9 3/4-inch bit and 120 kg for a 13 3/4-inch bit. 129/ The 13 3/4-inch bit is assumed to have been used for the drilling meterage under the conductor casing, and the 9 3/4-inch bit is assumed to have been used for the remaining meterage. Data for these computations were obtained from Tables 2, 3, 5, and 6, pp. 9, 10, 13, 16, 17, respectively, above. These sizes of bits are the minimum sizes that could have been used for the size of the casings generally used, and the weights given are, therefore, minimum estimates.
d. The meterage per bit in the Ural-Volga area was estimated to be 19 meters on the basis of a statement that the average per bit was "not yet 20 meters." 130/ The estimated number of bits is, therefore, probably a minimum estimate.

of 3 categories: "cold" wells with a bottom-hole temperature to 40°C, "hot" wells with a bottom-hole temperature to 75°C, and extra-deep wells with a bottom-hole temperature to 100-120°C. 131/ In 1954 a gypsum-alumina cement, which reduced the hardening time considerably, was used for cementing the conductor string in Tatarskaya ASSR, and in 1955 its use was to be extended to cementing the production string and to other specialized uses throughout the Ural-Volga area. 132/

The amount of cement required for casing a well varies with the diameter of the casing used and the depth to which it is set. It is estimated that the wells of the Ural-Volga area require 30 to 45 tons of cement for setting casing with the present depths and casing program. 133/* Estimated inputs of oil well cement in the Ural-Volga area and in the Tuymaza oilfields of Bashkirskaya ASSR in 1946 and 1951-54 are shown in Table 8.**

Additional amounts of cement are required for building foundations for the derrick and surface equipment. In 1945 an average Soviet well required about 1,400 sacks (70 tons) of cement, 135/ more than half of which probably was used for foundations for surface equipment.

A 1950 price for oil well cement was 250.05 rubles per ton. 136/ At this price the cost of cement for the Tuymaza oilfields in 1951 was about 706,900 rubles.

5. Drilling Fluids.

In the Ural-Volga area in recent years, water, rather than conventional drilling muds, has often been used for drilling fluid.*** In 1953 in Kuybyshevskaya Oblast, more than 40 percent of the

* In the US, wells as deep as 5,000 feet (1,524 meters) require an average of 442 sacks of cement (18.8 tons), wells from 5,001 to 10,000 feet deep (1,525 to 3,049 meters) require an average of 350 sacks (14.9 tons), and wells more than 10,000 feet deep (more than 3,049 meters) require 1,400 sacks (59.7 tons). 134/

** Table 8 follows on p. 25.

*** A drilling fluid is pumped through the drill pipe and through the bit to carry the cuttings to the surface, to lubricate and cool the bit, to support the walls of the well, and to control pressures. Drilling fluid referred to as "mud" is a mixture of water, clay, and certain chemical additives.

Table 8

Estimated Inputs of Oil Well Cement in the Ural-Volga Area and in the Tuymaza Oilfields of Bashkirskaya ASSR a/ 1946 and 1951-54

		Metric Tons
Year	Ural-Volga Area	Tuymaza Oilfields
1946	5,000 to 6,250	2,030
1951	N.A.	2,835
1952	N.A.	3,220
1953	N.A.	5,355
1954	46,440 to 49,320	5,775

a. The estimates are for "tamponage" cement used for setting casing and do not include any cement used for construction. The estimates are based on an estimated requirement of about 25 tons of cement per well in the Ural-Volga area in 1946, about 36 tons per well in 1954, and about 35 tons per well in the Tuymaza oilfields. 137/ The range of error is estimated to be plus or minus 15 percent.

drilling was done with water, 138/ and at the Tuymaza oilfields 76.2 percent was done with water. 139/ In 1954, water was used in 60 to 70 percent of all the drilling operations in the Ural-Volga area. 140/ The use of water is reported to increase the efficiency of turbodrills, to lengthen the period between repairs, and to increase the drilling speed by about 40 percent. 141/

The use of water has also greatly reduced the cost of drilling. By the use of water instead of mud in Tuymaza in 1953, the cost per meter drilled was reduced 35.73 rubles, a saving of more than 60,000 rubles per well. 142/ At this rate, more than 7 million rubles were saved in 1953 in the Tuymaza fields, and the drilling muds that were used cost about 2,211,000 rubles.

The use of water, however, has not been completely successful. Most of the rock formations of the Ural-Volga area can be drilled satisfactorily with water, but the use of water in drilling some formations has resulted in cave-ins and the consequent loss of time to repair the damage. 143/

In 1954, bentonite* powder was frequently used as a component of drilling muds. A shortage in the output of bentonite, however, limited its use. 144/ At the Tuymaza oilfields the clays used for drilling muds are of poor quality and have to be brought from great distances. These clays cannot be used without the addition of caustic soda and soda ash. Drilling an average Tuymaza oil well requires about 20 tons of soda products. 145/ In 1946, Tuymaza used about 1,160 tons of these chemicals, but in 1953 and 1954 the use of water reduced the requirements for soda products to about 700 tons. The 1950 price for caustic soda was 1,647.94 rubles per ton, 146/ a fact which accounts for the emphasis on reducing the use of these chemicals.

B. Electric Power.

Electric power is used widely in almost all phases of drilling and production operations in Soviet oilfields.** In Soviet drilling operations, electricity is the most economical type of power. 147/ Because of a shortage of electric power, however, much of the drilling in the Ural-Volga area throughout the postwar period has been powered by steam or diesel engines. 150/ In the Ural-Volga area, only the Bashkirskaya ASSR and the Krasnokamsk fields of Molotovskaya Oblast used electric power for drilling in 1946, and in those areas it was used only in small amounts. 151/ In 1951 it was proposed to increase the amount of drilling by electric power to 61 percent of all drilling, 152/ but actually 66 percent of all Soviet drilling rigs were

* A type of clay.

** In the US, electricity is practically never used to power drilling rigs, because of the high cost and the remoteness of drilling sites from power lines. In 1947, 71 percent of all US drilling rigs were powered by internal combustion engines, 21 percent by steam, and 8 percent by diesel electric drive. 148/ Butane, diesel oil, and natural gas are the fuels generally used for drilling in the US. 149/

still powered by diesels in that year. 153/ In 1954, although steam-powered rigs were no longer widely used, 154/ large numbers of diesel engines were still in use. 155/ Even at Tuymaza, which has its own power plant 156/ and where the most modern equipment and methods are employed, many rigs were still on diesel drive in June 1955 because of a shortage of electric power. 157/

The norms for the average expenditure of electric power per meter of drilling in the Ural-Volga area in 1946 ranged from 130 kilowatt-hours (kwh) for shallow developmental drilling to 560 kwh for extra-deep exploratory drilling in Krasnokamsk. In Bashkirskaya ASSR the norms ranged from 180 to 260 kwh per meter. 158/ With the increase in drilling speeds the consumption of power per meter has decreased. In 1948, experiments with fast drilling in shallow wells in Krasnokamsk reduced the consumption of power from 130 kwh to 70 to 72 kwh per meter. 159/ The only available data on consumption of electricity in drilling in 1954 were for one drilling office at the Tuymaza oilfields, which used 113 kwh per meter of turbine drilling. 160/ In the USSR as a whole a 1953 publication reported the average expenditure of power to be 175 to 200 kwh per meter of drilling for wells 1,500 to 2,000 meters deep. 161/

Petroleum production operations in the USSR are almost entirely electrified. In 1946 the expenditure of power per ton of oil pumped in the Ural-Volga area ranged between 7.5 kwh in the Kinel' fields of Kuybyshevskaya Oblast to 22 kwh in Krasnokamsk. In Tuymaza the expenditure per ton was 12.6 kwh. 162/ This rate of consumption of power apparently has not changed appreciably since 1946; in 1953 the average expenditure for the USSR as a whole was given as 12 to 18 kwh per ton. 163/ The compressor method of production, which requires 3 to 4 times as much power as pumping, 164/ has been largely eliminated in the Ural-Volga area. 165/

All other electric power requirements in the oilfields of the Ural-Volga area in 1946 varied from 2 kwh per ton of production at the Kinel' fields to 32.1 kwh at the Krasnokamsk fields. 166/ The average consumption of 4.25 kwh per ton of production at Tuymaza in 1946 167/ was consistent with the average for the USSR of 2 to 5 kwh reported in 1953. 168/

At Tuymaza since 1948, and more recently in other oilfields of Tatarskaya and Bashkirskaya ASSR's, water flooding has been used. Water flooding requires large quantities of electric power for the pumping stations. The Tuymaza oilfields, which pump 50,000 cubic meters of water per day into the input wells, 169/ probably use almost 100 million kwh of electric power per year for this purpose.*

Because of insufficient data on the actual percentage of wells drilled by electric power and the percentage of the total crude oil produced from pumping wells in the Ural-Volga area, no documented estimate can be made for the consumption of electric power in the area as a whole. It seems probable, however, that the total consumption of electric power in the oilfields of the Ural-Volga area in 1954 was between 550 and 650 million kwh. Estimated consumption of electric power in the Tuymaza oilfields of Bashkirskaya ASSR in 1946 and 1954 is shown in Table 9.**

C. Labor.

Except for data on certain categories of labor in a few specific areas, information concerning the labor input in the petroleum industry is too fragmentary to permit estimates. The drilling phase of the industry is the most standardized in the use of labor. A Soviet drilling crew consists of 15 to 21 men, the exact number depending on the type of power used to operate

* From data given in source 170/ the average consumption of electric power per cubic meter of water pumped was computed to be 5.5 kwh.

** Table 9 follows on p. 29.

Table 9

Estimated Consumption of Electric Power in the Tuymaza Oilfields of Bashkirskaya ASSR 1946 and 1954

Thousand Kilowatt-Hours

Purpose	1946	1954
Drilling wells	6,500 to 8,700 a/	25,425 to 28,250 b/
Pumping wells	1,260 c/	14,400 to 19,200 d/
Auxiliary needs	8,500 e/	32,800 f/
Total	16,260 to 18,460	72,625 to 80,250 g/

a. The average expenditure of power per meter of drilling was estimated at 220 kwh. 171/ It was assumed that about 30 to 40 percent of the total drilling meterage in 1946 was drilled by electric power. Figures were rounded.

b. It is estimated that about 225,000 to 250,000 meters were drilled by electric power in 1954. The average expenditure of power was estimated to be 113 kwh per meter. 172/

c. Only 5 percent of the total production of Tuymaza was produced by pumping in 1946. 173/ The production by pumping is estimated roughly at about 100,000 tons. The expenditure of electric power was 12.6 kwh per ton. 174/

d. It is estimated that about 15 to 20 percent of the total production in 1954 was produced by pumping, roughly a maximum of 1.2 million to 1.6 million tons. The 1947 norm of 12 kwh per ton of production 175/ was used to make this estimate because the Soviet average figure of 12 to 18 kwh per ton published in 1953 176/ indicates there probably has been no significant change in the expenditure of power for pumping.

e. The estimate was based on the expenditure of 4.25 kwh per ton of production. 177/ The 1946 production was estimated roughly at about 2 million tons.

f. The estimate was based on the 1947 norm of 4.1 kwh per ton of production 178/ and on estimated maximum production of 8 million tons.

g. There probably is a wide margin of error in this estimate because of the lack of a firm production figure for 1954 and the unknown effects of new technology, which probably consumes large quantities of power. The power consumed by the water-flooding operations alone may bring this total to 170 to 180 million kwh. (See p. 28, above.)

the rig.* 180/ It is estimated, therefore, that in the Ural-Volga area between 1,750 and 2,500 workers were employed in the actual operation of drilling rigs in 1946 and between 7,500 and 9,500 in 1954.** In the Tuymaza oilfields, about 700 men were employed in drilling in 1946 and a mimimum of 840 in 1954.**

The workers employed in various support and auxiliary activities connected with the drilling of wells far outnumber the workers in drilling crews. A derrick construction brigade usually has 14 men, and other special brigades, consisting of 2 to 5 workers, are employed in the installation of drilling equipment, blow-out preventers, boilers, and diesel engines. 181/ Together with the drilling and construction-assembly brigades, workers such as electricians, transport workers, tractor operators, and mechanics make up a drilling sector. The total number of workers for each sector may be 74 to 87 men, or -- if there are 2 drilling crews in 1 sector -- from 95 to 105 men.*** 183/ On the basis of this type of organization, the total number of workers employed directly or indirectly in the drilling operations at Tuymaza in 1954 probably was between 2,500 and 5,000.

Because of the inadequacy of the available information, the labor input for the production phase of the oilfield operations in the Ural-Volga area cannot be estimated with any degree of accuracy. The organization of production operations is not so standardized as is that of drilling operations. There is a great variation in labor requirements, which are determined by such factors as the number and distribution of operating wells, the methods of production (flowing or pumping), the terrain of the oilfield, and the amount of treatment necessary for the crude oil. In 1938 the number of production workers per well in the Ural-Volga area was 2.7, and in the USSR as a whole it was 1.7. 184/ In one of the Tuymaza oilfields in 1953,

---

* Electric power requires 15 men; diesel, 18 men; and steam, 21 men. 179/

** For the estimated number of operating rigs, see Table 4, p. 13, above. The estimates for the number of workers have been rounded.

*** This was the organization of fast-drilling sectors in the Krasnodar oilfields in 1948. 182/ The organization of fast-drilling sectors in the Ural-Volga area probably is similar, although the total number of employees may be larger than in an average sector.

however, 1 man could service 5 or 6 wells. 185/ Automation has been introduced in a few fields and has contributed to reducing the number of workers per well. 186/ There are not enough specialists trained in the fields of electronics, telemechanics, and radio technology, however, and automation still has a limited use in Ural-Volga oilfields. 187/ In oilfields where water flooding is employed, the average number of workers per well is twice that in other areas. In such fields, about 6.4 percent of the total number of workers engaged in the production of petroleum are employed in the waterflooding operations. 188/

Because of the greater yield per well in the Ural-Volga area, labor productivity is 2.5 times as high as it is in the "old regions."* In 1954 in the "new regions" the petroleum output was 10 times as high as in 1940, but there were only 4 times as many workers employed. 189/

Of the total number of workers employed by an oilfield administration, less than 50 percent are engaged in the actual production of petroleum. 190/ Large numbers are employed in construction, transport, repair, and other services. At Tuymaza in 1954, for example, about 400 workers were employed in the operation of boilers for heating, and 150 men were employed in the transport of workers to and from their jobs. 191/

Despite the relatively large manpower requirements in the petroleum industry, there is no evidence to indicate any serious shortage of labor in the Ural-Volga area. In 1954, some difficulty was encountered in the support of the exploratory drilling locations because some labor and transport had been diverted to agriculture. 192/

D. Capital Investment.

One of the largest capital investment items of the Soviet petroleum industry is the cost of drilling wells. In 1955, about 25 percent of the total investment in the petroleum industry was allocated to drilling, 193/ and about 30 to 40 percent of the capital expenditures in the extractive phase of the industry is estimated to be for drilling. 194/

* The Soviet source does not define the terms new regions and old regions. The term new regions was interpreted to refer primarily to the Ural-Volga area and old regions to the fields at Baku and in the North Caucasus.

In 1940-41, drilling required an even larger share of the capital investments of the petroleum industry -- almost half of the capital expenditures of the extractive phase and a third of the investment of the industry as a whole. 195/

It is probable that in the Ural-Volga area in 1945-47 the cost of drilling wells was more than 50 percent of the investments in the extractive phase and in some areas may have been as much as 60 or 65 percent. One reason for the relatively large proportion of expenditures for drilling in the total investment at that time was the intensive exploration and development of the newly discovered deposits in the Devonian formations and the relatively high cost of drilling in those hard-rock areas. Furthermore, the cost of producing the oil in those areas was relatively low because of the large proportion of flowing wells and the absence of the compressor method of production. 196/ The compressor method is the most costly method and may account for 10 or 15 percent of the total expenditures of an oil production trust. 197/ With the greater development of the petroleum resources in the Ural-Volga area and with improved drilling techniques, drilling costs have declined. 198/ On the other hand, the cost of producing operations has increased in several areas as a result of the introduction of water flooding. It is believed, therefore, that drilling may have accounted for 30 to 40 percent of the total expenditures in the extractive phase of the industry in the Ural-Volga area in 1954 and 1955.

Of the total cost of drilling in 1946, the cost of materials was 29.1 percent; fuel and power, 16 percent; labor, 12.6 percent; and depreciation of equipment, 16.9 percent.* 199/ The relative proportion of these items to the total cost of drilling has apparently not changed significantly since 1946. The cost of materials and of fuel and power was still about 45 percent of the total in 1954. 200/ Of the cost of materials -- casing, cement, drilling fluid components, cable, lumber, and spare parts -- the cost of casing is the largest item -- 50 percent or more of the total. 201/ The cost of casing is about 15 to 20 percent of the total cost of a well, 202/ and the cost of all other materials is about 10 percent. 203/

* The source gave these percentages for the eastern areas as a whole, of which the Ural-Volga area is the major part.

There is a wide range in the total costs of wells in the Ural-Volga area. According to the official Soviet price list 204/ on which the estimates for the costs of drilling all Soviet wells in 1946-50 were based, the cost of drilling a well in the Ural-Volga area in 1945-46 ranged from about 54,000 rubles for a shallow developmental well (250 meters deep) to more than 3 million rubles for a deep exploratory well (3,400 meters deep).* 205/ The cost per meter for these wells was 215 rubles and 894 rubles, respectively. The average cost per meter of all types of wells drilled in the Ural-Volga area in 1946 was 572 rubles.** 206/

Evidence on which to calculate drilling costs in 1954 is very fragmentary. On the basis of the estimated amount of casing used in an average well in 1954, however, it is possible to make a rough estimate of the total cost of a well. An average well, 1,750 meters deep, in the Ural-Volga area was estimated to require about 83.1 tons of casing,*** which cost an average of approximately 1,500 rubles per ton.*** As the cost of casing is about 15 to 20 percent of the total cost of a well, an average Ural-Volga well in 1954 probably cost between 623,500 rubles and 831,000 rubles, or between 356 and 475 rubles per meter. The only wells for which actual 1954 drilling costs are known are exploratory wells, which would normally be more costly than the average wells. In Kuybyshevskaya Oblast the cost of drilling an exploratory well ranged from 500,000 to 6 million rubles. 207/ One exploratory well in this oblast, 2,252 meters deep, cost 2,150,700 rubles, or 955 rubles per meter, and another well, 2,650 meters deep, cost 1,137,100 rubles, or 429 rubles per meter. 208/ These actual costs, however, were considerably lower than the planned costs, probably estimated on the basis of previous experience, which amounted to 1,030 rubles and 780 rubles per meter, respectively.

Because of the wide range in the estimates of the volume of drilling and in the average costs of drilling in the Ural-Volga area,

---

* In 1945 prices.

** This is a straight average of all types, and no attempt was made to weight by number of wells of each type. Because of the large proportion of the less expensive developmental wells in the total of wells drilled, a weighted average probably would be lower.

*** Including the joints. (See p. 19, above.)

estimates for the total investments in the drilling of wells and in the extractive phase as a whole will necessarily have such a wide range as to be of value only as an indication of the possible order of magnitude of such investments. On the basis of the estimated cost of an average Ural-Volga well in 1954, it is estimated that the total 1,290 to 1,370 wells drilled may have cost between 800 million and 1.15 billion rubles. As the cost of drilling wells was estimated to be 30 to 40 percent of the investments in the extractive phase, the total investments in this phase of the industry in 1954 may have been between 2 billion and 3.8 billion rubles.

Because considerable data are available on the amount of drilling and the costs of drilling in the Tuymaza oilfields in 1946, the estimates for the expenditures of that trust can be made. The proportion of the different items of expenditure to the total expenditures would be considerably changed in this trust in 1954, however, because since 1948 the cost of water flooding has become a major item of expenditure. The cost of water flooding in 1955 was 15 to 18 percent of the total production costs at Tuymaza. 209/ In spite of the great amount of capital expended for water-flooding operations, the greatly increased production obtained by this method has made the cost of Tuymaza crude oil considerably less than the average for the USSR as a whole. 210/ Estimated capital expenditures in the Tuymaza oilfields of Bashkirskaya ASSR in 1946 are shown in Table 10.*

Large capital expenditures have recently been made by the petroleum industry throughout the Ural-Volga area for the construction of roads, housing, transportion and communications facilities, warehouses, and supply bases. A major portion of the 800 million to 900 million rubles to be expended by the petroleum industry of the USSR for such construction during the next few years 211/ will certainly be allocated to the Ural-Volga area. In 1955, three-fourths of the total construction work of one main administration of the Ministry of Construction of Petroleum Industry Enterprises were allocated to Bashkirskaya and Tartarskaya ASSR's alone. 212/

* Table 10 follows on p. 35.

Table 10

Estimated Capital Expenditures in the Tuymaza Oilfields of Bashkirskaya ASSR
1946

Purpose of Expenditure	Amount (Rubles) a/
Drilling of wells	
Materials	11,717,000 b/
Power and fuel	6,442,000 b/
Labor c/	5,073,000 b/
Depreciation of equipment	6,805,000 b/
Overhead and administration	5,999,000 b/
Other expenses	4,228,000 b/
Total drilling	40,265,000 d/
Equipment for producing wells	6,927,000 e/
Other major oilfield equipment, such as storage tanks and pipelines	5,808,000 e/
All other expenditures	10,610,000 f/
Total expenditures	63,610,000 g/

a. In 1945 prices.
b. This breakdown is based on data for all the eastern areas of the USSR. Of the cost of drilling, the cost of materials comprised 29.1 percent; energy expenditures, 16 percent; labor force, 12.6 percent; depreciation of equipment, 16.9 percent, overhead and administrative expenses, 14.9 percent; and other expenditures, 10.5 percent. 213/
c. On the basis of source 214/ and of the fact that the average monthly wages of drilling workers in Baku was 612 rubles in January and 960 rubles in December 1946, 215/ labor in this category is interpreted to refer only to drilling crews. Other types of labor, such as transport and construction, are probably included in "overhead" or "other."

Table 10

Estimated Capital Expenditures in the Tuymaza Oilfields of Bashkirskaya ASSR 1946 (Continued)

d. The number has been rounded. The estimate, in 1945 prices, was computed from data on drilling costs for the various types of wells drilled at Tuymaza during 1945-46. 216/ From these data the average cost per meter was computed to be 406.7 rubles.
e. The estimate is based on data for one unidentified oil production trust in 1946 from source 217/. Because the trust described employed the compressor method of production, allowance was made for the absence of a compressor system at Tuymaza. On the assumption that other operating conditions in the two trusts were similar, the equipment for producing wells was estimated to comprise more than 10 percent of the total investment and other oilfield equipment more than 9 percent.
f. Residual.
g. The data referred to in note e were used. With an allowance for the absence of a compressor system at the Tuymaza oilfields and with the assumption that other operating conditions were similar in the two trusts, the drilling of wells at Tuymaza was estimated to comprise 63 to 64 percent of the total investment. The percentage used to compute the total investment at Tuymaza was 63.3 percent.

III. Comparison of Input Requirements in the Ural-Volga Area and in Alberta, Canada.

Because of the similarity of the Alberta and the Ural-Volga areas, a comparison of the input requirements in the two areas will give a basis for an evaluation of the efficiency of the extractive phase of the petroleum industry in the Ural-Volga area. Estimated reserves and production of crude oil in Alberta and in the Ural-Volga area in 1946-54 are shown in Table 11,* and estimated drilling operations in Alberta and in the Ural-Volga area in 1946-54 are shown in Table 12.** Comparative

* Table 11 follows on p. 39.
** Table 12 follows on p. 40.

data on drilling operations and inputs in Alberta and in the Ural-Volga area in 1946 and 1954 are shown in Table 13.* Although comparable information is available for only a relatively small number of inputs, the comparative figures on these inputs show the superiority of the operating efficiency of the petroleum industry in Alberta.

The relatively low output per drilling rig in the Ural-Volga area is a direct reflection of the poor management and inefficient construction techniques used in the Ural-Volga area. Although a few of the leading drilling crews in the Ural-Volga area have operated their rigs efficiently and have equaled the average meterage per rig in Alberta, the majority of the crews are hampered by administrative delays, slow construction work, and loss of time caused by accidents and repairs. 218/ Because of the inefficient construction techniques and the lack of mechanized equipment for assembling and dismantling drilling rigs, the rigging-up and tearing-down operations in the Ural-Volga area frequently require a month or more 219/; in the oil industry of the West, 1 or 2 weeks is usual. 220/

The inferior quality of Soviet drill pipe is reflected in the large consumption of drill pipe in the Ural-Volga area compared with that in Alberta. Even with the wide use of turbine drilling, which has resulted in the saving of a large quantity of drill pipe, the Ural-Volga area still uses about five times as much drill pipe per meter drilled as does Alberta.

The casing program in Alberta is similar to that used in the Ural-Volga area. There are usually 2 strings of casing -- a surface string set to about 600 feet (183 meters) and a production string of 5 1/2- or 7-inch casing set through the productive zone. 221/ The chief reason for the greater use of casing in the Ural-Volga area appears to be the failure of the Soviet industry to salvage casing from dry holes. Moreover, it appears to be the standard Soviet practice to case all wells for the entire length of the hole; in Alberta, casing is usually set through the productive zone and not necessarily to the bottom of the hole. 222/

The larger casing requirements in the Ural-Volga area would require a proportionately larger amount of oil well cement than is used in Alberta. The Alberta cement requirements, however, are not available for comparison.

* Table 13 follows on p. 41.

Data on the performance of drilling bits in Alberta are not available for the area as a whole for comparison with the Ural-Volga area. Information on the use of bits in very deep wells of one Alberta field, however, revealed that an average of 13.5 meters per bit for wells about 3,000 meters deep was increased to 33.6 meters per bit for wells of that depth as a result of the use of a larger drill collar. 223/ These wells, among the deepest in Alberta, are considerably deeper than the average, and the performance of bits in this one field cannot be considered typical. The penetration rates per bit in these deep wells presumably are among the lowest rates in Alberta. The rates do indicate, however, that the average meterage per bit in the Ural-Volga area, estimated to be a maximum of 19 meters,* is probably considerably lower than the meterage per bit in Alberta, except in very deep drilling.

The cost of drilling wells in Alberta is about $60,000** to $75,000 for developmental wells of medium depth (1,500 to 1,700 meters) and about $150,000 to $250,000 for extra-deep developmental wells (2,400 to 2,700 meters). Exploratory wells are usually more costly. They average $100,000 to $125,000 for wells 1,500 to 2,100 meters deep, and extra-deep wells of more than 4,000 meters may cost $1 million or more. 224/ Because of the artificiality of the official ruble-dollar exchange rate, it is not possible to make an accurate comparison between the costs of Alberta wells and the estimated cost of an average Ural-Volga well of between 623,500 and 831,000 rubles*** (between $155,875 and $207,750 at the official rate). Labor inputs and costs in the extractive phase of the petroleum industry in Alberta in 1946-49 are shown in Table 14.**** Data for the Ural-Volga area are not sufficient for adequate comparisons with the data on Alberta.

---

* See p. 21, above.
** In terms of US dollars.
*** See p. 33, above.
**** Table 14 follows on p. 42.

Table 11

Estimated Reserves and Production of Crude Oil in Alberta and in the Ural-Volga Area a/
1946-54

Year	Proved Reserves First of Year (Million Metric Tons)		Gross Additions to Reserves During Year (Million Metric Tons)		Production During Year (Million Metric Tons)		Net Change in Reserves During Year (Million Metric Tons)		Producing Wells, End of Year (Number)	
	Alberta	Ural-Volga b/	Alberta	Ural-Volga b/	Alberta	Ural-Volga b/	Alberta	Ural-Volga b/	Alberta	Ural-Volga
1946	N.A.	210.3	N.A.	45.0	0.96 c/	3.7	N.A.	41.3	517 d/	N.A.
1947	19.1 e/	251.6	N.A.	45.0	0.92 f/	5.2	N.A.	39.8	519 d/	N.A.
1948	N.A.	291.4	N.A.	66.4	1.48 g/	6.7	N.A.	59.7	774 d/	N.A.
1949	N.A.	351.1	N.A.	69.8	2.73 g/	8.4	N.A.	61.4	1,243 d/	N.A.
1950	N.A.	412.5	N.A.	100.3	3.72 h/	10.3	N.A.	90.0	1,779 i/	N.A.
1951	157.1 j/	502.5	28.1 j/	91.7	6.1 j/	13.4	22.0 j/	78.3	2,511 k/	N.A.
1952	179.0 l/	580.5	34.6 l/	71.2	7.9 l/	16.5	26.7 l/	54.7	3,312 k/	N.A.
1953	205.8 m/	635.5	23.6 m/	68.8	10.4 m/	19.2	13.2 m/	49.6	4,000 k/	N.A.
1954	219.0 n/	685.1	52.8 n/	60.0	11.8 n/	22.1	41.0 n/	37.9	4,328 o/	N.A.

a. The Ural-Volga area covers about 475,000 square miles, and Alberta covers about 225,000 square miles.
b. All estimates on the Ural-Volga area in this table were taken from source 225/.
c. 226/
d. 227/
e. The total proved reserves of Canada as a whole were 150 million barrels. In 1946, Alberta produced 7,138,532 barrels, 94.4 percent of the total Canadian production of 7,564,930 barrels. 228/ Assuming the ratio of proved reserves to annual production is the same in Alberta as in Canada as a whole, the indicated proved reserves in Alberta as of 1 January 1947 were 94.4 percent of 150 million barrels, or 141.6 million barrels (7.418 barrels per metric ton equals 19,088,703 tons).
f. 229/
g. 230/
h. 231/
i. 232/
j. 233/
k. 234/
l. 235/
m. 236/
n. 237/
o. End of August. 238/

Approved For Release 1999/09/26 : CIA-RDP79-01093A001100050001-1

Table 12

Estimated Drilling Operations in Alberta and in the Ural-Volga Area
1946-54

Year	Drilling (Thousand Meters)		Wells Drilled (Number)		Average Depth of Wells (Meters)		Operating Rigs (Number)		Drilling Per Rig (Meters)		Wells Drilled Per Rig (Number)	
	Alberta	Ural-Volga a/	Alberta	Ural-Volga a/	Alberta	Ural-Volga a/	Alberta	Ural-Volga b/	Alberta	Ural-Volga b/	Alberta	Ural-Volga b/
1946	122.5 c/	250 to 300	100 d/	200 to 250	1,225	1,225	20 e/	99 to 124	6,127	2,475	5.00	2.02
1947	269.0 f/	N.A.	212 g/	N.A.	1,269	N.A.	20 to 50 e/	N.A.	7,686	N.A.	6.06	N.A.
1948	507.2 h/	N.A.	356 h/	N.A.	1,425	N.A.	50 to 85 e/	N.A.	7,570	N.A.	5.31	N.A.
1949	997.9 i/	N.A.	784 j/	N.A.	1,273	N.A.	100 e/	N.A.	9,979	N.A.	7.84	N.A.
1950	1,236.4 k/	N.A.	1,012 l/	N.A.	1,222	N.A.	118 m/	N.A.	10,478	N.A.	8.58	N.A.
1951	1,560.5 n/	N.A.	1,197 n/	N.A.	1,304 n/	N.A.	137 o/	N.A.	11,390	N.A.	8.74	N.A.
1952	2,138.3 n/	N.A.	1,619 n/	N.A.	1,321 n/	N.A.	209 p/	N.A.	10,230	N.A.	7.75	N.A.
1953	1,937.1 n/	N.A.	1,426 n/	N.A.	1,358 n/	N.A.	143 q/	N.A.	13,546	N.A.	9.97	N.A.
1954	1,730.1 n/	2,250 to 2,400	1,153 n/	1,290 to 1,370	1,500 n/	1,750	122 r/	502 to 533	14,181	4,500	9.45	2.57

a. Data in this column from Table 2, p. 9, above.
b. Data in this column from Table 4, p. 13, above.
c. 239/
d. 240/
e. There were 20 rigs at the end of 1946, 50 at the end of 1947, 85 at the end of 1948, and 100 in March 1949. 241/ An average of 35 rigs for 1947 and 67 rigs for 1948 were used in computing the meters drilled per rig and wells drilled per rig.
f. 242/
g. 243/
h. 244/
i. 245/
j. 246/
k. 247/
l. 248/
m. Interpolation.
n. 249/
o. Monthly average. 250/
p. 251/
q. 252/
r. In October. 253/

Approved For Release 1999/09/26 : CIA-RDP79-01093A001100050001-1

Table 13

Comparative Data on Drilling Operations and Inputs in Alberta and in the Ural-Volga Area 1946 and 1954

Item	1946		1954	
	Alberta	Ural-Volga	Alberta	Ural-Volga
Meters drilled per rig a/	6,127	2,475	14,181	4,500
Wells drilled per rig a/	5.00	2.02	9.45	2.57
Kilograms of drill pipe used per meter drilled	N.A.	19.2 b/	1.8 c/	9.2 b/
Kilograms of casing used per meter drilled	29.1 d/	49.4 b/	N.A.	46.3 b/
Meters of casing used per meter drilled	0.77 d/	1.12 b/	N.A.	1.09 b/

a. From Table 12, p. 40, above.
b. Computed from data shown in Tables 2 and 6, pp. 9 and 17, above.
c. In 1952 the Petroleum Administration for Defense, Department of the Interior, estimated that in 1954 the Canadian petroleum industry would use 8,215 short tons of drill pipe to drill an estimated 2,800 wells to an average depth of 4,890 feet. This estimate was based on experience factors derived from oil company operating data.
d. Alberta used a total of 310,360 feet, or 3,934.9 short tons, of casing in 1946. 254/

Table 14

Labor Inputs and Costs in the Extractive Phase of the Petroleum Industry in Alberta 1946-49

Labor Inputs and Costs	1946 a/	1947 b/	1948 c/	1949 d/
Number of employees				
On salary	394	118	87	200
On wages	978	1,042	1,360	1,709
Total	1,372	1,160	1,447	1,909
Cost of labor (US $)				
Salaries	971,266	278,080	260,270	717,993
Wages	2,042,950	2,606,120	3,797,897	5,122,922
Total	3,014,216	2,884,200	4,058,167	5,840,915
Cost of fuel and electricity (US $)	865,694	717,829	1,876,482	531,365
Cost of process supplies used e/ (US $)	65,293	89,729	73,024	334,614

a. 255/
b. 256/
c. 257/
d. 258/
e. Not defined in the source.

IV. Conclusions and Forecasts.

A. Conclusions.

The study of the input requirements in the extractive phase of the petroleum industry in the Ural-Volga area of the USSR and in the petroleum producing area of Alberta, Canada, led to the following general conclusions:

1. The level of efficiency in drilling operations in the Ural-Volga area in 1954, as reflected in certain basic and important input requirements, was still considerably below that of the petroleum industry under comparable conditions in the Free World.

2. Most basic types of equipment are generally available in sufficient quantity to supply the Ural-Volga oilfields. In 1954 and 1955, complex electronic and automatic devices were being manufactured in such small quantities in the USSR that automation has not yet been widely introduced into drilling and producing operations. The Soviet petroleum industry produces a smaller selection of equipment, in both size and quality, than is available in the US and Canada. Construction operations in the Ural-Volga oilfields are greatly handicapped by a lack of mechanized construction equipment.

3. The quality of Soviet drill pipe and bits is greatly inferior to the quality of drill pipe and bits produced in the US. Even with the large proportion of turbine drilling, which is more economical than rotary drilling in the use of drill pipe, the Ural-Volga area used considerably more drill pipe per meter drilled than did Alberta under similar geologic conditions. The average meterage per bit in the Ural-Volga area is also apparently considerably lower than it is in Alberta.

4. The development of the petroleum resources of the Ural-Volga area has been handicapped by a shortage of good-quality clays, such as bentonite, for drilling fluids; electric power for drilling purposes; and industrial water for water-flooding operations.

5. Although there is a relatively large manpower requirement in the oilfields of the Ural-Volga area, there has been no evidence of

a labor shortage. There are, however, few specialists trained in the use of highly complicated automatic equipment. When such equipment becomes more widely available, training programs for its use will be necessary.

6. The petroleum industry requires large capital inputs. The total capital inputs in the extractive phase of the Ural-Volga petroleum industry in 1954 may be estimated roughly at between 2 billion and 3.8 billion rubles. Additional large capital outlays are required for improvements in transport, communications, water and power supply, and repair and supply bases.

B. Forecasts.

The Soviet petroleum industry can be expected to make every effort to overcome its most obvious weaknesses. Improvements in annual meterage per drilling rig have already become apparent during 1954 and 1955 and can be expected to continue as a greater amount of automatic and mechanized equipment is used.

The Soviet metallurgical industry is being put under pressure to improve the quality of its tubular goods and drilling bits and to produce a larger assortment of sizes and qualities. It is probable that there will be some improvements in quality, and a wider selection will become available as a result of this pressure.

The shortages of electric power and industrial water will be alleviated to some extent during the next few years by the completion of the hydroelectric power projects along the Volga and Kama Rivers and the reservoir and canal projects in the Tatarskaya ASSR. As the demand for water and power continues to increase, however, shortages of both these inputs will probably continue to be a problem in the Ural-Volga oilfields.

Estimated and forecast input requirements for the extractive phase of the petroleum industry in the Ural-Volga area in 1954-61 are shown in Table 15.* The 1955 estimate and the forecasts were based on forecasts of annual gross additions to reserves. 259/ Although these estimates and forecasts do not take into account

* Table 15 follows on p. 46.

the effects of increased efficiency and improvements in technology that will undoubtedly occur in the Soviet petroleum industry, the progressively greater amount of drilling and deeper drilling that will be required to discover new petroleum deposits may offset those effects. It has been observed in oil producing areas of the Free World that inputs tend to increase in relation to output as new oil deposits become harder to find, as drilling becomes deeper, and as the proportion of unsuccessful wells increases.

Table 15

Estimated and Forecast Input Requirements for the Extractive Phase of the Petroleum Industry in the Ural-Volga Area
1954-61

Type of Input	Estimates			Forecasts					
	1954 a/	Inputs per Million Metric Tons of Gross Additions to Reserves 1954 b/	1955 b/	1956 b/	1957 b/	1958 b/	1959 b/	1960 b/	1961 b/
Operating drilling rigs (units)	502 to 533	8.37 to 8.88	593 to 629	616 to 654	639 to 678	663 to 703	686 to 728	710 to 753	733 to 778
Drilling bits (units)	118,400 to 126,300	1,973 to 2,105	139,700 to 149,000 c/	145,200 to 154,900 c/	150,700 to 160,800 c/	156,300 to 166,800 c/	161,800 to 172,600 c/	167,300 to 178,500 c/	172,800 to 184,400 c/
Tubular goods (metric tons)	144,350 to 153,800	2,405.8 to 2,563.3	170,300 to 181,500 c/	177,100 to 188,700 c/	183,800 to 195,800 c/	190,500 to 203,000 c/	197,300 to 210,200 c/	204,000 to 217,400 c/	210,700 to 224,500 c/
Oil well cement (metric tons)	46,440 to 49,320	774 to 822	54,800 to 58,200 c/	57,000 to 60,500 c/	59,100 to 62,800 c/	61,300 to 65,100 c/	63,500 to 67,400 c/	65,600 to 69,700 c/	67,800 to 72,000 c/
Electric power (million kwh)	550 to 650	9.17 to 10.83	650 to 765 c/	675 to 795 c/	700 to 825 c/	725 to 850 c/	750 to 880 c/	780 to 920 c/	805 to 950 c/
Labor (number of workers)	7,500 to 9,500	125 to 158.3	8,850 to 11,200 c/	9,200 to 11,650 c/	9,550 to 12,100 c/	9,900 to 12,550 c/	10,250 to 13,000 c/	10,600 to 13,400 c/	10,950 to 13,850 c/

a. Information in this column is from the tables and text of this report.
b. The annual gross additions to reserves used as bases for the estimates and forecasts in this table are as follows (in million metric tons): 1954, 60.0; 1955, 70.8; 1956, 73.6; 1957, 76.4; 1958, 79.2; 1959, 82.0; 1960, 84.8; 1961, 87.6. 260/
c. The figures have been rounded.

Approved For Release 1999/09/26 : CIA-RDP79-01093A001100050001-1

APPENDIX A

METHODOLOGY

The general method used in the preparation of the estimates in this report was to apply input factors derived, for the most part, from Soviet publications to the estimated total annual meterage and number of wells of average depth completed in one year. The method by which the annual meterage, number of wells completed, and average depth of wells were estimated on the basis of Soviet data on specific wells and drilling organizations and a geological study of the area is given in detail in the tables and in the Introduction. The input factors and the method by which they were applied to the drilling data are given in the tables or in the sections of the report concerning the various inputs.

As a specific example of how this general method was applied, the estimates for the casing inputs in the Ural-Volga area in 1954 were developed in the following manner:

On the basis of Soviet references to actual wells in the Ural-Volga area, it was determined that the majority of the wells were cased with two strings of casing. The conductor string, which ranged in length from 100 to 300 meters, was estimated to be about 150 meters long in the majority of the wells. The estimated 1,290 to 1,370 wells drilled in the Ural-Volga area in 1954, therefore, required 193,500 to 205,500 meters of casing for the conductor strings. The diameter of the casing in the conductor string in the available examples of actual wells ranged from 10 3/4 inches to 14 3/4 inches, but the 12 3/4-inch size seemed to be most commonly used. The weight of 85.2 kg per meter was arbitrarily selected as an average weight for the conductor casing because it is the weight of one type of 12 3/4-inch casing and is about midway between the two extremes of 58.6 kg per meter for the lightest weight of 10 3/4-inch casing and 108 kg per meter for the heaviest weight of 14 3/4-inch casing. At an estimated average weight of 85.2 kg per meter, therefore, the 193,500 to 205,500 meters of conductor casing used in 1954 weighed 16,486.2 to 17,508.6 tons. The second string of casing, the production string, was set for the entire length of the hole in the available examples of actual wells, whether developmental or exploratory. Because there is no evidence of any attempt to salvage casing from dry holes

in the USSR, it was assumed that the production casing was set for the entire length of all wells drilled or for the total meterage drilled -- 2.25 million to 2.40 million meters. From the examples of actual wells it was estimated that the majority of the wells were cased with 6 5/8-inch casing. The average weight of 39 kg per meter for the production casing was arbitrarily selected in the same manner as was the average weight for the conductor casing. The total weight of the production casing in the Ural-Volga wells drilled in 1954 was, therefore, 87,750 to 93,600 tons. The total casing used in the conductor and production strings in the Ural-Volga area in 1954 was 2,443,500 to 2,605,500 meters, or 104,236.2 to 111,108.6 tons.

APPENDIX B

GAPS IN INTELLIGENCE

Soviet sources give fairly complete information on the equipment and techniques used in the extractive phase of the petroleum industry in the USSR. The data to which these input factors can be applied, however, are generally inadequate or unavailable. Statistics on annual drilling meterage or wells completed are rarely available, except for areas or sectors too small to be of significance. The percentage of dry holes of the total wells drilled is never given, nor are data available on the number of flowing wells and pumping wells at any time in the postwar period.

The information on geophysical exploration and the scope of such operations is too fragmentary to permit any reliable input estimates on this aspect of the petroleum industry in the Ural-Volga area.

There is also little information on storage or transportation facilities for crude oil. The method of distribution of the crude oil production and the probable or proposed construction of trunk pipelines are important gaps in intelligence.

APPENDIX C

SOURCE REFERENCES

The chief sources for this report are Soviet publications, mainly technical books and journals. The central press, primarily Pravda and Izvestiya, have also yielded considerable information. These Soviet publications were found to be consistent in their presentation of technology and practices and are considered to be reliable for this type of information. Other sources used in the report are the geological study of the Ural-Volga area and the subsequent analysis and summary of that study.

Evaluations, following the classification entry and designated "Eval.," have the following significance:

Source of Information	Information
Doc. - Documentary	1 - Confirmed by other sources
A - Completely reliable	2 - Probably true
B - Usually reliable	3 - Possibly true
C - Fairly reliable	4 - Doubtful
D - Not usually reliable	5 - Probably false
E - Not reliable	6 - Cannot be judged
F - Cannot be judged	

"Documentary" refers to original documents of foreign governments and organizations; copies or translations of such documents by a staff officer; or information extracted from such documents by a staff officer, all of which may carry the field evaluation "Documentary."

Evaluations not otherwise designated are those appearing on the cited document; those designated "RR" are by the author of this report. No "RR" evaluation is given when the author agrees with the evaluation on the cited document.

---

1. Pravda, 28 Dec 55, p. 3. U. Eval. RR 3.
2. CIA. CIA/RR 61, Petroleum Resources of the Ural-Volga Area of the USSR, 15 Aug 55, p. 18-21. S/US ONLY.

STATSPEC

3. [redacted]
4. CIA. CIA/RR 61 (2, above).

STATSPEC For

5. [redacted]
6. Izvestiya, 24 May 55, p. 2. U. Eval. RR 3.
7. Pravda, 18 May 55, p. 1. U. Eval. RR 3.
8. USSR, Gosudarstvennyy Nauchnyy Institut. Bol'shaya sovetskaya entsiklopediya (Great Soviet Encyclopedia), vol 28, Moscow, 1954, p. 157. U. Eval. RR 3.
   Ibid., vol 52, 1947, p. 632. U. Eval. RR 3.
   Encyclopaedia Britannica, Chicago, 1949, vol 1, p. 525. U. Eval. RR 1.
9. Neftyanoye khozyaystvo, no 9, 1948, p. 4. U. Eval. RR 3.
10. Pravda, 1 Jul 55, p. 2. U. Eval. RR 3.
11. World Oil, 15 Aug 55, p. 178. U. Eval. RR 1.
12. CIA. CIA/RR 61 (2, above), p. 6. S/US ONLY.
    World Petroleum, May 55, New York, p. 55-63. U. Eval. RR 1.
13. Takhayev, Kh.Ya. Bashkiriya (Bashkiriya), Moscow, 1950, p. 180. U. Eval. RR 3.
14. Ibid., p. 182. U. Eval. RR 3.
15. Pravda, 6 Dec 54, p. 2. U. Eval. RR 3.
16. The Encyclopedia Americana, New York, 1955, vol 1, p. 336 a. U. Eval. RR 1.
17. Izvestiya, 14 Apr 53, p. 2. U. Eval. RR 3.
    Neftyanoye khozyaystvo, no 11, 1955, p. 1-10. U. Eval. RR 3.
18. Mozzhukhin, P.V. Ekspluatatsiya sooruzheniy i oborudovaniya zakonturnogo zavodneniya neftyanykh plastov (Use of Installations and Equipment in Contour Water-Flooding of Petroleum Strata), Moscow, 1955, p. 5-7. U. Eval. RR 3.

19. Izvestiya, 2 Mar 55, p. 2. U. Eval. RR 3.
20. Ibid., 24 May 55, p. 2. U. Eval. RR 3.
Ibid., 21 Jun 55, p. 1. U. Eval. RR 3.
21. Tomashpol'skiy, L.M. Kuybyshevskaya neft' (Kuybyshev Petroleum), 1947, p. 34. U. Eval. RR 3.
22. Pravda, 30 Aug 55, p. 2-3. U. Eval. RR 3.
23. US Geological Survey. Short Summary Geologic Report on the Ural-Volga Oil Region with Emphasis on the Geology of the Oil and Gas Deposits, 1954, p. 131. OFF USE. Eval. RR 2.
CIA. CIA/RR 61 (2, above), p. 30-31. S/US ONLY.
24. US Geological Survey (23, above).
25. USSR. Preyskurant porayonnykh rastsenok na stroitel'stvo neftyanykh i gazovykh skvazhin (Price List of Regional Rates in the Construction of Oil and Gas Wells), Moscow, 1948, p. 201. U. Eval. RR 3. (hereafter referred to as USSR. Preyskurant)
26. CIA. FDD Translation no 444, 16 Aug 55, Information on USSR Petroleum Industry, p. 7. OFF USE. Eval. RR 2. (tr of Bol'shaya sovetskaya entsiklopediya, vol 29, 2d ed, Moscow, 1954, p. 509-541.)
27. Neftyanoye khozyaystvo, no 3, 1955, p. 3. U. Eval. RR 3.
28. Pravda, 6 Dec 54, p. 2. U. Eval. RR 3.
29. USSR. Preyskurant (25, above), p. 200-210. U. Eval. RR 3.
25X1A 30. Tomashpol'skiy, op. cit. (21, above), p. 80. U. Eval. RR 3.
31. [redacted]
32. Moscow News, 17 Jan 45. U. Eval. RR 3.
Nauka i zhizn, no 4, 1945. U. Eval. RR 3.
33. Pravda, 10 Jun 47. U. Eval. RR 3.
34. USSR. Bol'she nefti rodine (More Petroleum for the Motherland), 1953, p. 86. U. Eval. RR 3. (hereafter referred to as USSR. Bol'she)
35. Neftyanoye khozyaystvo, no 1, 1947, p. 3. U. Eval. RR 3.
36. Ibid., p. 18. U. Eval. RR 3.
37. Neftyanoye khozyaystvo, no 8, 1955, p. 8. U. Eval. RR 3.
38. Ibid.
39. Ibid.
40. Pravda, 13 Jan 55. U. Eval. RR 3.
41. Ibid., 3 Mar 55. U. Eval. RR 3.

42. Ibid., 13 Jan 55. U. Eval. RR 3.
43. Ibid., 6 Dec 54. U. Eval. RR 3.
44. Neftyanoye khozyaystvo, no 8, 1955, p. 8. U. Eval. RR 3.
45. Protasov, G.N., and Udyanskiy, N.Ya. Bureniye neftyanykh i gasovykh skvazhin (Drilling Oil and Gas Wells), Moscow, 1954, p. 141. U. Eval. RR 3.
46. Neftyanoye khozyaystvo, no 1, 1955, p. 26. U. Eval. RR 3.
47. Ibid., p. 26. U. Eval. RR 3.
48. USSR. Opyt ekspluatatsii i remonta oborudovaniya v neftyanoy promyshlennosti (Experience in the Use and Repair of Equipment in the Petroleum Industry), Moscow, 1953, p. 152. U. Eval. RR 3. (hereafter referred to as USSR. Opyt)
49. Protasov and Udyanskiy, op. cit. (45, above), p. 28. U. Eval. RR 3.
50. Ibid.
51. Pravda, 3 Mar 55. U. Eval. RR 3.
52. Izvestiya, 24 May 55, p. 2. U. Eval. RR 3.
53. Neftyanoye khozyastvo, no 1, 1955, p. 23. U. Eval. RR 3.
54. Ibid., no 3, 1947, p. 14. U. Eval. RR 3.
55. Oil and Gas Journal, vol 53, no 39, 31 Jan 55, p. 180. U. Eval. RR 1.
56. Pravda, 6 Mar 46. U. Eval. RR 3.
57. Neftyanoye khozyaystvo, no 8, 1955, p. 7-8. U. Eval. RR 3.
58. Ibid., no 6, 1954, p. 10. U. Eval. RR 3.
59. Pravda, 6 Dec 54, p. 2. U. Eval. RR 3.
60. Ibid., 27 May 55, p. 2. U. Eval. RR 3.
61. Neftyanoye khozyaystvo, no 4, 1954, p. 88. U. Eval. RR 3.
62. Pravda, 3 Mar 55, p. 2. U. Eval. RR 3.
63. Ibid., 1 Jul 54, p. 2. U. Eval. RR 3.
64. Izvestiya, 2 Mar 55, p. 2. U. Eval. RR 3.
65. Planovoye khozyaystvo, no 5, Sep-Oct 55. U. Eval. RR 3.
66. Izvestiya, 2 Mar 55, p. 2. U. Eval. RR 3.
67. Protasov and Udyanskiy, op. cit. (45, above), p. 213-215. U. Eval. RR 3.
68. Rice Institute, Department of Economics. Petroleum Research Project, Capital Requirements Arising from the Drilling of Wells for Oil, Gas and Condensate, Houston, 1 Jul 52, p. 105. U. Eval. RR 1.
69. Neftyanoye khozyaystvo, no 8, 1955, p. 22. U. Eval. RR 3.
70. Ibid., no 1, 1955, p. 28. U. Eval. RR 3.
71. Ibid., no 8, 1955, p. 22. U. Eval. RR 3.

72. Neftyanoye khozyaystvo, no 8, 1955, p. 22. U. Eval. RR 3.
73. Ibid., no 7, 1948, p. 3. U. Eval. RR 3.
74. USSR. Bol'she, p. 59. U. Eval. RR 3.
75. Neftyanoye khozyaystvo, no 8, 1955, p. 19. U. Eval. RR 3.
76. Protasov and Udyanskiy, op. cit. (45, above), p. 214. U. Eval. RR 3.
77. USSR. Preyskurant (25, above).
78. Protasov and Udyanskiy, op. cit. (45, above), p. 362-363. U. Eval. RR 3.
79. Ibid.
80. Murav'yev, V.M. Spravochnik dlya masterov po dobyche nefti (A Handbook for Masters of Petroleum Extraction), Moscow, p. 7. U. Eval. RR 3.
81. Nikolayevskiy, N.M. Ekonomika razrabotki neftyanykh mestorozhdeniy (The Economics of Working Petroleum Deposits), Moscow, 1946, p. 36. U. Eval. RR 3.
82. Ibid., p. 35. U. Eval. RR 3.
83. Izvestiya, 6 Feb 55. U. Eval. RR 3.
Neftyanoye khozyaystvo, no 6, 1954, p. 22. U. Eval. RR 3.
84. Neftyanoye khozyaystvo, no 8, 1954, p. 12. U. Eval. RR 3.
85. USSR. Preyskurant (25, above), p. 200-210. U. Eval. RR 3.
86. Nikolayevskiy, op. cit. (81, above).
87. Planovoye khozyaystvo, no 5, Sep-Oct 55. U. Eval. RR 3.
88. Bakinskiy rabochiy, 22 Sep 55. U. Eval. RR 3.
89. Ibid., 17 Sep 55. U. Eval. RR 3.
90. Ibid., 22 Sep 55. U. Eval. RR 3.
91. Protasov and Udyanskiy, op. cit. (45, above), p. 366-367. U. Eval. RR 3.
92. Ibid., p. 360-366. U. Eval. RR 3.
93. Neftyanoye khozyaystvo, no 12, 1955, p. 19. U. Eval. RR 3.
94. USSR. Preyskurant (25, above).
95. Ibid., p. 200-210. U. Eval. RR 3.
96. Neftyanoye khozyaystvo, no 9, 1955, p. 7-9. U. Eval. RR 3.
97. Bakinskiy rabochiy, 22 Sep 55. U. Eval. RR 3.
98. Protasov and Udyanskiy, op. cit. (45, above), p. 362-365. U. Eval. RR 3.
99. Neftyanoye khozyaystvo, no 12, 1955, p. 19. U. Eval. RR 3.
100. CIA. FDD U-7042, 6 Jun 55, chap 4, p. 10. OFF USE. Eval. RR 3. (tr of P.M. Fomichev. Finansirovaniye bureniya neftyanykh i gazovykh skvazhin (Financing the Drilling of Oil and Gas Wells), Moscow, 1953. U)

101. Ibid., Appendix 9, p. 26. OFF USE. Eval. RR 3.
102. Neftyanoye khozyaystvo, no 9, 1955, p. 8. U. Eval. RR 3.
103. Prok, I.Ya. Prakticheskoye rukovodstvo po ekspluatatsii skvazhin dlya masterov po dobyche nefti (A Practical Guide in the Use of Wells for Masters of Petroleum Extraction), Moscow, 1954, p. 31. U. Eval. RR 3.
104. Neftyanoye khozyaystvo, no 7, 1955, p. 3. U. Eval. RR 3.
105. Prok, op. cit. (103, above), p. 32. U. Eval. RR 3.
USSR. Bol'she. p. 12. U. Eval. RR 3.
106. Oil and Gas Journal, vol 53, no 39, 31 Jan 55, p. 140. U. Eval. RR 1.
107. Chizhichenko, D.A., Bazlov, M.N., and Tsyganok, P.I. Neftepromyslovoye khozyaystvo (The Petroleum Industry), Moscow, 1952, p. 67-68. U. Eval. RR 3.
108. Izvestiya, 24 May 55, p. 2. U. Eval. RR 3.
109. Nikolayevskiy, op. cit. (81, above).
110. Protasov and Udyanskiy, op. cit. (45, above), p. 191-193. U. Eval. RR 3.
111. USSR, Byuro Tekhniko-Ekonomicheskoy Informatsii Tsimtnefti. Iz praktiki bureniya v rayonakh Vtorogo Baku (From Drilling Practice in the Regions of the Second Baku /Oil Well/), Moscow, 1950, p. 5. U. Eval. RR 3.
Neftyanoye khozyaystvo, no 2, 1954, p. 63. U. Eval. RR 3.
112. Protasov and Udyanskiy, op. cit. (45, above), p. 191-193. U. Eval. RR 3.
113. Neftyanoye khozyaystvo, no 8, 1955, p. 8. U. Eval. RR 3.
114. Ibid., no 2, 1955, p. 9. U. Eval. RR 3.
115. Ibid., no 8, 1955, p. 8. U. Eval. RR 3.
116. Ibid., no 7, 1954, p. 80. U. Eval. RR 3.
117. World Petroleum Report, 1955 ed, New York, 1955, p. 115. U. Eval. RR 1.
118. Brantly, J.E. Rotary Drilling Handbook, 5th ed, New York, 1952, p. 207-209. U. Eval. RR 1.
119. Uren, L.C. Petroleum Production Economics, 1st ed, New York, 1950, p. 435-437. U. Eval. RR 1.
120. Ogonek, no 11, Mar 55, p. 2. U. Eval. RR 3.
121. Neftyanoye khozyaystvo, no 9, 1955, p. 10. U. Eval. RR 3.
122. Ibid., no 1, 1955, p. 23-24. U. Eval. RR 3.
123. Ibid., no 1, 1947, p. 18. U. Eval. RR 3.
124. Ibid., no 1, 1955, p. 23-24. U. Eval. RR 3.
125. Ibid.
126. CIA. FDD U-7042 (100, above), Appendix 8, p. 22. OFF USE. Eval. RR 3.

127. Neftyanoye khozyaystvo, no 9, 1955, p. 10. U. Eval. RR 3.
128. Ibid., no 8, 1955, p. 8. U. Eval. RR 3.
129. Protasov and Udyanskiy, op. cit. (45, above), p. 193, U. Eval. RR 3.
130. Ogonek (120, above).
131. Protasov and Udyanskiy, op. cit. (45, above), p. 406-407. U. Eval. RR 3.
132. Neftyanoye khozyaystvo, no 1, 1955, p. 29. U. Eval. RR 3.
133. Protasov and Udyanskiy, op. cit. (45, above), p. 428. U. Eval. RR 3.
134. World Petroleum Report, op. cit. (117, above).
135. Planovoye khozyaystvo, no 2, 1945, p. 64. U. Eval. RR 3.
136. CIA. FDD U-7042 (100, above), Appendix 9, p. 27. OFF USE. Eval. RR 3.
137. Protasov and Udyanskiy, op. cit. (45, above), p. 428. U. Eval. RR 3.
138. Neftyanoye khozyaystvo, no 2, 1954, p. 61. U. Eval. RR 3.
139. Ibid., no 6, 1954, p. 17. U. Eval. RR 3.
140. Ibid., no 4, 1955, p. 87. U. Eval. RR 3.
141. USSR. Bol'she (34, above), p. 85, U. Eval. RR 3.
142. Ibid., p. 86. U. Eval. RR 3.
143. Neftyanoye khozyaystvo, no 1, 1955, p. 27-28. U. Eval. RR 3.
144. Ibid., p. 29. U. Eval. RR 3.
145. USSR. Bol'she (34, above).
146. CIA. FDD U-7042 (100, above), Appendix 9, p. 21. OFF USE. Eval. RR 3.
147. Neftyanoye khozyaystvo, no 6, 1955, p. 8. U. Eval. RR 3.
148. Petroleum Data Book, 2d ed, Dallas, 1948, p. D-18. U. Eval. RR 1.
149. Rice Institute (68, above), p. 95-98. U. Eval. RR 1.
150. Tomashpol'skiy, op. cit. (21, above).
151. Energeticheskiy byulleten', no 12, 1947, p. 22. U. Eval. RR 3.
152. Ibid., no 5, 1951, p. 29. U. Eval. RR 3.
153. USSR. Opyt (48, above), p. 84. U. Eval. RR 3.
154. USSR. Bol'she (34, above), p. 59. U. Eval. RR 3.
155. Neftyanoye khozyaystvo, no 1, 1955, p. 27. U. Eval. RR 3.
156. Energeticheskiy byulleten', no 6, 1947, p. 1-9. U. Eval. RR 3.
157. Neftyanoye khozyaystvo, no 6, 1955, p. 8. U. Eval. RR 3.
158. Energeticheskiy Byulleten', no 12, 1947, p. 22. U. Eval. RR 3.
159. Ibid., no 10, 1948, p. 26-28. U. Eval. RR 3.
160. Neftyanoye khozyaystvo, no 8, 1955, p. 20. U. Eval. RR 3.

161. Kutsenov, V.A., and Shteyngauz, E.O. Voprosy tekhniko-ekonomicheskogo proyektirovaniya krupnykh gidrostantsiy v energosistemakh (Problems of Technical and Economic Planning of Large Hydroelectric Power Stations in Power Systems), Moscow, 1953, p. 368. U. Eval. RR 3.
162. Energeticheskiy byulleten', no 12, 1947, p. 21. U. Eval. RR 3.
163. Kutsenov and Shteyngauz, op. cit. (161, above).
164. Ibid.
165. Neftyanoye khozyaystvo, no 7, 1955, p. 3. U. Eval. RR 3.
166. Energeticheskiy byulleten', no 12, 1947, p. 21. U. Eval. RR 3.
167. Ibid.
168. Kutsenov and Shteyngauz, op. cit. (161, above).
169. Bakinskiy rabochiy, 21 Oct 55. U. Eval. RR 3.
170. Mozzhukhin, P.V., op. cit. (18, above), p. 91. U. Eval. RR 3.
171. Energeticheskiy byulleten', no 12, 1947, p. 22. U. Eval. RR 3.
172. Neftyanoye khozyaystvo, no 8, 1955, p. 20. U. Eval. RR 3.
173. Planovoye khozyaystvo, no 1, 1947, p. 44. U. Eval. RR 3.
174. Energeticheskiy byulleten', no 12, 1947, p. 21. U. Eval. RR 3.
175. Ibid.
176. Kutsenov and Shteyngauz, op. cit. (161, above).
177. Energeticheskiy byulleten', no 12, 1947, p. 21. U. Eval. RR 3.
178. Ibid.
179. Golyakov, P.A., and Guryevich, Ya.D. Spravochnik po normirovaniya na neftepromyslakh (Handbook on Standardization in the Petroleum Industry), Moscow, 1948, p. 87. U. Eval. RR 3.
180. Ibid. Eval. RR 3.
181. Ibid., p. 87-93. U. Eval. RR 3.
182. Neftyanoye khozyastvo, no 9, 1948, p. 42. U. Eval. RR 3.
183. Ibid.
184. Nikolayevskiy, N.M. Proizvoditel'nost' truda v promyshlennosti SSR (Productivity of Labor in the Industry of the USSR), Moscow-Leningrad, 1940, p. 160-163. U. Eval. RR 3.
185. USSR. Bol'she (34, above), p. 29. U. Eval. RR 3.
186. Neftyanoye khozyaystvo, no 7, 1955, p. 2. U. Eval. RR 3.
187. Izvestiya, 28 Dec 55. U. Eval. RR 3.
188. Neftyanoye khozyaystvo, no 7, 1955, p. 2. U. Eval. RR 3.
189. Ibid., p. 1. U. Eval. RR 3.
190. Ibid., p. 3. U. Eval. RR 3.
191. Ibid., no 8, 1955, p. 8. U. Eval. RR 3.
192. Ibid., no 1, 1955, p. 23. U. Eval. RR 3.
193. Ibid., no 10, 1955, p. 4. U. Eval. RR 3.

194. Brenner, M.M. Tekhpromfinplan neftedobyvayushchego tresta (Technical Industrial and Financial Plan for a Petroleum Extraction Trust), Moscow, 1951, p. 58, 95. U. Eval. RR 3.
195. Yevseyenko, M.A., ed. Spravochnik po bureniyu neftyanykh skvazhin (Handbook of Drilling Oil Wells), Moscow, 1947, p. 3. U. Eval. RR 3.
196. Neftyanoye khozyaystvo, no 7, 1955, p. 3. U. Eval. RR 3.
197. Brenner, op. cit. (194, above), p. 94-97. U. Eval. RR 3.
Neftyanoye khozyaystvo, no 3, 1947, p. 11. U. Eval. RR 3.
198. Neftyanoye khozyaystvo, no 8, 1955, p. 8. U. Eval. RR 3.
Ibid., no 9, 1955, p. 7-11. U. Eval. RR 3.
Pravda, 6 Dec 54. U. Eval. RR 3.
199. Neftyanoye khozyaystvo, no 3, 1947, p. 11-12. U. Eval. RR 3.
200. Ibid., no 9, 1955, p. 7. U. Eval. RR 3.
201. CIA. FDD U-7042 (100, above).
202. Neftyanoye khozyaystvo, no 12, 1955, p. 19. U. Eval. RR 3.
203. Brenner, op. cit. (194, above), p. 65. U. Eval. RR 3.
204. USSR. Preyskurant (24, above).
205. Ibid., p. 203, 205. U. Eval. RR 3.
206. Ibid., p. 200-210. U. Eval. RR 3.
207. Neftyanoye khozyaystvo, no 9, 1955, p. 12. U. Eval. RR 3.
208. Ibid., no 3, 1955, p. 92. U. Eval. RR 3.
209. Mozzhukhin, op. cit. (18, above), p. 137. U. Eval. RR 3.
210. Pravda, 4 Jul 55, p. 2. U. Eval. RR 3.
211. Neftyanoye khozyaystvo, no 1, 1955, p. 28. U. Eval. RR 3.
212. Stroitel'naya gazeta, 28 Aug 55, p. 3. U. Eval. RR 3.
213. Neftyanoye khozyaystvo, no 3, 1947, p. 11-12. U. Eval. RR 3.
214. USSR. Preyskurant (24, above), p. 143. U. Eval. RR 3.
215. Neftyanoye khozyaystvo, no 4, 1947, p. 62. U. Eval. RR 3.
216. USSR. Preyskurant (24, above).
217. Ibid., no 3, 1947, p. 10-12. U. Eval. RR 3.
218. Pravda, 6 Dec 54, U. Eval. RR 3.
Izvestiya, 28 Dec 55. U. Eval. RR 3.
219. Trud, 7 Apr 55. U. Eval. RR 3.
220. Petroleum Data Book, 1st ed, Dallas, 1947, p. D 124-D 126. U. Eval. RR 1.
221. World Petroleum, May 55, p. 84. U. Eval. RR 1.
222. Ibid.
223. Oil and Gas Journal, vol 53, no 39, 31 Jan 55, p. 185. U. Eval. RR 1.
224. World Petroleum (221, above), p. 156. U. Eval. RR 1.

225. CIA. CIA/RR 61 (2, above), p. 22. S/US ONLY.
226. Canada, Petroleum and Natural Gas Conservation Board. Alberta Petroleum Industry, 1946, Calgary, 1946, p. 1. U. Eval. RR 1.
227. Canada, Dominion Bureau of Statistics, The Crude Petroleum and Natural Gas Industry, 1949, Ottawa, 1949, p. H-6. U. Eval. RR 1.
228. 1947 World Oil Atlas, 30 Jun 47, p. 35, 71. U. Eval. RR 1.
229. Canada, Petroleum and Natural Gas Conservation Board. Alberta Petroleum Industry, 1947, Calgary, 1947, p. 1. U. Eval. RR 1.
230. American Institute of Mining and Metallurgical Engineers. Statistics of Oil and Gas Development and Production Covering 1949, New York, 1950, vol 4, p. 409. U. Eval. RR 1.
231. American Institute of Mining and Metallurgical Engineers. Statistics of Oil and Gas Development and Production Covering 1951, vol 6, New York, 1952, p. 574. U. Eval. RR 1.
232. World Oil, 15 Jul 51, Houston, p. 150. U. Eval. RR 1.
233. American Gas Association and American Petroleum Institute. Proved Reserves of Crude Oil, Natural Gas Liquids and Natural Gas, 31 Dec 51, p. 21. U. Eval. RR 1.
234. Canadian Petroleum Association, Statistical Branch. Statistical Bulletin, Canadian Petroleum Association, Fall 1955. U. Eval. RR 1.
235. American Gas Association and American Petroleum Institute. Proved Reserves of Crude Oil, Natural Gas Liquids and Natural Gas, 31 Dec 52, p. 21. U. Eval. RR 1.
236. Ibid., 31 Dec 53, p. 21. U. Eval. RR 1.
237. Ibid., 31 Dec 54, p. 21. U. Eval. RR 1.
238. World Oil, Dec 54, p. 218. U. Eval. RR 1.
239. Canada, Petroleum and Natural Gas Conservation Board (226, above), p. 5. U. Eval. RR 1.
240. Canada, Dominion Bureau of Statistics. The Crude Petroleum Industry, 1948, Ottawa, 1948, p. 3. U. Eval. RR 1.
241. World Oil, 15 Jul 49, p. 77. U. Eval. RR 1.
242. Canada, Petroleum and Natural Gas Conservation Board (229, above), p. 6. U. Eval. RR 1.
243. Petroleum Data Book, 2d ed, Dallas, 1948, p. B-66. U. Eval. RR 1.
244. World Oil, 15 Jul 49, p. 72. U. Eval. RR 1.
245. Ibid., 15 Jul 51, p. 154. U. Eval. RR 1.

246. American Institute of Mining and Metallurgical Engineers. Statistics of Oil and Gas Development and Production Covering 1949, vol 4, New York, 1950, p. 409. U. Eval. RR 1.
247. World Oil, 15 Jul 51, p. 154. U. Eval. RR 1.
248. American Institute of Mining and Metallurgical Engineers. Statistics of Oil and Gas Development and Production Covering 1950, vol 5, New York, 1951, p. 476. U. Eval. RR 1.
249. World Petroleum, May 55, New York, p. 56. U. Eval. RR 1.
250. Drilling, Aug 52, vol 13, no 10, p. 60. U. Eval. RR 1.
251. American Institute of Mining and Metallurgical Engineers. Statistics of Oil and Gas Development and Production Covering 1952, vol 7, New York, 1953, p. 586. U. Eval. RR 1.
252. American Institute of Mining and Metallurgical Engineers. Statistics of Oil and Gas Development and Production Covering 1953, vol 8, New York, 1954, p. 424. U. Eval. RR 1.
253. World Oil, Dec 54, p. 220. U. Eval. RR 1.
254. Canada, Petroleum and Natural Gas Conservation Board (226, above), p. 5. U. Eval. RR 1.
255. Canada, Dominion Bureau of Statistics. The Crude Petroleum Industry in Canada, 1946, Ottawa, 1947, p. 2. U. Eval. RR 1.
256. Canada, Dominion Bureau of Statistics. The Crude Petroleum Industry in Canada, 1947, Ottawa, 1949, p. 2. U. Eval. RR 1.
257. Canada, Dominion Bureau of Statistics. The Crude Petroleum Industry, 1948, Ottawa, 1948, p. 1. U. Eval. RR 1.
258. Canada, Dominion Bureau of Statistics (227, above), p. H-3. U. Eval. RR 1.
259. CIA. CIA/RR 61 (2, above), p. 22. S/US ONLY.
260. Ibid.