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RESEARCH AID

PRODUCTION OF NATURAL GAS AND  
NATURAL-GAS LIQUIDS IN THE USSR



ORR PROJECT 25.192

28 May 1954

CENTRAL INTELLIGENCE AGENCY

OFFICE OF RESEARCH AND REPORTS

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FOREWORD

This research aid represents the first effort to estimate the postwar production in the USSR of the three components comprising total petroleum production: crude oil, natural-gas liquids, and natural gas. Official Soviet published prewar data, as shown in this research aid, clearly discriminate between these three components of petroleum production. Conversely, the fragmentary data on quantitative postwar petroleum production claimed by the USSR cannot be concisely related to either total petroleum production or any combination of petroleum production components.

In the USSR the term neft' (translated as either petroleum or oil) is used indiscriminately to designate crude oil only, crude oil plus natural-gas liquids, or crude oil plus unrevealed quantities of natural gas. This use contrasts with US practice of designating crude oil, natural-gas liquids, and natural gas as separate components of petroleum.

To illustrate the relative size of petroleum production in the USSR and the US, the claimed production of neft' in the USSR is usually compared with the production of crude oil in the US. For example, 1953 US production of crude oil of 316 million metric tons is compared with the Soviet-claimed production of 52 million metric tons, indicating US production to be about 6 times that of the USSR.

In recent years the Soviet-claimed production of neft' actually has included increasing quantities of natural-gas liquids, thus invalidating the comparison. A more accurate estimate of the relative petroleum production in the two countries is given by a comparison of the total output of petroleum -- crude oil plus natural-gas liquids plus natural gas. On this basis, the 1953 US production of 545 million metric tons compared with the estimated Soviet production of 57.2 million metric tons indicates that US production was 9.5 times that of the USSR, more than 50 percent greater than the ratio derived by the commonly used method of comparison.

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PRODUCTION OF NATURAL GAS AND NATURAL-GAS LIQUIDS  
IN THE USSR\*

Summary

It is estimated that natural-gas liquids produced in the USSR in 1953 were equal to about 6 percent of the weight of crude oil, as contrasted with a 10-percent ratio in the US. It appears that in Soviet oilfields additional natural-gas liquids can be recovered from wet natural gas now being wasted, probably with less effort than would be required for an equivalent increase in crude oil.

The utilization of natural gas in the USSR is in its early stages. Existing pipelines are mostly low-capacity short lines designed to serve local needs in or near the oil and gas fields. Since World War II, a few large-capacity natural-gas trunk lines, designed to transport natural gas from the fields to large centers such as Moscow and Kiev, have been completed. The capacity of these lines is probably being increased by looping (paralleling) and by other measures. The Fifth Five Year Plan (1951-55) calls for an 80-percent increase in gas production.

Current production estimates for 1953 are 49.6 million metric tons\*\* of crude oil, 3.1 million tons of natural-gas liquids, and 4.5 million tons of natural gas. The sum of these 3 components indicates a total 1953 petroleum production in the USSR of 57.2 million tons. The current Soviet claims for the production of neft' (translated as either petroleum or oil) in the USSR in 1953 are from 52 to 53 million tons.

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\* The estimates and conclusions contained in this research aid represent the best judgment of the responsible analyst as of 15 Feb 1954.  
\*\* Tonnages throughout this research aid are given in metric tons.

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I. Production.

Estimates and forecasts of the production of natural gas and natural-gas liquids in the USSR by years from 1927-28 to 1940 and from 1945 to 1955 are given in Table 1.\* No effort has been made to estimate the production of these commodities during the World War II years, 1941 through 1944.

Also shown in Table 1 are the estimates of the annual production of crude oil in the USSR and of the total production of petroleum -- crude oil plus natural-gas liquids plus natural gas. A column headed "Total Liquid Hydrocarbons" shows the sum of the production of crude oil plus natural-gas liquids.

The estimates and forecasts shown in Table 1 are based upon the most reasonable evaluations of the meaning of the fragmentary quantitative data available in the postwar period. The possible minimum and maximum values are based upon the corresponding extreme alternate assumptions concerning these data. Presentation of the fragmentary data, citation of sources, and discussion of the assumptions and their application are discussed in detail in Appendix A.

Prewar data in Table 1 are largely from official sources discussed in Appendix A and cited in Appendix C.

II. Terminology and Technology.

Definitions of the terms crude oil, natural-gas liquids, natural gas, and petroleum are given in Appendix A. This appendix also covers the terminology and the technology of recovery of these components from oil and gas deposits. Briefly, the three components of petroleum, crude oil, natural-gas liquids, and natural gas, are intimately associated in all oil deposits and, in exploiting such deposits, are extracted simultaneously from oil wells. In gas deposits (which are exploited by gas wells), only two components occur, natural-gas liquids and natural gas. In some gas deposits producing so-called "dry" gas, only negligible quantities of natural-gas liquids are present. In contrast, practically all oil deposits, and many gas deposits, yield "wet" gas, from which natural-gas liquids can be extracted in sufficient quantities to warrant the processing of such gas. The processing of wet gas for recovery of natural-gas liquids may range from simple scrubbers for the recovery of "drip" gasoline, or "lease condensate," to complex modern

\* Table 1 follows on p. 3.



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Table 1

Estimated Production of Crude Oil, Natural-Gas Liquids, and Natural Gas in the USSR  
1927-28 - 1940 and 1945-55 a/\*

Year	Crude Oil			Natural-Gas Liquids			Total Liquid Hydrocarbons			Natural Gas			Total Petroleum		
	Estimated Probable Quantity b/	Estimated Maximum Range	Estimated Probable Quantity c/	Estimated Maximum Range	Estimated Probable Quantity b/	Estimated Maximum Range	Estimated Probable Quantity c/	Estimated Maximum Range	Estimated Probable Quantity c/	Estimated Maximum Range	Estimated Probable Quantity b/	Estimated Maximum Range	Estimated Probable Quantity b/	Estimated Maximum Range	
Prewar															
1927-28	11.472		0.024		11.496		0.253		11.749		0.273		11.749		
1928-29	13.509		0.028		13.537		0.273		13.810		0.417		13.810		
1930	18.451		0.055		18.506		0.417		18.923		0.691		18.923		
1931	22.392		0.079		22.471		0.691		23.162		0.810		23.162		
1932	21.413		0.096		21.509		0.810		22.319		1.328		22.319		
1933	21.489		0.087		21.576		0.882		22.458		1.559		22.458		
1934	24.218		0.066		24.284		1.328		25.612		1.840		25.612		
1935	25.238		0.087		25.325		1.559		26.884		1.848		26.884		
1936	27.890		0.116		28.006		1.848		29.846		1.878		29.846		
1937	28.501		0.136		28.637		1.848		30.485		1.979		30.485		
1938	30.186		0.167		30.353		1.878		32.231		2.091		32.231		
1939	30.417		0.189		30.606		1.979		32.585				32.585		
1940	30.661		0.221		30.882		2.091		32.973				32.973		

\* Footnotes for Table 1 follow on p. 4.

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Table 1

Estimated Production of Crude Oil, Natural-Gas Liquids, and Natural Gas in the USSR  
1927-28 - 1940 and 1945-55 a/  
(Continued)

Year	Crude Oil			Natural-Gas Liquids			Total Liquid Hydrocarbons			Natural Gas			Total Petroleum		
	Estimated Probable Quantity b/	Estimated Maximum Range	Estimated Probable Quantity c/	Estimated Maximum Range	Estimated Probable Quantity b/	Estimated Maximum Range	Estimated Probable Quantity c/	Estimated Maximum Range	Estimated Probable Quantity c/	Estimated Maximum Range	Estimated Probable Quantity b/	Estimated Maximum Range	Estimated Probable Quantity b/	Estimated Maximum Range	
Postwar															
1945	19.4	17.2 to 19.4	0.1	0.1 to 0.1	19.5	17.3 to 19.5	2.3	2.0 to 2.3	21.8	19.3 to 21.8					
1946	21.7	19.2 to 21.7	0.2	0.2 to 0.2	21.9	19.4 to 21.9	2.6	2.3 to 2.6	24.5	21.7 to 24.5					
1947	26.0	22.7 to 26.0	0.3	0.3 to 0.3	26.3	23.0 to 26.3	3.2	2.8 to 3.2	29.5	25.8 to 29.5					
1948	29.4	25.8 to 29.4	0.4	0.4 to 0.4	29.8	26.2 to 29.8	3.5	3.1 to 3.5	33.3	29.2 to 33.3 d/					
1949	33.6	29.7 to 33.6	0.6	0.5 to 0.6	34.2	30.2 to 34.2	3.7	3.3 to 3.7	37.9	33.5 to 37.9					
1950	37.6	33.4 to 37.6	0.8	0.7 to 0.8	38.4	34.1 to 38.4	3.9	3.5 to 3.9	42.3	37.6 to 42.3					
1951	41.6	37.2 to 42.0	1.2	1.1 to 1.2	42.8	38.3 to 43.2	4.2	3.8 to 4.2	47.0	42.0 to 47.4 g/					
1952	45.6	41.2 to 47.0	2.1	1.9 to 2.2	47.7	43.1 to 49.2	4.3	3.9 to 4.4	52.0	47.0 to 53.6					
1953	49.6	45.1 to 52.0	3.1	2.8 to 3.2	52.7	47.9 to 55.2	4.5	4.1 to 4.7	57.2	52.0 to 59.9					
1954	53.6	51.7 to 60.8	4.0	3.9 to 4.5	57.6	55.6 to 65.3	5.5	5.3 to 6.2	63.1	60.9 to 71.5					
1955	57.6	57.6 to 69.6	5.0	5.0 to 6.0	62.6	62.6 to 75.6	7.0	7.0 to 8.5	69.6	69.6 to 84.1					

a. Data from Appendix A, Tables 8, 9, and 12, which follow on pp. 25, 30, and 37, respectively.

b. Estimated to be correct within plus or minus 1 percent for the years 1927-28 to 1940.

c. Estimated to be correct within plus or minus 10 percent for the years 1927-28 to 1940.

d. Because of rounding, these totals differ from a summation of their components.

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plants designed for the selective recovery of the several lighter hydrocarbons comprising the entire range of natural-gas liquids. A brief presentation of these various processes is given in Appendix A.

III. US Practice and Data.

In the US, specific quantitative data are compiled and published covering the production of each of the three components comprising petroleum -- crude oil, natural-gas liquids, and natural gas, and, since 1946, annual estimates of the proved reserves of each of these three components have been compiled and published by a joint committee of the American Petroleum Institute and the American Gas Association. 1/\* Table 2 shows the annual production of these components in the US for 1946 and for 1953 in millions of metric tons and in percentage by weight of the crude oil.

Table 2

Production of Crude Oil, Natural-Gas Liquids, and Natural Gas in the US  
1946 and 1953

Component	1946		1953	
	Quantity (Million Metric Tons)	Crude Oil (Percent)	Quantity (Million Metric Tons)	Crude Oil (Percent)
Liquid Hydrocarbons				
Crude Oil	235	100.0	316	100.0
Natural-Gas Liquids	13	5.5	32	10.1
Total	<u>248</u>	<u>105.5</u>	<u>348</u>	<u>110.1</u>
Marketed Natural Gas	94	40.0	197	62.3
Total Petroleum	<u>342</u>	<u>145.5</u>	<u>545</u>	<u>172.4</u>

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

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Following is a comparison of the average annual growth in the production of each of the components listed in Table 2, during the period 1946-53:

	<u>Percent</u>
Crude Oil	4.3
Natural-Gas Liquids	13.7
Natural Gas	11.1

Thus in the postwar period the US production of natural-gas liquids has increased at a rate of 3.1 times that of crude oil, and the production of natural gas has increased at a rate of 2.6 times that of crude oil. Furthermore, this high rate of increase for these two components was from a relatively high level of output at the beginning of the 1946-53 period. Several factors account for these high postwar growth rates. For natural-gas liquids the principal factor is the low cost of labor and material required per barrel for the recovery of natural-gas liquids from the gas being extracted from oil and gas deposits compared with the cost per barrel of new crude-oil production. Published cost studies <sup>2/</sup> indicate that the capital investment required per barrel of daily increase in natural-gas liquids production is \$1,313 compared with parallel investment of \$3,664 for crude oil. The postwar growth of marketed natural gas in the US has been made possible by the construction of several new transcontinental natural-gas trunk lines connecting the sources of supply with large markets for natural gas.

IV. Soviet Practice and Data.

Russian language texts published in Moscow since 1950 reveal a technological grasp of petroleum-industry practices comparable with those in the US during the postwar period. The extent to which these practices have been applied is assumed to depend upon the economic advantage to be gained related to the input of labor and materials needed to attain such an economic advantage.

A recently published Russian language text <sup>3/</sup> for use by the Soviet petroleum industry gives comprehensive and relevant data on the problems of the gas industry, including the extraction and

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recovery of natural gas and natural-gas liquids from oil and gas deposits. This text indicates that technical capabilities to produce these latter components in the USSR compare favorably with such capabilities in the US.

Table 3 shows the estimated annual production of crude oil, natural-gas liquids, and natural gas in the USSR for 1945 and 1953 taken from Table 1, for comparison with similar data for the US shown in Table 2.

Table 3

Production of Crude Oil, Natural-Gas Liquids, and Natural Gas  
in the USSR  
1945 and 1953

Components	1945		1953	
	Quantity (Million Metric Tons)	Crude Oil (Percent)	Quantity (Million Metric Tons)	Crude Oil (Percent)
Liquid Hydrocarbons				
Crude Oil	19.4	100.0	49.6	100.0
Natural-Gas Liquids	0.1	0.5	3.1	6.3
Total	<u>19.5</u>	<u>100.5</u>	<u>52.7</u>	<u>106.3</u>
Marketed Natural Gas	2.3	11.9	4.5	9.1
Total Petroleum	<u>21.8</u>	<u>112.4</u>	<u>57.2</u>	<u>115.4</u>

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V. Production of Natural-Gas Liquids in the USSR.

In Table 3 it will be noted that the estimated production of natural-gas liquids in the USSR in 1953 is equal to 6.3 percent of the production of crude oil. This is slightly higher than the 5.5 percent shown in Table 2 for the US in 1946 but substantially below the 10.1 percent for the US in 1953. The rate of increase of the production of natural-gas liquids in the USSR in the postwar period, as reflected by the estimates in Table 3, is high. The production of this component of the production of petroleum in the USSR, however, started from a very low level in 1945. In addition, the increased production of crude oil in the USSR since 1948 has been almost wholly from new and deeper deposits in which the availability of natural-gas liquids is much higher than in the older and shallower deposits which were the principal source of petroleum in the USSR in the prewar years and during the immediate postwar years of restoration and rehabilitation of the old producing oilfields.

Table 1 indicates an estimated current rate of increase of approximately 1 million tons per year in the production of natural-gas liquids in the USSR. This high rate of increase cannot be sustained after the capacity for processing wet gas withdrawn from the oil, which has been previously flared (wasted), approaches the quantity of such wet gas available for processing. It is estimated that this condition will develop after 1955 and that the annual growth in the production of natural-gas liquids in the USSR after that time will trend toward the annual rate of increase in the production of crude oil, rather than maintain the high rate indicated in Table 3. This current annual increase of 1 million tons per year in the estimated production of natural-gas liquids in the USSR was first reached by the US petroleum industry in 1929, when the increase over 1928 was 1.2 million tons. As early as 1923, however, the US registered an annual increase of 0.87 million tons of natural-gas liquids. 4/

Modern postwar processing of wet gas for the recovery of natural-gas liquids, as revealed by both US 5/ and Soviet 6/ technical publications, shows a very large increase in the recovery of the natural-gas liquids entrained in wet gas. For example, from 1935 to 1951 the yield of natural-gas liquids per thousand cubic feet of gas processed increased 57 percent in the US. 7/ Because of the postwar increase in availability of wet gas for processing in the USSR, as shown in Appendix A, and because of the very substantial increase in the proportionate recovery of natural-gas liquids per unit quantity of

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wet gas, a current annual increase of 1 million tons per year for this component of the production of petroleum in the USSR is a reasonable estimate. Comparison with the known annual increases of the same component in the US in the 1920's supports this estimate.

A more detailed exposition of the basis for the postwar estimates of the production of natural-gas liquids in the USSR, as shown in Table 1, is given in Appendix A.

VI. Production of Natural Gas in the USSR.

In contrast to the estimated production of natural-gas liquids in the USSR, the postwar production of natural gas has been on a much lower level, and the annual growth in the production of natural gas has been at a much lower rate. The primary reason for this difference is the high inputs of labor and material required to build the long natural-gas trunk lines needed to transport to centers of population the large quantities of natural gas being flared in the oilfields.

Table 4 presents the most pertinent data available on natural-gas trunk lines in the USSR. More detailed data are given, and sources are cited, in Appendix A.

Table 4

Significant Data on Natural-Gas Trunk Lines in the USSR

<u>Natural-Gas Trunk Line</u>	<u>Year Completed</u>	<u>Length (Kilometers)</u>	<u>Annual Capacity (Million Metric Tons)</u>
Dashava to L'vov	1940	70	0.13
Yelshanka to Saratov	1942	18	0.20
Buguruslan to Kuybyshev	1943	160	0.20
Saratov to Moscow	1946	843	0.37
Dashava to Kiev	1948	513	0.62
Total for Eight Years		<u>1,604</u>	<u>1.52</u>

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In 1950 the Buguruslan-Kuybyshev pipe line was looped (paralleled) with another line, thereby doubling its capacity. The Saratov-Moscow and Dashava-Kiev lines were both major projects of the USSR. It is unlikely that additional projects of this size have been completed since 1948, but it is likely that the capacity of existing trunk lines has been increased by looping, by increasing the number of compressor stations, and, in some cases, by increasing the maximum operating pressures. In contrast, postwar construction of natural-gas trunk lines and branch transmission lines in the US increased from 77,280 miles in 1945 to 118,160 miles in 1952, an average annual construction of 5,840 miles (9,400 kilometers) of such lines. In 1952 the 20 major natural-gas pipe-line systems in the US operated 57,242 miles (92,122 kilometers) of main transmission lines having a maximum capacity of 15.747 million cubic feet daily, which is equivalent to an annual capacity of 135 million tons of natural gas. <sup>8/</sup> Comparison of these US data with the Soviet data shown in Table <sup>4</sup> indicates that the over-all magnitude of the natural-gas industry of the US is about 100 times that of the USSR. As the total 1953 production of petroleum in the US was 9.5 times that in the USSR, as shown in Tables 1 and 2, it is obvious that the relative position of the natural gas industry in the USSR is abnormally low.

The Fifth Five Year Plan (1951-55) <sup>9/</sup> calls for an 80-percent increase in the production of all types of fuel gas, including natural gas, during this 5-year period. This increase is reflected in Table 1, with the production of natural gas in 1950 estimated to be 3.9 million tons and in 1955 to be 7 million tons. The Fifth Five Year Plan also requires a fivefold increase in pipe-line transport. The estimates of the production of natural gas in the USSR for the postwar period, 1945 through 1953, and forecasts for 1954-55 are based, in general, on the capacity of the natural-gas trunk lines completed through 1948, as shown in Table 4, plus reasonable additions to the capacity of such lines in the past 5 years, plus rapidly increasing utilization of natural gas in oil-producing regions. In order to meet the goal of the Fifth Five Year Plan, an accelerated increase in such activities will be necessary in the 1954-55 year.

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APPENDIX A

METHODOLOGY

1. Introduction.

The methods used for estimating the annual production of petroleum components in the USSR, as shown in Table 1,\* are completely different in the prewar and postwar periods. This difference arises from the relative availability of data for these periods.

Official Soviet prewar production statistics on the three components of petroleum production -- crude oil, natural-gas liquids, and natural gas -- are sufficiently complete so that a minor use of conventional interpolation and extrapolation methods provides a satisfactory compilation of prewar annual estimates.

Postwar Soviet data on petroleum production, in contrast, are very fragmentary and cannot be firmly identified with either the total production of petroleum or the production of crude oil. The data given in Table 1 for the postwar period are the result of an initial analysis of the available data as described in this appendix. As additional postwar data become available and further analyses are made, the postwar data shown in Table 1 should be revised.

2. US Terminology.

a. Petroleum.

The US Bureau of Mines definition, 1945 10/ is: "Petroleum is an extremely complex mixture of naturally occurring hydrocarbons and other substances that are found in the solid, liquid, and gaseous states. Asphalts and mineral waxes are common varieties of solid petroleum; crude oil is liquid petroleum, and natural gas is a form of petroleum in the gaseous or vapor state."

This definition of petroleum is the one now most widely used by US petroleum technologists and is accepted by the American Petroleum Institute. 11/ It is quite different, however, from the

\* P. 3, above.

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definition which was in use throughout the oil industry of the US 30 years ago and is still used in some quarters: "Petroleum: an oily, inflammable, liquid mixture of numerous hydrocarbons, chiefly of the paraffin series, found in the earth." 12/

The nontechnical usage of the term "petroleum" has changed in its emphasis in the past 10 years, as revealed by the 1942 and 1953 editions of the Encyclopedia Americana. In 1942, crude oil was emphasized as the most important form of petroleum. The 1953 definition states that petroleum "appears chiefly in the form of natural gas and crude oil, either separately or in close association or inter-solution with each other."

b. Natural Gas.

The current American Petroleum Institute definition of natural gas is as follows: "Gaseous forms of petroleum, commonly called 'natural gas,' consist of mixtures of hydrocarbon gases and vapors, the more important of which are methane, ethane, propane, butane, pentane, and hexane, all of the paraffin series ( $C_n H_{2n+2}$ )." 13/

c. Natural-Gas Liquids.

The currently accepted definition of natural-gas liquids is as follows: "Natural gas liquids are defined as those hydrocarbon liquids that are gaseous in the reservoir but are obtainable by condensation or absorption. Natural gasoline, condensate, and liquefied petroleum gases fall in this category. In order to prevent misunderstanding of this term it is further amplified as follows: the natural-gas liquids are those heavier hydrocarbon components of the natural gas which may be removed and reduced to the liquid state by various processes. These processes usually take place in field separators, scrubbers, gasoline plants, or cycling plants. The liquids so collected and the products made from them in some of the modern plants are known by a variety of names, but they have been grouped together under the general heading 'Natural Gas Liquids.'" 14/

d. Petroleum Production.

In this research aid the production of petroleum applies only to that part of the petroleum withdrawn from oil and gas wells which is conserved or saved. In oilfields the natural gas produced with the crude oil is frequently flared, or wasted, because of lack of

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demand at the source. Nearly all natural gas now being flared in the US is either dry natural gas or gas so lean in natural-gas liquids that recovery is not warranted. Gasfields are not developed or produced unless the market outlet for the gas is such that the production of petroleum in the fields is the same as gross withdrawals less minor handling losses and field use.

e. Gross Withdrawals.

The term gross withdrawals, as used in US Bureau of Mines natural-gas statistics, 15/ is the sum of the marketed production of natural gas, plus the gas used in repressuring oil deposits in oil-fields, plus the gas vented and wasted. The latter category includes gas flared at field plants and other measured wastes but does not include, except where data are available, direct waste at the wells. In this research aid, estimated gross withdrawals of petroleum in the USSR is the sum of the production of petroleum plus the total waste. It is assumed, however, that production of crude oil and gross withdrawals of crude oil are identical.

3. Soviet Terminology.

The Russian word neft', with its various grammatical forms, is almost exclusively used to express the US terms "petroleum" and "oil." Neft' is translated as either petroleum or oil, and Russian-English dictionaries give both terms without well-defined preference. The word petroleum is used to a limited extent in Russian literature with the same meaning as its English counterpart. An official US Army publication 16/ gives three English equivalents for neft' -- oil, crude oil, and petroleum. On the other hand, a recent and authoritative US publication on scientific Russian 17/ shows petroleum as the only equivalent for neft' in its Russian-English vocabulary, and neft' as the only equivalent for petroleum in its English-Russian vocabulary.

It is obvious that dictionary definitions alone will not show clearly what is meant by the Russian term neft' as used by the Soviet government in its statements on the production of petroleum. Actual usage appears to be the only criterion. Postwar usage cannot be clearly defined, for no concise breakdown has been given between the production of oil and the production of gas in the postwar period, as it was in prewar statistics. For example, in the Third Five Year Plan (1938-42), 18/ the 1942 goal is stated in one place as follows: "Crude oil with gas [neft' siraya s gazom] 54 million tons." In another place appears the following: "Production of petroleum (neft') in 1942 must

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be 49.5 million tons without gas and 54 million tons with gas." This clearly indicates the use of neft' as meaning either crude oil with wet natural gas -- petroleum -- or without natural gas -- crude oil. What is meant in a given case cannot be determined unless the production of each component, crude oil and gas, is stated.

Another prewar example of the use of the word neft' is significant because it is used to compare production of crude oil only, in 1 year, with production of crude oil plus natural gas, in a later year. This practice, if it has been applied to postwar production claims and percentage increases, can be misleading. This example is in a political dictionary, or lexicon, 19/ published in Moscow in 1940. It is apparently intended for use by political writers and economists as a reference book. In the brief article on the petroleum industry on page 374, appears the statement: "The production of petroleum (neft') increased from 9.2 million tons in 1913 to 32.2 million tons in 1938, i.e., by 3.5 times. ... In the Third Five-Year Plan ending in 1942 the production of petroleum (neft') will increase to 54 million tons, ... 177 percent in relation to the year 1937." According to official Soviet statistics the 1913 production cited in the above passage includes no gas, 20/ and the 1938 figure cited includes nearly 2 million tons of natural gas. 21/

It is clear from these citations that no reliance can be placed on what is meant by the word neft' in Soviet official production claims, unless it is accompanied by concise statements showing the components included.

4. Technology.

The normal hydrocarbons found in natural-gas liquids and in natural gas, with their principal physical properties, are shown in Table 5.\*

As reflected in Table 5, the hydrocarbons comprising natural-gas liquids and natural gas occur in both vapor and liquid phases under varying conditions of temperature and pressure. Under the relatively high pressures found in underground oil deposits, a part or all of these hydrocarbons are dissolved in the oil and are therefore in the liquid phase. As the oil flows to the well and thence to the surface, the pressure drops and liberates large quantities of these dissolved hydrocarbons, so that they appear at the well head in the vapor phase.

\* Table 5 follows on p. 15.

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Table 5

Selected Physical Properties of Normal Hydrocarbons Occurring in Natural-Gas Liquids and Natural Gas 22/

Hydrocarbon	Boiling Point at Atmospheric Pressure (°F)	Specific Gravity of Gas (Air = 1.00)	Specific Gravity of Natural-Gas Liquids (at 60 Atmospheres 60°F)	Vapor Pressure (at 100°F Pounds per Square Inch Gage)	Conversion Factor (Metric Tons per Thousand Cubic Meters of Gas)
Methane	-259	0.554	0.248	N.A.	0.679
Ethane	-128	1.038	0.377	N.A.	1.273
Propane	-44	1.522	0.508	174	1.866
Butane	31	2.007	0.584	37	2.461
Pentane	97	2.491	0.631	1	3.054
Hexane	156	2.975	0.664	-10	3.647

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This oil-gas mixture at the well head is discharged into a separator, or a series of separators, where the pressure is reduced to atmospheric pressure. The liquid-phase material resulting from this primary separating process is crude oil, or stock-tank oil. The vapor phase material is wet gas which carries varying quantities of natural-gas liquids. 23/

Because of its content of natural-gas liquids, which tend to condense and choke the line, wet gas as received at the well head or field separators cannot usually be transported readily for long distances through pipelines. It is therefore gathered in relatively short lines and delivered for processing to natural gasoline plants in or near the field. Simple traps and scrubbers may be used, however, to extract part of the natural-gas liquids before the wet gas reaches the processing plant.

In 1951 there were in the US 521 plants producing natural-gas liquids. 24/ Although most of these plants are located in or near the producing oil- and gasfields, some new plants are located on natural-gas trunk lines. These plants reprocess the gas being transported and thereby recover the residual natural-gas liquids not recovered in field plants. One recent plant built at the junction of 2 large natural-gas trunk lines processes annually about 4 million tons of this relatively dry natural gas, from which nearly one-half million tons of natural-gas liquids will be recovered. 25/

Soviet technology in natural-gas liquids and natural gas closely follows US practice. This is revealed in a textbook on the gas industry published in 1953 by the Soviet Ministry of the Petroleum Industry. 26/ One interesting and significant departure in approach has been noted in this Soviet text. US technology approaches the problem with the stock-tank oil as the starting point. The undisturbed liquid-phase material in the oil deposit, which is designated reservoir oil, is related to the stock-tank oil, or crude oil, by a volume-formation factor. Thus a volume-formation factor of 1.40 means that, because of the inclusion of dissolved components which are later liberated into the vapor phase in the producing process, 1 barrel of stock-tank oil is equivalent to 1.40 barrels of reservoir oil. Soviet technology approaches this problem from the basic concept of reservoir oil (plastovaya neft'). Crude oil is then related to the reservoir oil by a fraction such as 0.80, meaning that 1 ton of reservoir oil contains 0.8 ton of crude oil, and the remaining 0.2 ton being liberated as wet natural gas.

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Initially, many oil deposits have vapor-phase, or "gas-cap," material above and in contact and equilibrium with the liquid-phase material, or reservoir oil. Other deposits, which initially have all hydrocarbons in the liquid phase, develop gas caps, or vapor-phase materials, during the producing life of the field because of the reduction of reservoir pressure below the so-called bubble point of the reservoir oil, with resultant liberation of vapor-phase material in the reservoir.

In the US, annual estimates of crude oil, natural-gas liquids, and natural gas 27/ show the distribution of the two latter components in oil deposits according to whether they are dissolved in the oil or are associated with the oil as vapor-phase material. Table 6\* shows the distribution of these components and the proved reserves in gas deposits, all in terms of percent by weight of the crude oil.

Proved reserves of petroleum components in the US represent the estimated recoverable reserves of such components from known deposits with the technology and under the economic conditions existing as of the time of the estimate. This is an important distinction which should be recognized when comparing the US with a country such as the USSR, which has a completely different economic base, even though the technology may be comparable. A competent study 28/ shows that in 1950 US technology could recover 83.1 percent by volume of the natural-gas liquids contained in the natural gas available for processing, but, because of lack of assured market demand for the lighter hydrocarbons, only 48.8 percent by volume was actually recovered. Thus only 18.8 percent of the propane was recovered, although 70 percent could have been recovered technologically. Only 50.1 percent of the butanes was recovered as compared with a 90-percent recovery technologically feasible. For the heavier hydrocarbons, 90.4 percent was recovered, compared with 96 percent technologically recoverable. Since 1950, many plants in the US have been built or modified to recover larger proportions of these light hydrocarbons. One such plant 29/ will recover essentially all of the propane and heavier hydrocarbons plus 40 percent of the ethane, which will amount to 100,000 tons per year and will be used for the manufacture of various chemicals.

It is estimated that, as of 1950, Soviet oil deposits carried about the same distribution of natural gas and natural-gas liquids as those in the US, as shown in Table 6. Because of lack of a system of natural-gas trunk lines comparable to that in the US, however, the relative

\* Table 6 follows on p. 18.

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Table 6

Distribution of Proved Reserves of Petroleum Components  
in the US in Terms of Percent by Weight of Crude Oil  
1946 and 1952

<u>Component</u>	<u>Percent</u>	
	<u>1946</u>	<u>1952</u>
Oil		
Crude Oil	<u>100.00</u>	<u>100.00</u>
Natural-Gas Liquids		
Dissolved	3.09	4.88
Associated	2.06	2.07
Total	<u>5.15</u>	<u>6.95</u>
Natural Gas		
Dissolved	14.92	18.72
Associated	21.52	19.13
Total	<u>36.44</u>	<u>37.85</u>
Total Oil	<u>141.59</u>	<u>144.80</u>
Gas		
Natural-Gas Liquids	6.93	6.49
Natural Gas	96.14	84.84
Total Gas	<u>103.07</u>	<u>91.33</u>
Total Petroleum	<u>244.66</u>	<u>236.13</u>
Total Reserves <u>a/</u>		
Crude Oil	100.00	100.00
Natural-Gas Liquids	12.08	13.44
Natural Gas	132.58	122.69
Total Petroleum	<u>244.66</u>	<u>236.13</u>

a. From both gas and oil deposits.



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proportion of developed natural-gas deposits in the USSR is far below that of the US. For the same reason, the production of natural gas -- the natural gas actually recovered and utilized -- in oilfields is far below current US production.

Oilfields in the USSR before World War II were mostly the older, shallow fields in which the proportion of natural-gas liquids and natural gas was much lower than it is in more recently developed fields. An ever-increasing proportion of the Soviet petroleum production is from the new, deep fields in the Ural-Volga basin and from deeper deposits in the old producing areas.

This changing condition is reflected in Table 7,\* showing distribution of petroleum components in the USSR in percent by weight of crude oil for selected years. In order to indicate the range of variation of those components, the same data for recent years in the US as a whole and for selected oil-producing states are also shown. The Soviet data in Table 7 are derived from Tables 8\*\* and 9.\*\*\* It will be noted that the 1952 US data on production and withdrawals of petroleum components in Table 7 check closely with the distribution of the proved reserves of such components in the oil deposits of the US, as shown in Table 6.

##### 5. Transportation and Utilization.

This research aid is concerned primarily with the production of natural gas and natural-gas liquids in the USSR, and aside from limited data on natural-gas trunk lines, no quantitative data are presented on the transportation and utilization of these components. Certain significant qualitative data will be presented in this section, however, as an aid in appraising the validity of the estimated distribution of the production of natural-gas liquids and natural gas in the USSR as shown in Table 1.\*\*\*\*

Practically all the gas produced in the USSR prior to World War II was produced in oilfields and used in nearby localities. <sup>29/</sup> Some of the gas was processed for the recovery of natural gasoline, but the lighter propanes and butanes were not recovered. Most of the natural gas and natural-gas liquids were wasted.

\* Table 7 follows on p. 20.

\*\* Table 8 follows on p. 25.

\*\*\* Table 9 follows on p. 30.

\*\*\*\* P. 3, above.

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Table 7

Production Compared with Gross Withdrawals from Oilfields of Crude Oil, Natural-Gas Liquids, Natural Gas, and Total Petroleum in the USSR and the US Selected Years, 1930-52

Year	Country	Production from Oilfields				Gross Withdrawals from Oilfields							
		Crude Oil Produced (Percent)	Natural-Gas Liquids Produced (Percent of Crude Oil)	Total Liquid Hydrocarbons Produced (Percent of Crude Oil)	Natural Gas Produced (Percent of Crude Oil)	Total (Percent of Crude Oil Produced)	Crude Oil Withdrawn (Percent of Crude Oil Produced)	Natural-Gas Liquids Production (Percent of Gross Withdrawals)	Natural Gas Production (Percent of Crude Oil Produced)	Total (Percent of Crude Oil Produced)	Total Petroleum Withdrawn (Percent of Crude Oil Produced)		
1930	USSR	100	0.3	100.3	2.3	102.6	100	2.3	102.6	13	18.9	12	121.2
1940	USSR	100	0.7	100.7	6.8	107.5	100	2.3	107.5	31	18.9	36	121.2
1950	USSR	100	2.1	102.1	6.6	108.8	100	13.3	122.1	16	29.5	23	142.8
1955	USSR	100	8.3	108.3	7.8	116.1	100	13.4	129.5	62	29.5	26	142.9
1950	US	100	6.9	106.9	18.1	125.0	100	13.1	138.1	53	31.3	58	144.5
1952	US	100	7.0	107.0	28.7	135.7	100	N.A.	135.7	N.A.	38.1	75	145.1
	Mex Mexico	100	9.5	109.5	67.6	177.1	100	N.A.	177.1	N.A.	76.3	89	185.8
	Oklahoma	100	9.3	109.3	35.8	145.0	100	N.A.	145.0	N.A.	48.1	74	157.4
	Texas	100	8.8	108.8	34.6	143.3	100	N.A.	143.3	N.A.	43.6	79	152.3
	Illinois	100	2.5	102.5	1.3	103.8	100	N.A.	103.8	N.A.	4.7	29	107.2
	California	100	6.0	106.0	28.0	134.0	100	N.A.	134.0	N.A.	30.6	91	136.6

a. Because of rounding these totals differ from a summation of their components.

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Wartime and postwar construction of natural-gas trunk lines (see Table 4\*) has provided a means for developing and utilizing some of the gas deposits of the USSR and has provided an outlet for increased quantities of natural gas from oilfields. Because of the greatly increased withdrawals of natural gas in the postwar period from the newer and deeper oil deposits, however, it is estimated, as shown in Table 9,\*\* that the current percentage of oilfield gas conserved and utilized is actually lower than it was in the immediate prewar period. This condition cannot be remedied until additional natural-gas trunk lines are completed.

With respect to natural-gas liquids, the picture is different. There is a fair volume of fragmentary data indicating that, in addition to the production of natural gasoline in the USSR, there is a rapidly expanding utilization of liquefied petroleum gases. These are the lighter components, mostly propane and butane, which were not recovered in the prewar period in the USSR. As these lighter natural-gas liquids, usually designated as LPG, can be distributed only in pressure containers, their distribution is occasionally noted in intelligence materials. Therefore, they serve as a valuable indicator of the total production of natural-gas liquids, as the production of natural gasoline is a necessary part of the recovery of the lighter hydrocarbons comprising the LPG.

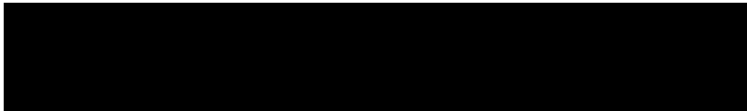

The following citations are representative of the fragmentary intelligence on the distribution and utilization of liquefied petroleum gases (liquid gas or LPG) in the USSR. It is offered merely as qualitative evidence and without analysis or evaluation.

<u>Date of Information</u>	<u>Item</u>
1948	A 15766 FDD U-3088, "Motor Vehicles Operating on Gas-Filled Cylinder." C. Source: <u>Mashinos-troyeniye</u> , Vol. 11, 1948. Two types of cylinders are used, low pressure for LPG at 16 atmospheres, and high pressure for compressed gas at 200 atmospheres. Data given on tank weights, performance, and the like.

\* P. 9, above.

\*\* P. 30, below.

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<u>Date of Information</u>	<u>Item</u>	
1949	<u>Trud</u> , No. 170, Moscow, 21 Jul 1949. U. Calls for increased distribution and use of LPG and compressed natural gas.	
1951	<u>Trud</u> , No. 274, Moscow, 23 Nov 1951. U. Describes Baku LPG station for servicing railroads.	
1952	<u>Kommunist</u> , Baku, 4 Jan 1952. U. Describes establishment of first LPG station for servicing motor vehicles.	
1952		25X1A2g
1952	<u>Auto-Motor</u> , Budapest, 15 Nov 1952. U. Describes apparatus reportedly in use in the USSR for converting motor vehicles to use of LPG.	
1953	 2 Mar 1953. C. Review of natural gas resources by Academician Chudakov points toward greatly expanded use of LPG and compressed natural gas for all types of mobile transport.	25X1A8a
1953	<u>Izvestiya</u> , "Gas Installations in Cities," Moscow, 18 Nov 1953. U. Reviews growth of gas distribution and utilization and states that servicing of various cities and settlements not reached by gas pipe lines will be done by LPG in cylinders.	

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<u>Date of Information</u>	<u>Item</u>
1953	<u>Pravda</u> , Moscow, 26 Nov 1953. U. Amplifies discussion in foregoing item naming several cities to be served by LPG and adds "A large number of special railroad and trunk tank cars as well as steel spheres are to be built in 1954 for supplying liquid gas."
1953	CIA 2109636, WDGS R-1332-53. C. Gives details for operating on compressed gas the Soviet GAZ-51-B truck which is offered for export.

6. Prewar Data.

As a whole, Soviet statistics on prewar petroleum production present no serious difficulty in their interpretation. This is particularly true of the official compilation of statistics covering the period 1927-28 to 1935, published in 1936 in a single volume (Socialist Construction in the USSR), which has been fully translated. 30/ The method of presentation of statistics on petroleum production in this volume is typical of the method followed by the USSR in the prewar years, including the period 1936-40, although the data are less complete in these latter prewar years. The first 40 pages of this 538-page volume are devoted to general tables covering the social and economic growth of the USSR over the previous several years. These data are those most widely quoted in the press and in general economic articles. The first and most important entry for petroleum production is in Table 1, "Principal Indices of Socialist Construction in the USSR," where on page 5 under the subheading "Industry," appears "Output of crude petroleum and natural gas" with the total quantities by years shown in thousands of metric tons. In Table 2, "Summary of Large-Scale Industry as of 1934," on page 42 under the subheading "Fuel Extraction" are four entries: 1. coal mining, 2. crude petroleum production, 3. peat extraction, and 4. combustible shales. As there is no separate entry for natural gas production, it appears that in this case crude petroleum production includes natural gas. This tends to be verified by the entry for 1934 in Table 1, "Summary for the Petroleum Industry," page 135, where the gross output in millions of rubles for crude petroleum production is shown as 589,

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which checks with the similar entry on page 42. Here, also, there is no entry for the value of natural gas production only.

Thus far in Socialist Construction in the USSR 1936, some ambiguity has appeared in the meaning of the term "crude petroleum production" when it is related to such items as value of gross output, number of wage earners, and the like, but it apparently covers both crude oil and natural gas with the entrained natural-gas liquids. This ambiguity is resolved in Table 4, "Output of Petroleum Products in Physical Units," on page 138. Most of this table covers refined petroleum products which are so designated under a subheading, but the first three entries are "crude oil," "natural gas," and "total crude oil and gas." The quantities under the last entry are the same as those under "Output of crude petroleum and natural gas" in Table 1 on page 5. As there is in Table 4 no separate item for natural-gas liquids, it is obvious that natural gas in this table is wet natural gas before the extraction of the natural-gas liquids. This latter item is accounted for in Table 6, "Output of Petroleum Refining Industry," on page 140, under the designation "Benzine obtained from natural gas." Thus the production of the 3 components, crude oil, natural-gas liquids, and natural gas, comprising the total petroleum production in the USSR, can be definitely identified for the period covered by this official publication.

One additional column entry of interest in this same volume, Socialist Construction in the USSR 1936, is in Table 11, "Oil Extraction: By Methods," page 143, under the column entitled "Total extraction of petroleum," which shows the same quantities as are given for crude oil only in Table 4, page 138. This entry indicates that, despite the other entries which indicated the inclusion of natural gas, petroleum can mean crude oil. The main title of Table 11, "Oil Extraction," however, reduces the significance of the columnar heading, "Petroleum," within the table and is an indication that natural gas is excluded.

Table 8\* presents the estimates of prewar data on production of petroleum components in the USSR by years from 1927-28 to 1940. Sources of data are summarized as follows:

\* Table 8 follows on p. 25.

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Table 8  
Estimated Prewar Production and Withdrawals of Crude Oil, Natural-Gas Liquids, and Natural Gas in the USSR  
1927-28 - 1940

Line Number	Year	Crude Oil Produced (Thousand Metric Tons)		Natural-Gas Liquids Recovered from Natural Gas (Thousand Metric Tons)		Total Liquid Petroleum Hydrocarbons (Thousand Metric Tons)		Natural Gas Produced and Utilized (Thousand Metric Tons)		Total Petroleum Production (Thousand Metric Tons)	Estimated Gross Withdrawals in Oilfields a/			
		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)		(9)	(10)	(11)	(12)
1	1927-28	11,472	24	0	24	11,496	253	0	253	11,749	2,173	12	264	9
2	1928-29	13,509	28	0	28	13,537	273	0	273	13,810	2,558	11	311	9
3	1930	18,451	55	0	55	18,506	417	0	417	18,923	3,495	12	424	13
4	1931	22,392	79	0	79	22,471	691	0	691	23,162	4,241	16	515	15
5	1932	21,413	96	0	96	21,509	791	19	810	22,319	4,056	20	492	20
6	1933	21,469	87	0	87	21,556	871	11	882	22,458	4,070	22	494	18
7	1934	24,218	66	0	66	24,284	1,308	20	1,328	25,612	4,587	29	557	12
8	1935	25,238	87	0	87	25,325	1,540	19	1,559	26,884	4,760	32	581	15
9	1936	27,890	116	0	116	28,006	1,820	20	1,840	29,846	5,282	34	642	18
10	1937	28,501	136	0	136	28,637	1,888	20	1,908	30,485	5,398	34	656	21
11	1938	30,186	167	0	167	30,353	1,858	20	1,878	32,231	5,718	32	694	24
12	1939	30,417	189	0	189	30,606	1,959	20	1,979	32,585	5,762	34	699	27
13	1940	30,661	221	0	221	30,882	2,071	20	2,091	32,973	5,807	36	705	31

a. In columns 11 and 13, percent means the percent production of gross withdrawals.

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The data in lines 1 to 8 inclusive, columns 1 to 6 inclusive, are copied or derived by simple computation from source 31/. Lines 1 to 8, column 7, are copied directly from source 32/, and columns 8 and 9 are simple additions.

The basic data on production of crude oil in line 9 and lines 11 to 13 are from source 33/, and the basic data on production of crude oil and total production of petroleum in line 10 are from source 34/. The total gas production, line 10, column 8, is derived from source 35/ and the remaining data in lines 9 to 13, columns 1 to 9, are by addition, interpolation, and extrapolation.

The data in lines 1 to 13, columns 10 to 13, are derived from reserve data in source 36/ for 1935 (line 8), and the remaining years are estimated on this same pattern of distribution, varied according to the annual production of crude oil in column 1. These data on gross withdrawals are used as a guide in interpolating and extrapolating data not otherwise available in the remainder of the table.

Data on the production of natural-gas liquids in 1940 (line 13, column 3) are from a secondary source 37/ which is considered acceptable for prewar data.

7. Postwar Data.

Official Soviet quantitative postwar data on petroleum production are limited to the 1950 target for the Fourth Five Year Plan (1946-50), claimed fulfillment for 1950, goal for 1960, annual increases in 1951, and production in 1952 and 1953. These quantitative data are supplemented by claimed percentage increases over previous years. These quantitative data are summarized as follows:

a. 1950 target for the Fourth Five Year Plan was stated to be 35.4 million tons of neft' and 8.4 billion cubic meters of natural gas. 38/

b. 1950 target was fulfilled 10 December 1950 and was exceeded by 2.2 million tons of neft' by the end of 1950. 39/

c. 1960 goal of 60 million tons announced in Stalin's speech of 9 February 1946. 40/



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d. 1951 statement by Beriya that annual increase in output had been 4.5 million tons in recent years. 41/

e. 1952 statement by Malenkov to the 19th Party Congress that 1952 production would be 47 million tons and that the 3-year increase (1949-51) in extraction was 13 million tons. 42/

f. 1953 production of 52 million tons cited in manifesto of the Central Committee of the Soviet Communist Party, 10 February 1954. 43/

The 1955 target for the Fifth Five Year Plan has been officially stated only in terms of an 85-percent increase over 1950. 44/ The principal discussion of the Plan directives for the petroleum industry was in the speech by N.K. Baibakov, Minister of the Petroleum Industry, on 11 October 1952. 45/ It may be significant that the only quantitative references in this speech to petroleum production were from the Stalin goal announced in 1946 of 60 million tons by 1960. In Baibakov's speech, there are 3 separate references to this 60-million-ton goal, stressing that it would be reached ahead of schedule. The 60-million-ton goal announced by Stalin in 1946 appears to have been, and to continue to be, the chief goal of the Soviet petroleum industry. It is even reported to have been the subject for the Soviet postage stamp showing an oil-well derrick and the slogan, "60 million tons of oil annually." 46/

It has been widely assumed that these quantitative data on petroleum production in the USSR refer to the output of crude oil. In view of the Soviet prewar practice of reporting total petroleum production (crude oil plus natural gas) as the primary output statistic for the industry, there does not appear to be sufficient evidence to justify this conclusion.

It appears probable that the practice of assuming that these Soviet postwar petroleum output data were on crude oil only originated with a 31 January 1947 American Embassy despatch from Moscow 47/ which read, in part: "Total production of crude oil in 1945 was 19.4 million metric tons, excluding gas. [Source: Baku Worker, 29 May 1946.]"

Reference to the source cited in this despatch 48/ reveals it to be a three-column newspaper report quoting M.C. Koslov, Deputy Minister of the Petroleum Industry of the Southern and Western Regions of the USSR. All but one paragraph refer to regional and district plans. The one paragraph which refers to the Soviet Fourth Five Year

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Plan for the entire petroleum industry is translated as follows:  
"The great Stalin Plan task, said Comrade Koslov, provides for the 5-year period an increase in extraction equivalent to 13 prewar years. The average annual increase comprises 3.2 million tons, as compared to 1.4 million tons in the First Five Year Plan and 1.1 million tons in prewar years."

The quantity of 19.4 million tons for 1945 quoted in the American Embassy despatch from Moscow was derived from the statement in the Baku Worker by subtracting 5 annual increases of 3.2 million tons each, or 16 million tons, from the 1950 goal of 35.4 million tons previously announced for the Fourth Five Year Plan. Identifying this 19.4 million tons as crude oil, however, must have been based upon some other source. The comparisons given in the Baku Worker to prewar production cannot be positively identified either with the production of crude oil only or with the total production of petroleum. During the 13-year period ending in 1940, the Soviet annual production rate increased 20.4 million tons for crude oil and 22.4 million tons for total petroleum. Neither of these figures is equivalent to the 16-million-ton annual production increase planned for the 1946-50 period. During the First Five Year Plan (1928-32), the average annual production increases were 2.23 million tons for crude oil and 2.36 million tons for total petroleum. Neither of these figures checks with the 1.4 million tons attributed to this period in the Baku Worker. Selected prewar years will give the 1.1-million-ton increase cited in the Baku Worker for both crude oil (1935-40) and total petroleum (1932-40). On the basis of the source cited in the Moscow despatch, there appears to be no definite justification for assuming the 1945 production of 19.4 million tons is crude oil only, without gas.

The fact that the Fourth Five Year Plan (1946-50) carried separate quantitative goals for neft' (35.4 million tons) and natural gas (8.4 billion cubic meters) carries an implication that they are separate quantities. Because of the Soviet prewar primary reporting practice of converting gas volumes to weight (metric tons) and adding this to the crude oil, however, there is some doubt as to whether the 8.4 billion cubic meters of gas is included in the 35.4 million tons of neft' or is over and above that quantity.

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A search has revealed one publication <sup>49/</sup> indicating that the 8.4 billion cubic meters of natural gas should be added to the 35.4 million tons of neft' in order to obtain the planned goal for 1950 for total petroleum production. Table 3 on page 19 of this source shows growth of fuel extraction in the USSR. A column for the 1950 plan shows for oil and gas (neft' i gaz), 43.8, and a footnote states, "In numerical value, oil 35.4 million tons and gas 8.4 million cubic meters." The footnote is in error, as it should read billion (milliard) instead of million (million) for the cubic meters of gas. This error plus the fact that the author has added weights and volumes together may throw some doubt on the validity of his data, but there appears to be no doubt that in obtaining the total goal for the Fourth Five Year Plan, he intended to show these two petroleum components as additive.

In order to establish a basis for estimating postwar production of petroleum components in the USSR, the following assumptions have been made:

a. That the 1950 goal of 35.4 million tons of neft', and the over-fulfillment of this goal to the amount of 37.6 million tons for 1950, represents crude-oil production only. It should be noted that the basis for this assumption, as given in the foregoing analysis and citations, refers exclusively to the goal of 35.4 million tons, and not necessarily to the fulfillment of 37.6 million tons.

b. That the 1955 goal of an 85-percent increase over 1950 refers numerically to 37.6 as a base, and therefore indicates a goal of 69.6 million tons of neft' for 1955.

c. That the 1955 goal, derived as in b, above, at 69.6 million tons, represents total petroleum production -- that is, crude oil, plus natural-gas liquids, plus natural gas.

d. That the 60-million-ton goal announced by Stalin in 1946 for attainment by 1960 (or before) refers to crude oil.

On the basis of these assumptions, supplemented by estimated gross withdrawals of natural-gas liquids and natural gas from oil-fields, by estimated gasfield gas production based on natural-gas trunk line capacities, and by other fragmentary data cited, the estimates and forecasts of Soviet postwar petroleum production by components have been derived and are shown in Table 9.\*

\* Table 9 follows on p. 30.

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Table 9  
Estimated Postwar Production and Withdrawals of Crude Oil, Natural-Gas Liquids, and Natural Gas in the USSR  
1945-55

Line Number	Year	Crude Oil Produced (Million Metric Tons)		Natural-Gas Liquids Recovered from Natural Gas (Million Metric Tons)		Total Liquid Petroleum Hydrocarbons (Million Metric Tons)		Natural Gas Produced and Utilized (Million Metric Tons)		Total Petroleum Production (Million Metric Tons)		Estimated Gross Withdrawals in Oilfields g/	
		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
1	1945	19.4	0.1	0.0 b/	0.1	19.5	1.8	0.5	2.3	21.8	3.6	0.8	13
2	1946	21.7	0.2	0.0 b/	0.2	21.9	1.9	0.7	2.6	24.5	4.6	0.9	22
3	1947	26.0	0.3	0.0 b/	0.3	26.3	2.3	0.9	3.2	29.5	6.1	1.7	18
4	1948	29.4	0.4	0.0 b/	0.4	29.8	2.5	1.0	3.5	33.3	7.7	2.7	15
5	1949	33.6	0.6	0.0 b/	0.6	34.2	2.5	1.2	3.7	37.9	9.6	3.9	15
6	1950	37.6	0.8	0.0 b/	0.8	38.4	2.5	1.4	3.9	42.3	11.1	5.0	16
7	1951	41.6	1.1	0.1	1.2	42.8	2.5	1.7	4.2	47.0	12.3	5.5	20
8	1952	45.6	2.0	0.1	2.1	47.7	2.5	1.8	4.3	52.0	13.5	6.0	33
9	1953	49.6	3.0	0.1	3.1	52.7	2.6	1.9	4.5	57.2	14.6	6.7	45
10	1954 c/	53.6	3.9	0.1	4.0	57.6	3.3	2.2	5.5	63.1	15.8	7.2	54
11	1955 s/	57.6	4.8	0.2	5.0	62.6	4.5	2.5	7.0	69.6	17.0	7.7	62

a. In columns 11 and 13, percent means percent production of gross withdrawals.

b. Less than 50,000 metric tons.

c. Forecasts.

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This methodology provides what appears to be a reasonable balance between the three components of petroleum production -- crude oil, natural-gas liquids, and natural gas -- in the postwar USSR, considering the probable economic capabilities to find, develop, and utilize these components.

With respect to production of crude oil (column 1, Table 9), this method gives a relatively constant net annual increase after 1948, when the postwar restoration of the old producing properties is thought to have been largely completed. After that time, a constantly increasing proportion of Soviet petroleum production has come from new fields, resulting in the steady increase in annual percentage decline caused by depletion. This has demanded a constantly increasing effort on the part of the Soviet petroleum industry to overcome depletion and to gain a constant net increase in production, as shown in Table 9. There are insufficient data on postwar depletion of petroleum deposits in the USSR to compute its exact effect, but by analogy with US experience 50/ the data in Table 10\* present an estimate of the effect of such postwar depletion on the gross annual increases required in order to meet the estimates of the production of crude oil given in Table 9.

Thus, as indicated in Table 10, because of the effect of depletion, the effort required to maintain a new annual increase of 4 million tons in 1955 is approximately double the effort required for the same increase in 1948.

The estimates of postwar production of natural-gas liquids from oilfields (column 2, Table 9) are based upon estimated gross withdrawals of this component, shown in column 12, Table 9, and the assumed effect of the conservation or "hermetization" program, which has been actively pushed since 1949-50. Large losses of natural-gas liquids were recognized before World War II 51/ and were again mentioned immediately after the war. 52/ Hermetic sealing of oil wells was planned on a wide scale in the Fourth Five Year Plan. 53/ Beginning in 1949, 54/ there is increasing evidence that conservation of natural-gas liquids has been widely applied. 55/ This is reflected in the estimated percent recovery of available natural-gas liquids noted in column 13, Table 9. The recovery of natural-gas liquids from the relatively dry natural gases produced in Soviet gasfields is assumed to be negligible, as indicated in column 3,

\* Table 10 follows on p. 32.

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Table 10

Estimated Gross Annual Increases Required in Crude Oil Production  
in the USSR  
1945-55

Year	Production of Crude Oil <sup>a</sup> / (Million Metric Tons)	Assumed Annual Decline Caused by Depletion		Net. Annual Increase (Million Metric Tons)	Indicated Gross Annual Increase Required (Million Metric Tons)
		Per- cent	Quantity (Million Metric Tons)		
1945	19.4	10			
1946	21.7	10	1.94	2.3	4.2
1947	26.0	10	2.17	4.3	6.5
1948	29.4	10	2.60	3.4	6.0
1949	33.6	11	3.23	4.2	7.4
1950	37.6	12	4.03	4.0	8.0
1951	41.6	13	4.89	4.0	8.9
1952	45.6	14	5.82	4.0	9.8
1953	49.6	15	6.84	4.0	10.8
1954	53.6	15	7.44	4.0	11.4
1955	57.6	15	8.04	4.0	12.0

a. From Table 9, p. 30, above.

Table 9, and shown in more detail in column 10, Table 11.\* The availability of natural-gas liquids shown as "Propanes and Heavier" in column 8, Table 11, is based on published analyses of natural gas from Soviet gasfields. 56/

The postwar estimates of natural-gas production in the USSR shown in column 8, Table 9, are based on a 1945 figure derived from an unofficial Soviet source. 57/ This source stated that the 1950 goal for the production of natural gas was three times the 1945 production. This statement indicates a 1945 production of one-third of 8.4 billion cubic meters, or 2.8 billion cubic meters. This author also stated

\* P. 34, below.

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that the 1950 goal for production of natural gas was 4.5 billion cubic meters, indicating a 1945 production of only 1.5 billion cubic meters. The higher estimate of 2.8 billion cubic meters, however, is used for 1945 and is equivalent to the 2.3 million tons shown in Table 9, line 1, column 8. The remaining estimates of total production of natural gas, in column 8 for 1946 through 1953, are based on the official Soviet claims of percentage increases for each year over the preceding year. 58/ The increase for the full year 1953 is based upon the first 6 months, as the official announcement of fulfillment of the 1953 Plan failed to mention natural gas. 59/ Forecasts of production of natural gas for 1954 and 1955 are extrapolated to meet the Fifth Five Year Plan increase of 80 percent, or 7 million tons in 1955. To attain this forecast of production of natural gas in 1954 and 1955 will require substantial expansion of natural-gas trunk-line capacity. According to the Fifth Five Year Plan, in 1955 the "conveyance by pipeline should be approximately fivefold" that of 1950, 60/ so this 1955 goal for natural gas may be attained.

Table 11,\* showing data on natural-gas trunk lines in the USSR, is used as a basis for estimating that portion of natural gas produced in gasfields and shown in column 7 of Table 9. Then the natural gas produced and utilized from oilfields is the difference between columns 7 and 8, which is shown in column 6, Table 9. The data on natural-gas lines in the USSR shown in Table 11 have been drawn from various sources. 61/ They are intended to be used only as a basis for estimating Soviet production of natural gas from gasfields and do not represent a complete survey of gas pipe lines in the USSR.

The gross withdrawals of natural gas and natural-gas liquids from oilfields, shown in columns 10 and 12, Table 9, correspond to the prewar data in columns 10 and 12, Table 8. There are no postwar data on proved petroleum reserves in the USSR, however, so these gross withdrawals have been estimated as follows:

For 1950, it was assumed that the gross withdrawals from oilfields in the USSR of wet natural gas -- natural gas plus natural-gas liquids -- was about 43 percent by weight of the crude oil. This is substantially the same distribution as is shown in Table 6\*\* for oilfields in the US. This 1950 distribution is continued for the years 1951-55. For 1945 the gross withdrawals of natural-gas liquids plus natural gas represent 23 percent by weight of crude oil.

\* Table 11 follows on p. 34.

\*\* P.18, above.

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Table 11

Data on Natural-Gas Trunk Lines Serving Gasfields  
and Estimated Recovery of Natural-Gas Liquids from Such Fields in the USSR  
1950

Line Number	Natural-Gas Trunk Lines (1)	Year Completed (3)	Length (Kilometers) (4)	Diameter (Centimeters) (5)	Annual Capacity		Natural-Gas Liquids (Propanes and Heavier)		
					Million Cubic Meters (6)	Thousand Metric Tons (7)	Available (Thousand Metric Tons) (8)	Recovery (Percent) (9)	Production (Thousand Metric Tons) (10)
1	Dashava to L'vov	1940	70	N.A.	182	126	2	0	0
2	Yelshanka to Saratov	1942	18	N.A.	275	202	11	64	7
3	Buguruslan to Kuybyshev	1943	160	25	242	201	18	50	9
4	Saratov to Moscow	1946	843	30	500	368	21	71	15
5	Dashava to Kiev	1948	513	50	900	625	7	0	0
6	Buguruslan to Kuybyshev	1950	160	N.A.	250	208	18	50	9
	Total as of 1950		<u>1,764</u>		<u>2,349</u>	<u>1,730</u>	<u>77</u>	<u>52</u>	<u>40</u>

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This is slightly higher than is shown in Table 8 for 1940 and recognizes the increased proportion of production from the Ural-Volga fields in 1945. The gross withdrawals of natural gas and natural-gas liquids, as a percent of the weight of the crude oil, is interpolated for the years 1946-49 between the values for 1945 and 1950.

The weakest point in this method is the assumption that 1950 gross withdrawals of petroleum components from oilfields in the USSR follow the same pattern as in the US. There is, however, some justification for this assumption. Based on the average weight of wet gas produced in Soviet oilfields of 1.267 tons per thousand cubic meters, as derived from published gas analyses, <sup>62/</sup> the average gas factor corresponding to production of wet gas equivalent to 43 percent by weight of oil, is equal to 300 cubic meters of gas per cubic meter of oil. A reference dictionary for petroleum engineers and geologists published in Moscow in 1952 <sup>63/</sup> defines the gas factor as the quantity of gas in cubic meters produced with 1 cubic meter of oil. This authority states that large gas factors are characteristically of the order of 1,000 to 2,000 cubic meters of gas per cubic meter of oil, and even higher. It adds that very often gas factors are 100 to 200, and with the very small quantities of gas in the deposit, the gas factor may be 5 to 10 or lower. With an ever-increasing proportion of Soviet production of crude oil coming from the newer and deeper deposits, with their characteristically high gas-to-oil ratios (US terminology), or gas factors (Russian terminology), the assumption on which the gross withdrawals of natural gas plus natural-gas liquids are estimated in Table 9 is probably justified.

The distribution of gross withdrawals between natural gas and natural-gas liquids, shown in Table 9, is based on rather complete published analyses of natural gases in the USSR. <sup>64/</sup>

8. Range of Postwar Data.

The estimates of the postwar production of petroleum components in the USSR, shown in Table 9, are based on certain assumptions which have been stated in the foregoing analyses of these data. There is no way to test the absolute validity of those assumptions. Therefore, it is desirable to present the minimum and maximum values which would result from the extreme assumptions which might be made each way concerning the fragmentary data on postwar petroleum production in the USSR. These extreme assumptions are:

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Maximum Values: all claims and goals referring to production of neft' in the USSR apply exclusively to the production of crude oil;

Minimum Values: all the foregoing claims and goals apply exclusively to petroleum production -- crude oil, plus natural-gas liquids, plus natural gas.

By retaining the basic distribution pattern between components developed in Table 9, the data shown in Table 12\* have been computed for maximum and minimum values in accordance with the extreme assumptions described above. The estimated values shown in Table 12 are those derived in Table 9.

As more data on the production of petroleum in the USSR in the postwar period become available, and as available data are subjected to additional analysis, the estimates presented herein will be revised. It appears unlikely, however, that future revisions will fall outside the minimum and maximum limits, shown in Table 12, for crude oil or total petroleum. Future revisions of the production of natural-gas liquids and natural gas, particularly for the 1954-55 forecasts of production of natural gas, may depart substantially from the values shown.

\* Table 12 follows on p. 37.

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Table 12  
Estimated Maximum Range of Possible Values of Postwar Production of Petroleum Components  
in the USSR  
1945-55

Line Number	Year	Estimated Values						Minimum Values					
		Crude Oil	Natural-Gas Liquids	Natural Gas	Total Petroleum	Crude Oil	Natural-Gas Liquids	Natural Gas	Total Petroleum	Crude Oil	Natural-Gas Liquids	Natural Gas	Total Petroleum
		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
1	1945	19.4	0.1	2.3	21.8	19.4	0.1	2.3	21.8	17.2	0.1	2.0	19.3
2	1946	21.7	0.2	2.6	24.5	21.7	0.2	2.6	24.5	19.2	0.2	2.3	21.7
3	1947	26.0	0.3	3.2	29.5	26.0	0.3	3.2	29.5	22.7	0.3	2.8	25.8
4	1948	29.4	0.4	3.5	33.3	29.4	0.4	3.5	33.3	25.8	0.4	3.1	29.2 a/
5	1949	33.6	0.6	3.7	37.9	33.6	0.6	3.7	37.9	29.7	0.5	3.3	33.5
6	1950	37.6	0.8	3.9	42.3	37.6	0.8	3.9	42.3	33.4	0.7	3.5	37.6
7	1951	41.6	1.2	4.2	47.0	42.0	1.2	4.2	47.4	37.2	1.1	3.8	42.0 a/
8	1952	45.6	2.1	4.3	52.0	47.0	2.2	4.4	53.6	41.2	1.9	3.9	47.0
9	1953	49.6	3.1	4.5	57.2	52.0	3.2	4.7	59.9	45.1	2.8	4.1	52.0
10	1954	53.6	4.0	5.5	63.1	60.8	4.5	6.2	71.5	51.7	3.9	5.3	60.9
11	1955	57.6	5.0	7.0	69.6	69.6	6.0	8.5	84.1	57.6	5.0	7.0	69.6

a. Because of rounding, these two totals differ from a summation of their components.

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APPENDIX B

GAPS IN INTELLIGENCE

1. Prewar Data.

Deficiencies in prewar data presented in this research aid are not serious. No published data have been found for the production of natural-gas liquids for the years 1936-39, and the one source for the 1940 production is an unofficial estimate. These data have little strategic significance, however, and they are probably of the right order of magnitude. Some data on production of natural gas in the immediate prewar years are lacking, but they can be estimated to a close approximation.

2. Postwar Data.

Serious deficiencies exist in the postwar data on the production of petroleum in the USSR. These deficiencies are of two types: (a) lack of sufficient quantitative data, and (b) uncertainty as to what components of petroleum production are included in the fragmentary quantitative data which have been released. This latter problem is presented in Appendix A under Section 3, Soviet Terminology.

3. Comparison with US Data.

Any comparison of estimated or claimed postwar petroleum production in the USSR with the corresponding US production should be made only if the great difference in reliability between these production data are clearly understood.

US petroleum-production data, as published by the US Bureau of Mines, the American Petroleum Institute, and the American Gas Association, are aggregates of actual field shipments by districts and by States. Minor errors occur, but they are largely compensative, and the final national total for a relatively long period, such as a year, is known to be accurate within a very small range. Petroleum-production data from the world outside the Soviet Bloc are comparable to US data, although some show a slightly greater probable error. Because of the aggregative nature of these US and Free World data, field by field and month by month, they have an obvious inherent validity.

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In contrast, all postwar petroleum-production data relating to the USSR are highly suspect. There is no evidence that they represent an aggregation of actual field shipments nor is there a clear statement of what components are included. The many published criticisms of Soviet statistics 65/ apply with particular force to the postwar petroleum-production data.

4. Plant Data.

Very little postwar data have been found on plants in the USSR producing natural-gas liquids. To accomplish the estimated production of natural-gas liquids in the USSR of 3.1 million tons in 1953 would require 77 plants averaging the same output as did US plants in 1951. A good description of only one such plant has been published. 66/ Because natural gasoline plants are usually small, compared with refineries, and are located in or near oilfields rather than refining centers, very few appear on target lists. Six plants in the Baku fields and 1 in the Urals (Ishimbayeva), however, are listed in the current issue of the Bombing Encyclopedia. 67/

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APPENDIX C

SOURCES

1. Sources.

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

<u>Source of Information</u>	<u>Information</u>
A - Completely reliable	Doc. - Documentary
B - Usually reliable	1 - Confirmed by other sources
C - Fairly reliable	2 - Probably true
D - Not usually reliable	3 - Possibly true
E - Not reliable	4 - Doubtful
F - Cannot be judged	5 - Probably false
	6 - 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 will carry the field evaluation "Documentary" instead of a numerical grade.

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

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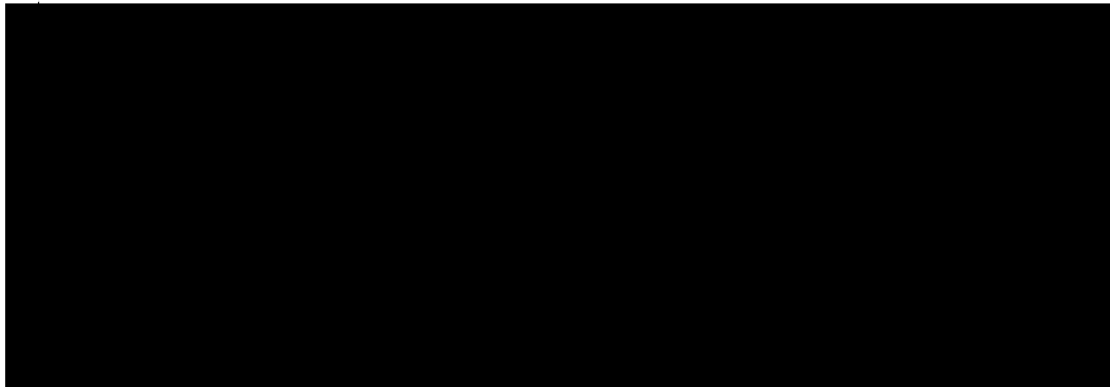
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