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DIRECTORATE OF
INTELLIGENCE

Intelligence Report

Prospects For Continued Soviet Exports Of Petroleum

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CENTRAL INTELLIGENCE AGENCY
Directorate of Intelligence
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INTELLIGENCE REPORT

Prospects For Continued Soviet Exports Of Petroleum

Introduction

Since the mid-1950s the USSR has been a substantial net exporter of fuels. In recent years, Soviet exports of oil to the Free World have been the largest single source of hard currency foreign exchange. However, the Minister of the Petroleum Extraction Industry in the USSR, V.D. Shashin, stated in 1969 that total Soviet exports of oil will not increase significantly in the future because of rising domestic demand. He also announced that the USSR will maintain a high level of exports to Eastern Europe but doubted that exports to the West would continue to increase indefinitely. Various Western specialists have made even more extreme predictions. They speculate that future Soviet production of petroleum will be unable to keep pace with rising requirements at home and in Eastern Europe, causing the USSR to become a net importer of oil during the 1970s and to procure large quantities of oil from the Middle East to meet its total requirements.

This report reviews the development of the Soviet petroleum industry in recent years and estimates its ability to satisfy the various demands that will be placed upon it over the next decade.

Note: This report was prepared solely by CIA. It was produced by the Office of Economic Research.

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Recent Position of the Petroleum Industry

Reserves

1. The USSR has abundant potential resources of petroleum, both onshore and offshore, that could make it the world's leading producer of petroleum by the end of the 20th century. However, 30% to 40% of these reserves are located in permafrost regions where their exploitation will be difficult and costly.

2. The capability of the Soviet Union to meet future demands for petroleum from its own resources is measured by the level of "proved" reserves, which means the oil estimated to be economically recoverable with existing production technology. Although detailed information is published on natural gas reserves, no official data on oil reserves have been disclosed since World War II, as the State Secrets Act of 1947 prohibits such publication. Soviet technical journals, however, have published certain link relatives that can be applied to prewar data to provide an estimate of Soviet oil reserves.

3. As part of a policy emphasizing self-sufficiency in strategic resources, Soviet geologists have regarded maintenance of a ratio of "proved" reserves to production of about 25 or 30 to 1 as highly desirable. The Soviet definition of "proved" reserves* is broader in scope than that used in the United States. Soviet geologists have indicated that perhaps only two-thirds to three-fourths of their estimated "proved" reserves can be considered as confirmed by drilling, and hence roughly comparable to the US definition of proved reserves. Consequently, Soviet claims of oil and gas reserves apply to probable and/or possible resources rather than to "proved" reserves, upon which firm plans for future production can be made.

4. Analysis of data in various Soviet technical journals led several US experts to conclude that as of 1 January 1961 the USSR had approximately 3 billion tons of "proved" oil reserves. This estimate implied that the ratio of such reserves to production was about 20:1. In January 1969, a Soviet journal

* For US and Soviet definitions of reserves, see Appendix A.

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reported that these reserves had increased 51% since 1960, while production of crude oil had more than doubled. No significant change in this pattern was foreseen in the near future. Therefore, as of 1 January 1969, Soviet "proved" reserves of oil were estimated at approximately 4.5 billion tons, or about 15 times the annual rate of output (309 million tons at the end of 1968). Assuming that two-thirds to three-fourths of these "proved" reserves can be equated to proved reserves according to the US definition, Soviet reserves totaled 3.0 to 3.4 billion tons, or about 10 to 11 times the annual rate of production. This situation approximated that of the United States where proved reserves were estimated at 4.2 billion tons in 1969, with a reserves to production ratio of about 10:1.

Exploration and Drilling

5. Most Soviet geophysical instruments used in mapping subsurface structures are less accurate than comparable US equipment. For example, the Soviet Union is about 7 to 10 years behind the United States in computerized seismograph technology which permits exploration of deep complex geologic formations. The first computerized seismic field unit was deployed in the northern regions of the USSR in 1969, whereas the application of this technology had contributed impressive benefits to petroleum exploration in the United States by 1963. Limited application of modern geophysical techniques has contributed to the lag in Soviet rates of petroleum discovery compared to the growth in production during the past decade.

6. Drilling has become a significant obstacle to oil and gas development in the USSR. Much of the drilling equipment and technology employed is inefficient and obsolete. Most of the turbodrills and rigs now in use were designed for shallow drilling in hard formations, such as those in the Urals-Volga region where wells generally are less than 2,000 meters deep. The extra weight and high rotational speeds of turbodrills facilitated the rapid drilling of shallow wells, but in regions with geological structures requiring deeper drilling, turbodrilling is less satisfactory. In soft formations and at depths below 2,500 meters the conventional turbo-drill is very inefficient. Although deeper drilling is becoming increasingly necessary both in the older

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producing fields and in the new areas being developed, the turbodrill continues to be used for about 80% of all drilling operations in the USSR. Soviet technicians have suggested modifications to make the turbodrill more effective, but most of its shortcomings persist. To improve deep drilling capability, Soviet experts have advocated the combined use of turbodrilling and rotary drilling -- turbodrilling to depths of 1,500 meters and rotary drilling beyond. The lack of high-quality drill pipe, however, precludes widespread use of rotary drilling. Soviet deep-drilling capability also is limited by the lack of high-powered mud pumps, blowout preventors, and high-quality bits. Soviet data reveal that 8 to 10 months are needed to drill a well to depths of 3,000 to 3,500 meters. In the United States, such wells are usually drilled in about a month. Soviet inability to drill faster, deeper, and more efficiently will limit the amount of oil and gas reserves that can be explored and exploited without disproportionate increases in investment.

7. Total drilling for exploration and development of oil and gas in the USSR rose from 7.1 million meters in 1959 to a peak of 11.7 million meters in 1967 and then declined to about 11.1 million in 1968. Of the total meters drilled during the 10-year period 1959-68, approximately 80% was for oil exploration and development. Drilling activity in 1970 does not appear to be increasing as it should to meet the needs for new reserves and greater production; the plan calls for total drilling to reach only about 10 million meters, and [] this goal will be difficult to reach.

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Production

8. During the past two decades the USSR has increased crude oil production at an average annual rate of about 12%, from 33.4 million tons in 1949 to 328 million tons in 1969 (see Table 1). Soviet output is second only to that of the United States, the world's largest producer. Rates of increase have declined, however, from almost 16% during 1956-60 to less than 8% since 1965, although the annual quantitative increase has risen from about 15 million tons per year in the earlier period to more than 21 million tons annually during 1966-69.

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Table 1

Production of Major Fuels in the USSR

<u>Year</u>	<u>Crude Oil (Million Metric Tons)</u>	<u>Natural Gas (Billion Cubic Meters)</u>	<u>Coal (Million Metric Tons)</u>
1950	37.9	5.8	261.1
1955	70.8	9.0	389.9
1958	113.2	28.1	493.2
1959	129.6	35.4	503.3
1960	147.9	45.3	509.6
1961	166.1	59.0	506.4
1962	186.2	73.5	517.4
1963	206.1	89.8	531.7
1964	223.6	108.6	554.0
1965	242.9	127.7	577.7
1966	265.1	143.0	585.6
1967	288.1	157.4	595.2
1968	309.2	169.1	594.0
1969	328	181.3	608
1970			
Plan	350	197	618

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9. The major portion of the increase in output during the past 20 years has come from the Urals-Volga oilfields, which in 1969 accounted for about 60% of national output. In 1970, Soviet production of crude oil is planned to reach about 350 million tons, and data on output during the first half of the year indicate that the goal can be attained. [redacted]

[redacted] output in the Urals-Volga fields should reach a maximum of about 207 million tons in 1970, and future growth in production will have to come primarily from deposits in Western Siberia and Central Asia. In recent years, the USSR has experimented with the use of nuclear explosives to stimulate production in some of the oilfields of the Urals-Volga where well yields had fallen sharply. Preliminary results indicated that production at one oilfield had been increased as much as 40% by such nuclear stimulation. US experts, however, do not consider this method, in its present state of development, a reliable or economical means of increasing recovery from oil or gas deposits.

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10. Production in the West Siberian region is, and will continue to be, plagued with problems and high costs because of the permafrost, extremes of climate, difficult terrain, shortages of equipment and labor, and poor transport and supply facilities. The lack of production equipment suitable for use in Siberian conditions is a major bottleneck. Chronic shortages of suitable drilling rigs, all-terrain vehicles, earthmoving equipment, and building materials are reported. Most of the oil tool manufacturing industry is located far from Siberian activity and has been slow to meet the needs of this region. Automation equipment is needed in the oil and gasfields to reduce the requirement for labor in the difficult operating conditions of Siberia, but little equipment of this type is available at present. There is inadequate planning for the construction of roads, railroads, pipelines, or electric power facilities before the fields are developed. In many instances equipment must be brought in by helicopter which adds significantly to the cost of development. In 1968, air freight alone accounted for 13 million rubles out of a reported total of 81 million rubles spent for exploration in West Siberia.

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Refining

11. In general, oil refining is a technologically backward branch of the Soviet petroleum industry. It lags far behind the United States in terms of the quality of individual products, product mix, depth of refining, and complexity of refining processes. This situation resulted from the failure to allocate necessary investment to refining during the late 1950s and early 1960s, a period of rapid growth in production of poorer quality crude oils that were more difficult to process. Some of the lag, however, can be attributed to the market, which differs considerably from that in the United States, especially as passenger automobile transport in the USSR is insignificant.

12. Soviet demand for high-quality oil products is increasing, especially for higher octane gasolines and diesel fuels with low sulfur content. However, many of the secondary processing facilities, such as catalytic cracking, hydrocracking, and catalytic reforming, which are necessary to improve quality and to increase flexibility of the product mix, are not being installed as rapidly as needed, or when completed are not operated at design capacity. The expansion of existing refineries has not been completed on schedule. In 1969, Soviet journals reported that not a single new refinery was started during 1961-68 and two important refineries planned in 1965 had not yet reached the blueprint stage. Failure to put new refineries in operation on schedule has required the more intensive use of existing facilities, including such practices as use of thermal cracking units for primary distillation.

13. As of 1 January 1970, total crude oil charge capacity (primary distillation capacity) in the USSR was about 285 million tons (5.7 million barrels per day), second only to the United States. Primary capacity has increased at an average rate of about 8% a year since 1958, but is not adequate to process all of the indigenous crude oil produced. Soviet planners apparently decided against building excess refining capacity when the USSR began to export large quantities of crude oil during the early 1960s. Refining capacity is continuing to expand, however, at about 15 million tons per year. Plans for 1971-75

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call for construction of primary distillation units with larger capacities -- up to 6 million tons per year rather than 1 million to 3 million tons -- and almost certainly the past level of annual additions to capacity can be maintained. Therefore, total primary capacity is expected to be some 375 million tons by the end of 1975.

14. The output of petroleum products rose from almost 92 million tons in 1958 to about 230 million in 1969, an average annual increase of about 9%. During this period the yield of products has been adequate to satisfy the quantitative demands of the economy and also to permit exports averaging about 20 million tons per year.

Domestic Consumption

15. During 1959-68, the apparent domestic consumption of petroleum products in the USSR rose at an average annual rate of 8.4%, increasing from almost 87 million tons in 1958 to about 194 million tons in 1968 (see Table 2). During the same period, Soviet production of crude oil increased at an average rate of 10.6% per year. Although the quantity of oil products in general has been adequate to satisfy the steadily growing domestic demand, some inflexibility in refinery operations has resulted at times in a range of product output that does not satisfy seasonal needs or that does not meet quality specifications. Consequently, sporadic local shortages of certain oil products occur. Local shortages also result from inadequate transport facilities during peak periods of consumption. For example, at harvest time when railroads are overburdened, supplies of diesel fuel tend to be tight.

Distribution

16. Transportation of oil in the USSR continues to be a major problem because of the concentration of crude oil production in a few regions far from the centers of refining and consumption. In the early 1960s oil pipeline transport developed slowly because greater priority was given to building the natural gas pipeline system. Until 1965 railroads carried more oil than any other mode of transport, at a cost of almost three times that of movement by pipeline. Since 1965, however, movement of oil by pipeline has accounted for the largest share of

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Table 2

Apparent Consumption of Oil Products in the USSR

Million Metric Tons						
<u>Year</u>	<u>Gasoline</u>	<u>Kerosine</u>	<u>Diesel Fuel</u>	<u>Lubricating Oils</u>	<u>Residuals and Others</u>	<u>Total</u>
1958	20.0	13.5	18.4	3.4	31.4	86.7
1959	21.3	14.6	20.6	3.7	34.0	94.2
1960	22.9	15.3	23.2	4.2	37.1	102.7
1961	23.8	16.1	26.7	4.4	40.3	111.3
1962	26.3	17.2	30.2	5.0	45.5	124.2
1963	29.0	18.0	33.8	5.5	50.7	137.0
1964	30.6	18.8	37.1	6.0	54.3	146.8
1965	32.2	18.9	40.5	6.3	58.4	156.3
1966	34.0	19.5	43.4	6.9	63.0	166.8
1967	36.4	20.6	48.5	7.3	69.1	181.9
1968	38.2	21.2	51.7	7.8	74.9	193.8

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total tons carried. In 1968, pipelines and railroads accounted for about 85% of all oil transported in the USSR.

17. The total length of the oil pipeline network in the USSR at the end of 1969 was about 37,000 kilometers. At least 80% of the system consisted of pipelines for transport of crude oil and the remainder for product movement. The total tons of oil carried by pipeline increased from almost 130 million tons in 1960, when the system consisted of 17,300 kilometers, to more than 301 million tons in 1968, over a total system of 34,100 kilometers. Most of the available data on future plans indicate that emphasis will be placed on construction of long-distance crude oil lines rather than product lines. At the same time, larger diameter lines will have to be used to move oil over greater distances. Domestic supplies of large-diameter pipe, however, are not adequate to meet the needs of both the oil and gas industries, and imports of such pipe will be required from Western and Eastern Europe to fulfill construction goals. If adequate supplies of pipe cannot be obtained, the Soviet oil industry may have to return to greater reliance on rail and maritime transport, thereby making pipe available for movement of natural gas that cannot be shipped by other means.

Foreign Trade

18. The USSR has been a net exporter of oil in increasing amounts since 1955. Net exports rose from slightly less than 4 million tons in 1955 to about 85 million tons in 1968, an average annual increase of about 26%. In 1969, however, total exports leveled off and net exports were about the same as in 1968. Exports of oil have represented a rising share of indigenous production of crude oil, increasing from 22% in 1960 to 28% in 1968. Total oil exports rose from about 33 million tons in 1960 to approximately 86 million tons in 1968 (see Table 3). During the years since 1960 about 55% of the oil exported from the USSR has been shipped to Free World countries. Such exports totaled about 42 million tons in 1969. The greatest part of this oil has been sold to industrialized countries to finance imports of technology and equipment needed for Soviet industrial development. In recent years exports of oil have been the largest single source of foreign exchange

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Table 3
Soviet Exports of Oil

Year	Million Metric Tons						
	Exports to Free World Countries ^{a/}			Exports to Communist Countries			
	Crude Oil	Products	Total ^{b/}	Crude Oil	Products	Total ^{b/}	Total ^{b/}
1955	0.7	3.1	3.8	2.2	2.0	4.2	8.0
1958	3.9	5.3	9.2	5.2	3.8	9.0	18.1
1959	6.1	8.0	14.1	6.4	4.8	11.3	25.4
1960	9.0	9.0	18.1	8.8	6.4	15.1	33.2
1961	13.3	9.5	22.8	10.1	8.3	18.4	41.2
1962	13.6	11.1	24.7	12.7	8.0	20.7	45.4
1963	15.4	13.0	28.4	14.8	8.2	23.0	51.4
1964	18.8	12.5	31.3	17.9	7.4	25.3	56.6
1965	21.0	14.5	35.5	22.4	6.5	28.9	64.4
1966	24.8	16.6	41.3	25.5	6.7	32.3	73.6
1967	26.8	16.9	43.7	27.3	8.1	35.4	79.0
1968	26.7	18.0	44.7	32.5	9.0	41.5	86.2
1969 ^{c/}	24.7	17.1	41.8	36.0	8.5	44.5	86.3 ^{d/}

a. Cuba is included in the Free World prior to 1960 and thereafter in the Communist countries.

b. Because of rounding, components may not add to the totals shown.

c. Preliminary.

d. Not including some 4 million tons procured from the Free World and reexported on Soviet account.

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earnings for the Soviet Union. Since 1955, annual hard currency earnings from oil exports to Free World countries rose from \$10 million to a maximum of \$375 million in 1968. During the past five years (1965-69), Soviet oil sales to the industrialized countries of the Free World earned a total of about \$1.5 billion in hard currency (see Table 4).

Prospects for Oil During 1971-80*Probable Soviet Production in 1975 and 1980*

19. The USSR probably can fulfill the announced goal for production of 450 million tons of crude oil in 1975 without significantly increasing its present level of drilling.* The average annual rate of growth in production of crude oil during 1971-75 would be only 5.2%, compared with 7.6% during the previous five years. The requisite yearly increase of 20 million tons, which is slightly less than the average yearly increase attained during 1966-70, seems feasible.

20. Soviet production of crude oil in 1980 is much more difficult to forecast. The plan calls for production of 550 million to 600 million tons in that year. Various methods of estimation suggest a possible production range of 450 million to 550 million tons. The anticipated decline in production in some of the older regions (coupled with more difficult climatic and geological conditions in new producing areas), rising exploration and development costs, and the lack of equipment embodying modern technology -- especially for drilling -- suggest that within this range production probably will be in the vicinity of 500 million tons. This estimate equates to an average annual expansion of only 2.1% during 1976-80, and the extraction of 10 million tons of additional crude oil each year. The importance of the petroleum industry as a domestic source of energy and as an earner of foreign exchange probably will lead Soviet planners to take the steps necessary to guarantee production of approximately this level even if production costs increase sharply.

* See Appendix B, Case 1.

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Table 4
Soviet Earnings of Hard Currency from Exports of Oil

<u>Year</u>	<u>Total Exports of Oil to Free World (Million Metric Tons)</u>	<u>Exports to Hard Currency Countries (Million Metric Tons)</u>	<u>Hard Currency Earnings Obtained from Oil Exports (Million US \$) ^{a/}</u>
1955	3.8	0.5	10
1960	18.1	9.3	99
1965	35.5	22.3	225
1966	41.3	25.4	257
1967	43.7	29.9	335
1968	44.7	31.0	375
1969 ^{b/}	41.8	27.9	340

a. Rubles were converted to dollars at the official rate of exchange of 0.9 ruble to US \$1.

b. Preliminary.

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21. Production of crude oil and natural gas generally is a function of the number of producing wells. As the number of wells increases each year, the drilling requirement rises. During the early 1960s the National Petroleum Council (NPC)* analyzed Soviet oil and gas exploration, drilling, producing, and transportation operations and concluded that drilling is the best indicator of ultimate producing potential. To evaluate future output possibilities on the basis of total drilling, production of both crude oil and natural gas must be considered. US experts in the NPC evaluation estimated that a total of 108 million meters would have to be drilled during 1964-70 to produce 360 million tons of oil and 250 billion cubic meters of gas by 1970, and maintain ratios of "proved" reserves to production of 17:1 for oil and 20:1 for gas. Subsequent information published in Soviet petroleum journals revealed that a total of 105 million meters were to be drilled for oil and gas during 1964-70. Drilling plans, however, have not been fulfilled during this period; by the end of 1970, less than 80 million meters will have been drilled. The production goals for 1970 have been lowered to 350 million tons for oil and 197 billion cubic meters for natural gas, but in consequence of the failure to fulfill drilling plans, achievement of even these revised goals will result in significant reduction of the reserves to production ratios.

22. In the NPC study, it was estimated that a total of 480 million meters would have to be drilled during 1961-80 to achieve production goals of 700 million metric tons of oil and 700 billion cubic meters of natural gas and to have a reserves to production ratio of 15:1 for oil and 20:1 for gas. Available data [redacted] indicated that about 500 million meters would have to be drilled during 1961-80 to meet the above production goals. Since that time, however, the goals for production in 1980 have been lowered considerably, to 550 million to 600 million

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* *NPC reports, Impact of Oil Exports from the Soviet Bloc, Vols. I and II (1962) and Supplement to the 1962 report (1964),* [redacted]

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tons of oil and 550 billion to 600 billion cubic meters of natural gas. Achieving even the low ends of the planned ranges, while maintaining the reserves to production ratios indicated above, would require annual drilling over the next ten years to average 2 to 3 times the amounts attained in recent years. In fact, however, total drilling has been declining, from about 11.7 million meters in 1967 to 10 million in 1970. Failure to invest in more exploratory and developmental drilling, if continued, will seriously impede the growth of production.

23. V.D. Shashin, Minister of the Petroleum Extraction Industry, stated early in 1969 that, based on past and present drilling efforts, the amount of drilling by 1980 would have to be 80% more than in 1968 if oil and gas production goals are to be reached, and that 1,600 more rigs and 2,317 more drilling crews would be required. This effort would almost double the number of rigs and crews and also double the average cost per meter drilled. At about the same time he indicated that fulfillment of future goals for production of oil and gas must be accomplished without any such steep rise in capital investment for drilling as has occurred in recent years. He emphasized that technical progress is essential for achieving the goals. Presumably such technical progress would include greater reliance on rotary drilling and development of light-weight drilling rigs suitable for use in the Siberian climate and terrain. Instead, however, there appears to be continued reliance on the turbodrill, and although new drilling rigs have been developed for use in Western Siberia, they are extremely heavy. Their transport between drilling sites requires three times as many tractors as did the older rigs, and frequently involves considerable loss of time. Downtime (time when the bit is not drilling on the bottom) now amounts to 60% to 70% of total drilling time in the USSR, compared with about 30% to 40% in the United States.

24. The drilling performance suggested by Shashin is not impossible in the light of past experience, but it appears improbable. The annual drilling depths achieved during 1960-62 were 80% greater than those attained in 1950-52, and annual drilling in 1964-67 was approximately double that of 1954-57. Those increases, however, were attained chiefly in the Urals-Volga region where conditions were more favorable than in the areas that will be exploited in the 1970s.

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An 80% increase in drilling by 1980 would require an average increase of about 1 million meters per year during 1971-80. This average is higher than any annual increase achieved in the past and probably will not be attained. If it could be, the lower ranges of the goals for production of oil and gas in 1980 could be reached by permitting the "proved" reserves to production ratios to fall to about 10:1 for both.*

25. If the USSR should continue to drill only at the level of the most recent years -- 10 million to 11 million meters per year -- it could produce 450 million to 500 million tons of crude oil and perhaps 350 billion cubic meters of natural gas in 1980 without letting the reserves to production ratios fall much below 10:1.** Therefore, crude oil production in 1980 can be estimated somewhere between the level of 450 million tons (virtually no improvement in drilling rates and no increase in annual production after 1975) and the 550 million tons (achieved with the almost equally unlikely 80% increase in drilling mentioned by Shashin). Within this range, a reasonable estimate may be a production of around 500 million tons.

26. Given the greater average depths of wells required, the use of more drilling rigs in prolonged deeper drilling, inexperience with multizone completion and directional drilling, and the more difficult drilling conditions to be encountered in the next decade, it is doubtful that average annual drilling rates will grow very much. Some improvement is possible, especially if the USSR is willing to make sufficient investment in new technology and equipment, some of it from Free World sources. The priority assigned to the petroleum industry as the USSR's leading earner of foreign exchange makes it appear unlikely that Soviet planners will fail to make a strenuous effort to provide the resources required to solve problems already recognized by their technicians. There have been indications that this will be the case. In recent years the USSR has turned

* See Appendix B, Case 2.

** See Appendix B, Case 3.

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to Free World countries for equipment and technology to overcome some of its deficiencies. In 1967 the USSR bought a mobile offshore drilling platform, valued at \$10 million, from the Netherlands for use in petroleum exploration in the Caspian Sea. Late in 1969, high-level Soviet officials invited a US firm to consider undertaking offshore work in the USSR. J.M. Gvishiani, Deputy Chairman of the State Committee for Science and Technology of the Council of Ministers of the USSR (and Kosygin's son-in-law), stated that the USSR has several projects under consideration involving offshore exploration for oil and gas and construction of underwater gas pipelines, including a pipeline to Japan. He indicated that the USSR had almost no specialized equipment for such work and that it would be easier to bring in outside contractors for the initial phase of the offshore program than to wait for development of Soviet technology.

Regional Trends in Production

27. Available information on trends in regional development of oil production was evaluated as a check on the validity of the above estimates which were based on national drilling rates and minimum desirable reserves to production ratios. The results of the two methods of estimation were found to be at least compatible.

28. Many of the productive deposits of the Urals-Volga region, which now accounts for about 60% of the current national output of crude oil, have been overproduced to meet annual goals and their producing life has been severely curtailed as a result. Faulty technical procedure in waterflooding oilfields at the initial stage of development -- for purposes of pressure maintenance -- has resulted in unexpected water encroachment in the producing oil zones, reduction in oil recovery, and loss of a significant part of the reserves in place. A critical loss in oil reserves as a result of such practices occurred in the Romashkino field, the largest in the USSR. This field, which now accounts for about one-fourth of total national production, originally was estimated to have recoverable reserves of 2.6 billion tons. With increased water encroachment in recent years, it is now estimated that no more than 1.6 billion tons will be recovered.

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29. The production forecast for 1980 from the Urals-Volga fields originally was about 350 million tons, but [redacted] the 207 million tons to be produced in 1970 will be about the maximum level of output. Once oilfields reach their maximum output, rates of decline often are similar to those of the buildup period, resulting in a bell-shaped curve for annual production throughout the life of the field. If this proves true in the Urals-Volga fields, output from the region may be in the neighborhood of 180 million tons in 1975 and 100 million tons in 1980. Given the extensive damage to the fields that has occurred, much larger production seems unlikely. The estimate of 100 million tons from the Urals-Volga in 1980 approximately coincides with the findings of a US petroleum geologist who has made an independent study of the most important Soviet oilfields.

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30. Technical errors in the development of relatively new large oil deposits in the Mangyshlak fields of western Kazakh apparently have reduced the potential recovery there as well. Instead of collecting associated gas and reinjecting it to stabilize formation pressure, Soviet technicians have flared it off, thereby causing a number of wells to stop flowing. Other wells stopped flowing when cold sea water injected to maintain pressure reduced the reservoir temperature below 90°F, thereby causing the highly paraffinic oil to solidify underground. When these wells stopped producing, the goals for production were lowered. The original goals called for Mangyshlak fields to produce 35 million to 40 million tons in 1975 and 65 million to 100 million tons in 1980. Recently, however, a Soviet oil industry official indicated that output from these fields is not expected to exceed 25 million tons in 1975 or 30 million tons in 1980. Production from Turkmen, the other significant oil producing region in Central Asia, is developing at about the same rate as production from Mangyshlak and total production from Central Asia probably will not be more than 60 million tons in 1975 and some 65 million tons in 1980.

31. In January 1970, Soviet policymakers announced that development of oil and gas reserves in Western Siberia would have top priority during the next decade. Annual production of oil from this region is scheduled to reach 100 million to 120 million tons by 1975 and 230 million to 260 million tons by 1980.

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These goals are considerably above those announced in the early 1960s which called for an output in 1980 of about 42 million tons from all of Siberia and the Far East.

32. West Siberian deposits are located in an uninhabited area, covered with permafrost and taiga and lacking in public utilities, transportation, and communication facilities. Their development will be much more expensive than development of those in the Urals-Volga region and logically could take longer. It took 22 years to reach an annual production of 100 million tons from the Tatar ASSR, the republic which is the largest producer of oil in the Urals-Volga region. The Tatar ASSR, it should be noted, was an area ideally suited for use of the turbodrill and which possessed established population centers and developed communication and transportation facilities. To produce 100 million to 120 million tons of oil from the West Siberian fields in 1975, only 10 to 12 years after the beginning of their development, will be difficult -- although possible if the most favorable prospects are developed first. Annual production has been growing much more rapidly in Western Siberia than it did during the comparable period of development in Tatar. The chance for continued rapid growth is improved somewhat by the high average well-yield achieved thus far in Western Siberia. V.D. Shashin has indicated that this average yield has been 3 to 4 times that from the fields of the Tatar ASSR. Thus production of 100 million tons per year could be achieved with a smaller number of wells than was required in the older fields.

33. Attainment of the goal for production of 230 million to 260 million tons of oil in Western Siberia in 1980 appears more unlikely than fulfillment of the goal for 1975. Once the most obvious prospects have been drilled, growth in production from the region can be expected to slow down. More efficient oilfield development than has occurred in the past, combined with a considerable amount of good luck, will be necessary if production from West Siberian reserves is to exceed 150 million to 200 million tons in 1980.

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34. Thus the three principal oil-producing regions of the USSR -- the Urals-Volga, Central Asia, and Western Siberia -- may be producing 340 million to 360 million tons of crude oil in 1975 and some 315 million to 365 million tons in 1980. Production from other regions in those years may total about 100 million tons and 135 million tons, respectively. On the basis of such regional information as is available it can be estimated that production of crude oil in the USSR as a whole could total some 440 million to 460 million tons in 1975 and 450 million to 500 million tons in 1980. For a regional distribution of Soviet crude oil production in selected years during 1965-80, see Table 5.

Domestic Demand for Oil

35. To forecast future levels of Soviet demand for oil the relationship of growth in total domestic demand* to growth in industrial production was established for the years 1955-68 and projected to 1975 and 1980 using two different assumptions (see Table 6 and Figure 1). The first projects industrial growth at an average annual rate of 6% during 1969-80 and implies a demand for 340 million to 360 million tons of oil in 1975 and 470 million to 490 million tons in 1980.** The second projects industrial growth at 6% per year during 1969-75 and 5% per year thereafter. This latter projection, which assumes diminishing returns to capital, implies a demand for 440 million to 460 million tons of oil in 1980.*** These figures imply that total demand for oil in the USSR will increase at an average annual rate of 6% to 7% during 1969-75 and 4% to 8% during 1976-80. Caution must be exercised in extrapolating the results of any regression exercise, although the level of demand for oil probably will fall within these ranges. The uncertainty of the projection beyond 1975 is, of

* Including consumption, losses, storage, and bunkers, all measured in crude oil equivalents.

** Ranges assume three standard errors of estimate from the computed regression line and rounding to two significant figures.



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Table 5

Estimated Production of Crude Oil in the USSR, by Region

Producing Region	Million Metric Tons					
	1965 ^{a/}	1968	1969	1970	1975	1980
Urals-Volga	173.6	201	204	207	180	100
West Siberia	1.0	12.2	21.4	30	100-120	150-200
Central Asia	13.8	22.6	26	30	60	65
North Caucasus	20.7	30.5	30.9	33	30	30
Azerbaijdzhan	21.5	21.1	20.4	20.2	20	20
Ukraine	7.6	12.1	13.4	15	20	25
Belorussia	Negl.	1.7	2.7	4.3	10	25
Komi	2.2	5.0	6	7	15	25
Far East	2.4	3.0	3.2	3.5	5	10
<i>Total</i>	<i>242.9</i>	<i>309.2</i>	<i>328.0</i>	<i>350</i>	<i>440-460</i>	<i>450-500</i>

a. Because of rounding, components may not add to the totals shown.

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Table 6

Soviet Domestic Demand for Oil and Growth in Industrial
Production

<u>Year</u>	<u>Domestic Demand for Oil (Million Metric Tons of Crude Oil Equivalents)</u>	<u>Index of Industrial Production</u>
1955	67.0	100
1956	78.8	109
1957	88.5	117
1958	98.8	129
1959	107.9	140
1960	118.1	151
1961	127.2	162
1962	142.1	175
1963	155.9	185
1964	167.6	196
1965	178.7	208
1966	191.3	223
1967	208.3	239
1968	221.8	253
1969		268 <u>a/</u>
1970		284 <u>a/</u>
1975		379 <u>a/</u>
1980		508 <u>a/</u> 484 <u>b/</u>

a. Assuming a 6% rate of industrial growth during 1969-80.

b. Assuming a 5% rate of industrial growth during 1976-80.

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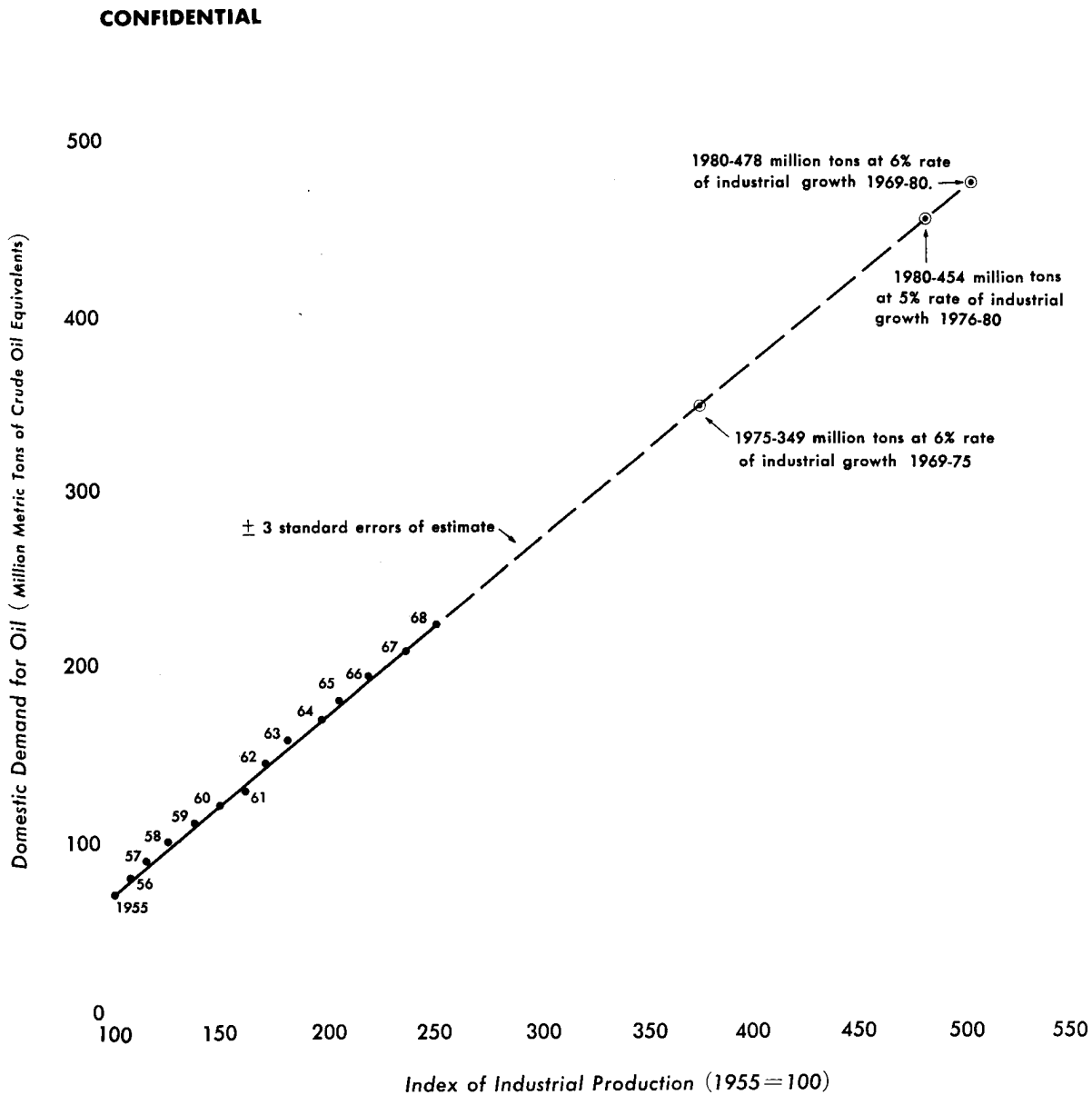


Figure 1. Relationship of total domestic demand for oil to growth in industrial production
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course, much greater, as is indicated by the ranges shown for both quantities and rates of increase.

36. Average annual rates of growth in total domestic demand for oil in the USSR have declined from 12.0% during 1956-60 to 8.6% during 1961-65 and to 7.5% during 1966-68. During these same periods, however, the average quantitative increases in demand for oil have risen from about 10 million tons per year to approximately 14 million tons. These past patterns of declining percentage rates of increase and growing quantitative increases in demand suggest that the most likely rates of growth in total demand for oil, considering possible improvements in technology and increases in efficiency of consumption, may be about 6.5% to 7% per year during 1969-75 and some 5% annually during 1976-80. Thus total domestic demand for oil may approximate 350 million tons in 1975 and 450 million tons in 1980. This estimate of demand in 1975 is compatible with the forecast of about 375 million tons of crude oil charge capacity at refineries in that year. It also appears reasonable when compared with estimated use of oil by agricultural tractors and combines in 1975 -- taken in conjunction with a Soviet projection of agriculture's share in total petroleum consumption in that year -- and is consistent with an estimate of increased requirements of the growing motor vehicle park during the first half of the 1970s.

Growing Demand in Eastern Europe

37. In addition to being faced with a growing domestic demand for oil, the USSR is expected to supply increasing quantities to the Communist countries of Eastern Europe. The total oil supply of these countries rose from about 25 million tons* in 1960 to more than 56 million tons in 1969, an average annual rate of growth of more than 9%. Available information on plans, combined with estimates of future consumption patterns, leads to the conclusion that Eastern Europe's demand for oil during 1970-80 probably will rise at a slightly slower rate, perhaps at about 8% annually. If this is the case, it will total some 90 million to 100

* Including crude oil and petroleum products expressed in crude oil equivalents.

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million tons in 1975 and 120 million to 135 million tons in 1980. This would be compatible with plans for refining capacity of at least 90 million tons by 1975.

38. Eastern Europe will be able to meet only a relatively small part of this demand from its own production which totaled about 17 million tons in 1969 and is not expected to rise much above 20 million tons per year by 1980. The largest part of Eastern Europe's requirement for oil will continue to be met by imports from the USSR. During 1960-69 such imports rose from about 9 million tons to almost 36 million tons, or from 37% to 63% of total East European supply. If Romania, which is itself a net exporter of petroleum, is excluded, Soviet oil accounted for almost 70% of Eastern Europe's oil supply in 1960 and about 85% in 1969 (see Table 7). Plans indicate that Eastern Europe expects imports of Soviet oil to continue to rise, reaching 60 million to 65 million tons by 1975 and perhaps as much as 75 million to 85 million tons by 1980. These expectations appear to coincide with intentions of the USSR to continue to supply most of the oil required by Eastern Europe. In recent years, much of the Soviet crude oil exported to Eastern Europe has been delivered via the Friendship pipeline system which extends from oilfields in the Urals-Volga region to Czechoslovakia, Hungary, Poland, and East Germany. This system, which was completed in the early 1960s and now has the capacity to deliver more than 20 million tons per year, is being paralleled. When the second line is finished in the mid-1970s, the entire system should be capable of transporting some 50 million tons per year. Continuation of the present level of Soviet deliveries by rail and maritime transport -- approximately 15 million tons of crude oil equivalent per year -- appears adequate to satisfy the additional East European requirement for Soviet oil in 1975.

39. Most of the East European countries have signed contracts with Middle East nations -- Iran, Iraq, and Syria -- to obtain oil in exchange for technical equipment and manufactured goods. The quantity of oil to be imported from the Free World will be rather small for the next several years, reaching about 15 million tons in 1975 -- of which Romania will import about one-third. By 1980, imports from the Free World may reach 30 million tons and account for as much as one-fourth of the total

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Table 7

Oil Supply in Eastern Europe a/

Million Tons of Crude Oil Equivalents

Year	Indigenous Production b/	Imports		Total Supply c/	Soviet Oil as a Share of Total Supply (Percent)	
		From the USSR	From the Free World			
1960	14.7 (1.5)	9.4	1.0	25.1	37	69 d/
1965	16.5 (1.3)	22.8	1.7	41.0	56	80 d/
1966	16.6 (1.0)	25.6	1.9	44.1	58	82 d/
1967	17.2 (1.0)	28.0	2.3	47.5	59	82 d/
1968	17.1 (0.7)	32.7	3.0	52.8	62	85 d/
1969						
Preliminary	16.7 (0.6)	35.5	4.3	56.5	63	85 d/
1970						
Estimated	17 (0.5)	40	6	63	63	85 d/
1975						
Estimated	18-19	60-65	14-16	92-100	60-71	74-88 d/
1980						
Estimated	20-21	75-85	25-30	120-136	55-71	66-88 d/

a. Including Bulgaria, Czechoslovakia, East Germany, Hungary, Poland, and Romania (Romania is a net exporter of petroleum and does not import oil from the USSR).

b. Including output of synthetic oil from processing of coal through 1970; quantities of synthetic oil are shown in parentheses.

c. Exports of oil products to Free World not deducted; such exports amounted to about 8 million tons in 1969.

d. Soviet oil as a share of Eastern Europe's total supply excluding Romania.

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East European supply of oil. Construction of an oil pipeline through Yugoslavia to Hungary, Czechoslovakia, and Poland to transport oil imported from the Middle East has been proposed for several years. Preliminary discussions indicate that the capacity of this line might be about 20 million tons per year, but no agreement has been reached among the countries involved concerning its financing. In any case, it is doubtful that it will be built before the mid-1970s.

Prospects for Oil Exports

40. Through 1975, the USSR will produce enough oil to meet its own needs and those of Eastern Europe while continuing to export to other areas. Just how much oil will be available for export to other areas is less certain. Extreme combinations of the ranges of possible production and of demand in the USSR and Eastern Europe imply that the amount could be as little as 15 million tons or as much as 60 million tons. The combinations of factors that would lead to either of these extremes, however, are unlikely. It appears more probable that in 1975 the USSR will produce some 100 million tons more than it will require to meet its own needs and that of this amount about 60 million tons will be allocated to meet the rising demands of Eastern Europe. This would leave approximately 40 million tons available for export to other Communist countries and to the Free World. If the USSR wishes to maintain its position as a supplier of these latter areas at about present levels, modest quantities of oil -- perhaps 10 million tons -- may have to be procured from Free World producers for reexport. The USSR has already entered into agreements with Middle East and North African countries -- Iraq, Syria, Egypt, Algeria, and Libya -- that may provide approximately this quantity of oil in 1975.

41. By 1980, the range of possibilities implicit in the foregoing analysis becomes much greater. At one extreme Soviet production would fall some 40 million tons short of covering domestic demand. At the other, the USSR would not only cover its own requirements and those of Eastern Europe, but have about 35 million tons available for export to other Communist countries and the Free World. Again, the extreme positions seem unlikely. Soviet production in 1980 probably will be sufficient to cover the needs of the USSR, but if production does not exceed 500 million tons and if domestic demand increases at the rates

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anticipated, the quantity of oil available for export will be sharply reduced. To supply the quantities of oil desired by Eastern Europe and to maintain exports to other Communist countries and to the Free World at or near present levels, the USSR may have to procure about 80 million tons from non-Communist sources. For a summary of possible future patterns of Soviet oil trade, see Table 8 and Figure 2.

42. During the past two years Soviet oil experts have noted the rising demand for oil in the USSR and have indicated that although the USSR will continue to sell oil to capitalist countries to earn much-needed foreign exchange, such exports may have reached their peak. These experts have expressed awareness that the United States, the world's leading producer of petroleum, depends on imports for more than 20% of its oil supplies. Soviet planners may be considering the possibility of a similar solution to some of their long-range problems.

43. Several possible courses of action are open to the USSR. The strong Soviet need for hard currency foreign exchange could motivate planners to increase exports to the Free World and to let the East European countries procure a much larger share of their oil directly from the Free World. However, it is unlikely that Eastern Europe could afford to buy the major part of its oil supply from Free World producers. Moreover, from the Soviet point of view, this course of action would have the disadvantage of reducing East European dependence on the USSR and, if carried far enough, could result in underutilization of the Friendship crude oil pipeline system. After expanding the capacity of this system to about 50 million tons per year by the mid-1970s, the USSR probably intends to utilize it.

44. The USSR could also act as a broker for sales of Middle East oil obtained primarily from national companies. Such sales could increase Soviet earnings of foreign exchange and help to keep Soviet oil available for export, both to Eastern Europe and to the Free World. Oil might be obtained from the Persian Gulf via a pipeline through Iran that could, for the most part, be built parallel to the route of a gas pipeline due to become operational in the fall of 1970. The oil could then be transported

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Table 8

Estimated Future Soviet Trade in Oil

	Million Metric Tons of Crude Oil Equivalents				
	1970	1975		1980	
		Range	Best Estimate	Range	Best Estimate
Production					
Plan	350	450		550-600	
Estimate	350	440-460	450	450-550	500
Demand for Soviet oil					
Domestic a/ Eastern Europe	260 40	340-360 60- 65	350 60	440-490 75- 85	450 80
Total	300	400-425	410	515-575	530
Available for export to other Communist countries and to Free World	50	15- 60	40	-125 to +35	- 30
Hypothetical levels of Soviet oil exports b/					
To other Communist countries	10	10	10	10	10
To the Free World	40	40	40	40	40
Total	50	50	50	50	50
Required imports from the Free World	c/	0- 35	10	15-175	80

a. Including losses, storage, and bunkers.

b. For illustrative purposes it was assumed that exports will continue at about present levels.

c. About 5 million tons to be procured from the Middle East under existing contracts, mostly for supply to other Communist countries.

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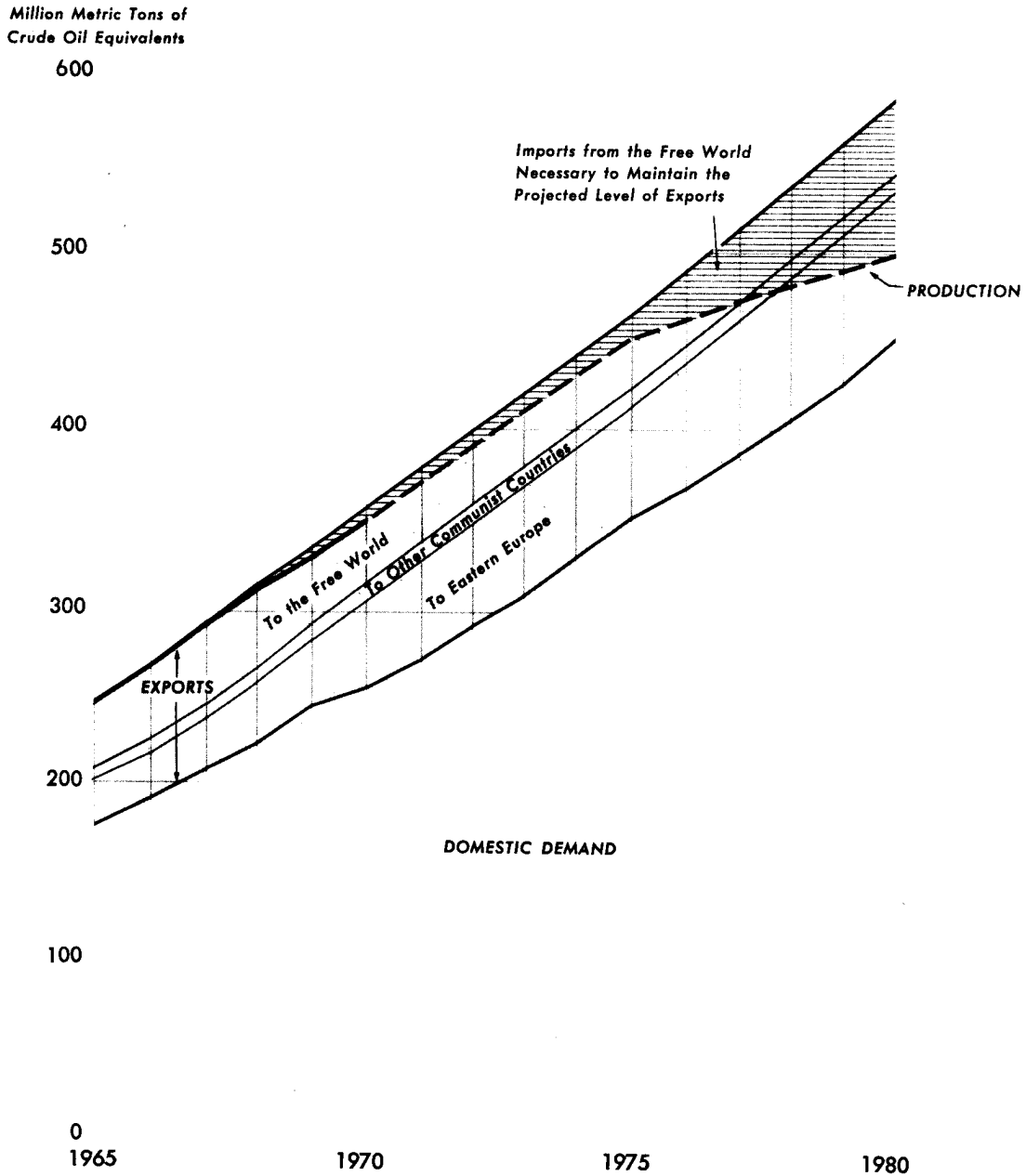


Figure 2. Estimated Soviet production, demand, and exports of oil

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by tanker and/or barge from the Black Sea to Eastern Europe, or it could be used in the European part of the USSR and Soviet crude oils from Central Asia or Western Siberia could be shipped via the Friendship pipeline to Eastern Europe. The Middle East oil possibly could be obtained on a barter basis for Soviet manufactured goods and military equipment without expenditure of hard currency.

Limited Possibility of Substituting Natural Gas for Oil

45. Widespread reports of huge reserves of natural gas in the USSR, and the recently concluded agreements whereby the USSR is to sell natural gas to Western Europe, have occasioned speculation that increased use of gas can relieve the pressure of growing Soviet and East European demand for oil and that foreign exchange earnings from exports of gas can become a significant supplement to earnings from oil exports. It is true that the USSR has large deposits of natural gas and that the share of natural gas in Soviet and East European fuel consumption is growing. Exports of gas during the next decade will be an important means of financing imports of badly needed large-diameter line pipe and equipment, and of earning some foreign exchange. However, more than half of all the "proved" Soviet gas reserves are located in permafrost regions where development would be difficult and costly. In many respects, the problems that must be overcome to expand the output of the gas industry are more difficult than those confronting the oil industry. The chronic shortfalls below planned gas production that have occurred during the past ten years probably will continue during the next decade.

Natural Gas Reserves and Production Problems

46. In January 1970, the Minister of the Gas Industry claimed that "commercial" reserves of natural gas had reached 10 trillion cubic meters and that they would increase to 12 trillion cubic meters by 1 January 1971. This statement was in keeping with recent Soviet practice of discussing national and regional gas reserves in terms of "commercial" reserves -- that is, reserve categories A & B & C₁ -- rather than in terms of reserves that have been "proved" by drilling, as reserve categories A & B.*

* See Appendix A.

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Inclusion of the C₁ category, which is estimated on the basis of geological data but not extensively tested by drilling, inflates the reserve estimates significantly. "Proved" reserves are estimated to have been about 2.5 trillion cubic meters as of 1 January 1969, equivalent to about a 15-year supply at the 1968 production rate of 169 billion cubic meters. The discrepancy between the inflated "official" estimates of "commercial" reserves that have been publicly announced and the reserves actually proved by drilling and available for production has become a source of embarrassment to Soviet officials. Negotiations concerning the possible sale of Soviet gas to Japan were suspended in February 1970 when Kosygin disclosed that reserves of gas in Sakhalin were actually only 16 billion cubic meters and not 60 billion as claimed in earlier talks and as reported in Soviet statistics. Thus the reserves would not be adequate to supply 2.4 billion cubic meters per year to Japan for 20 years as had been discussed in the negotiations.

47. In the older producing regions -- Ukraine SSR, Krasnodar and Stavropol Krays, Urals-Volga region, and the Gazli field in Central Asia -- that provide about 70% of present gas output, major fields are being depleted and exploration results have been poor. Total production of natural gas in these regions since 1966 has exceeded total additions to reserves. In the future, the bulk of new gas resources and new production will originate in West Siberia and Central Asia. Most of the reserves discovered in West Siberia have not yet been drilled extensively, perhaps only one well per structure thus far. On the basis of only 11 wells -- drilled 1 to 19 kilometers apart on the southern half of the structure -- the gas discovery at Urengoy was claimed to be the largest in the Soviet Union, containing 2.6 trillion cubic meters of commercial reserves. The reserves in this deposit accounted for more than half of total commercial reserves in Western Siberia as of 1 January 1969.

48. In many of the natural gasfields, rapid exploitation has been emphasized to maximize output, but in the process gas has been wasted and valuable reserves have been reduced unnecessarily. For example, in 1969, 10 billion cubic meters of associated

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gas and condensate, worth about 250 million rubles, were flared to facilitate more rapid production of oil and gas wells. The waste of this gas has reduced the producing life of many fields because of the loss of reservoir pressure.

49. As production of gas moves eastward to the remote, permafrost regions of West Siberia, the development problems become more severe. It is difficult for seismic equipment to detect the presence of oil and gas structures in permafrost areas, and in West Siberia permafrost is encountered at depths up to 500 meters. Therefore, only by drilling can an accurate delineation of the petroleum-bearing structure be obtained. Such drilling operations are difficult, especially if insulation is not supplied around the well bores to prevent the permafrost from thawing. Warm flows of gas at elevated temperatures can thaw permafrost up to 6 meters around the well and cause the casing to collapse, with subsequent loss of the borehole. Several producing gas wells in the large Tazov field developed ruptures in the permafrost surrounding the well, allowed the gas to escape, and destroyed a portion of the gas deposit.

Probable Production of Natural Gas

50. The problems of developing natural gas reserves in permafrost regions without adequate modern equipment and technology, coupled with shortages of large-diameter pipe and matching valves and compressors, will make fulfillment of production goals in 1975 and 1980 impossible. Instead of the planned output of 300 billion to 320 billion cubic meters in 1975, production probably will reach 270 billion to 280 billion. In 1980, output is unlikely to exceed 350 billion cubic meters, compared to the present goal of 550 billion to 600 billion cubic meters.

51. During the past 10 to 15 years output of natural gas rose rapidly in the USSR, but few annual production goals were attained. The shortfalls in output resulted from lack of production and transport equipment, shortages of large-diameter pipe, inadequate supplies of consumer equipment to receive the

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gas, and the lack of storage facilities to meet peak-load demands. The cumulative effect of these failures is evident in the fact that production in 1970 is now expected to be 197 billion cubic meters instead of the 310 billion to 325 billion foreseen in the plan for 1970, which was set early in the 1960s.

52. The new goal for production of 300 billion to 320 billion cubic meters of natural gas in 1975 probably could be met, although with greater difficulty than that for production of oil, if drilling were the sole prerequisite for plan fulfillment. However, construction of the pipeline system is the most critical factor in future production of natural gas, as pipelines are the only economical means of transportation. Very large quantities of large-diameter pipe (40 inches and over) and matching compressors must be procured before the pipeline networks planned for 1975 can operate at capacity. Domestic facilities to provide such pipe and ancillary equipment are not available, so sizable imports will be required. It is estimated that shortages of line pipe and of producing and consuming equipment will continue to contribute to shortfalls in output. Achieving the level of production planned for 1975 would require annual increases of approximately 21 billion to 25 billion cubic meters during 1971-75. During 1966-70, production rose less than 14 billion cubic meters annually, and only about 13 billion per year during 1967-69. It seems improbable that pipeline capacity can be expanded rapidly enough to permit annual increases in gas output to exceed 15 billion to 17 billion cubic meters. Such increases would result in a total production of 270 billion to 280 billion cubic meters in 1975, some 10% below the plan goal.

53. The goal for production of 550 billion to 600 billion cubic meters of natural gas in 1980 appears unattainable, and probably will be lowered as other gas goals have been during the past decade. Current Soviet plans are predicated upon the development and installation of line pipe with a diameter of 2,520 millimeters (99 inches) during 1973-80. The use of such pipe would permit shipment of 90 billion cubic meters per year through a single pipeline and would reduce the requirement for pipe, as about four pipelines with a diameter of 1,440 millimeters (56 inches) would have to be laid to transport the same volume of gas. The USSR, however, does not have the capability

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to fabricate the larger pipe or to manufacture the necessary matching valves and compressors. Soviet planners acknowledge that development of this pipe is a long-term project as is solution of the attendant problems of transporting and laying it.

54. By 1980, plans call for the completion of three natural gas pipelines with a diameter of 99 inches -- two from West Siberia and one from Central Asia -- to the Moscow area, a total length of 6,000 to 7,000 kilometers. Three additional gas pipelines with a diameter of 56 inches are to be built from West Siberia and Central Asia to serve the Urals and Moscow areas, respectively. The total requirement for pipe for these six lines would be about 13 million to 14 million tons. Also, other oil and gas pipelines of smaller diameter to be constructed will require an additional 4 million to 5 million tons of pipe by 1980. The USSR currently has a capability to produce about 1 million tons per year of 40-inch and 48-inch diameter pipe, and is developing capacity to produce 56-inch pipe. Soviet pipe-manufacturing facilities are not likely to be expanded enough to provide all of the pipe needed nor will imports of pipe and ancillary equipment be adequate to meet pipeline construction schedules. From 1960 through 1968 the Soviet Union imported a total of almost 2.5 million tons of large-diameter pipe, valued at about \$470 million. To fulfill the 1980 goals for pipeline construction would necessitate importing more than 1 million tons per year of large-diameter pipe and the expansion of domestic pipe-manufacturing facilities by at least 50%. It appears that the installation of 99-inch diameter pipe in the amounts anticipated by Soviet planners is too formidable a task to achieve by 1980. Therefore, pipeline capacity probably will not expand rapidly enough to permit the average annual increase in output of natural gas to be more than about 15 billion cubic meters. If this proves to be the case, production of natural gas in 1980 will be about 350 billion cubic meters. Estimate of regional output of natural gas in 1970, 1975, and 1980 are presented in Table 9.

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Table 9

Estimated Output of Natural Gas in the USSR,
by Region

<u>Producing Region</u>	<u>Billion Cubic Meters</u>		
	<u>1970</u>	<u>1975</u>	<u>1980</u>
Ukraine	57.3	50	20
North Caucasus	45	40	35
Central Asia	52.6	70	120-130
Urals-Volga	12	15-20	30
West Siberia	10	70-75	100-110
Azerbaijdzhan	4.5	5	5
Komi	15	20	25
Far East	0.3	2	5
<i>Total</i>	<i>196.7</i>	<i>272-282</i>	<i>340-360</i>

Domestic Demand for Natural Gas

55. Industry has been the major consuming sector, accounting for more than 80% of total gas use in recent years, and undoubtedly it will continue to occupy this dominant position, especially as the needs of the chemical and metallurgical industries expand. Plans call for the share of natural gas in the Soviet fuel balance to reach 25% by 1980, compared with about 19% at the present time. If, however, the production goal is underfulfilled by as much as 200 billion cubic meters in 1980, the output of other more expensive and less efficient fuels may have to be increased sharply to provide the energy required. Information obtained during a recent US coal delegation visit to the USSR indicated that investment in the coal industry is to be increased substantially. This, coupled with the

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higher-than-average increase in coal production attained in 1969 and a further rise in output planned for 1970, may reflect the beginning of a greater requirement for coal by consumers that originally expected to use oil or gas.* Planned increases in distribution of gas to the communal-household sector probably would be reduced first as solid fuels could be readily substituted. Coal might also be used instead of oil and gas in central heating and electric powerplants where flexibility in fuel use is possible if provided for in the design of the plant. No quantitative estimate of how much oil or gas could be freed in this manner is possible, but providing the necessary flexibility in facilities increases the capital cost of power stations up to 20%.

Prospects for Trade in Natural Gas

56. During the past two years the USSR has signed contracts agreeing to supply Austria, West Germany, and Italy with a total of 9 billion cubic meters per year of gas by 1975 and 10 billion to 11 billion annually by 1980. These sales will provide the USSR, during 1970-72, with about 2 million tons of 40-inch and 48-inch diameter pipe and auxiliary equipment for use in construction of its gas pipelines systems. Negotiations for sales of Soviet gas to France and Japan have been suspended in recent months, but may be resumed. If contracts are signed with these countries, annual Soviet deliveries of gas could reach 2.5 billion cubic meters to each by 1980.

* *The USSR has very extensive reserves of coal and is the world's leading coal producer. Most of the deposits, however, contain low-quality coals and are located in the eastern region far from present centers of consumption. Production, which has been growing at an average rate of almost 2% per year during the past decade, is scheduled to reach 618 million tons in 1970 (see Table 1). Plans provide for continued rise in the output of coal to 700 million tons in 1975 and about 850 million in 1985. A likely goal for 1980 appears to be some 775 million tons, which could be reached with an average annual rate of growth of slightly more than 2%.*

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57. During 1971-80 the USSR will be importing natural gas from Afghanistan and Iran. Afghanistan began to provide gas to the USSR in 1968 through a pipeline built by Soviet technicians with Soviet pipe and equipment. Imports of Afghan gas will reach about 2 billion cubic meters in 1970, increase gradually to 4 billion by 1975, and remain at that level until 1984. This gas will be used for the most part in the eastern part of Central Asia, but some of it may be moved through the Central Asia-Moscow pipeline system. Imports from Iran are due to begin in the fall of 1970, at a rate of 6 billion cubic meters per year. These imports are to rise to 10 billion cubic meters annually by 1974 and to remain at that level until 1984. Some of this gas will be used in the Caucasus area as local deposits of gas are becoming depleted and local demands are rising. For a few years, however, some of it could be diverted northward through the Ukrainian system. The Afghan and Iranian gas is being obtained at relatively low prices and can free more expensive Soviet gas for export to Eastern and Western Europe.

58. Gas pipelines already built from the USSR to Czechoslovakia and Poland will supply these countries with a total of about 4 billion cubic meters in 1975. Other pipelines planned or under construction from the USSR to Bulgaria, East Germany, and Hungary are to transport about 7 billion cubic meters in 1975. By 1980, Soviet exports to Eastern Europe could reach 15 billion to 20 billion cubic meters (see Table 10).

59. In 1975 the USSR will be a net importer of natural gas from the Free World, but overall it will be a net exporter of some 6 billion cubic meters as a result of deliveries to Eastern Europe. By 1980 the Soviet Union should be a total net exporter of 15 billion to 20 billion cubic meters of natural gas although its trade with the Free World is expected to be roughly in balance.

60. There is evidence that even with gas production failing to achieve planned levels and with domestic supplies remaining smaller than desired, Soviet planners place considerable importance on selling gas to the Industrial West to finance purchases of equipment and technology. In recent months

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Table 10

Estimated Supply of Natural Gas in the USSR

	Billion Cubic Meters		
	<u>1970</u>	<u>1975</u>	<u>1980</u>
Production			
Plan	225-240	300-320	550-600
Estimated actual	197	270-280	340-360
Imports	<u>4</u>	<u>14</u>	<u>14</u>
From Afghanistan	2	4	4
From Iran	2	10	10
Exports	<u>3.5</u>	<u>20</u>	<u>30-35</u>
To Eastern Europe	2.5	11	15-20
To the Free World	1	9	15 <u>a/</u>
Net supply <u>b/</u>	<u>200</u>	<u>260-270</u>	<u>320-340</u>

a. Assuming exports of about 2.5 billion cubic meters each to France and Japan.

b. Rounded to two significant figures.

the USSR has placed large orders (\$50 million so far) with US companies for tractors, bulldozers, and pipe-laying equipment for the construction of a gas pipeline from Novvy Port in the far north to the Soviet-Czechoslovak border via Moscow. Late in 1969, A.K. Kortunov, Minister of the Gas Industry, suggested to a representative of a US firm that the Soviet Union could compete in the sale of liquefied natural gas (LNG) to the United States at some future date. He visualized the possibility of a US consortium being formed to buy Soviet LNG in exchange for the delivery to the USSR of predetermined "turnkey" plants via the consortium. During recent trade negotiations with Japan, Soviet officials also sought Japanese participation in development of East Siberian

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natural resources. It was proposed that payment be made by deliveries of Soviet raw materials, including natural gas that would be transported by pipeline to a liquefaction plant at a Far East port and subsequently shipped to Japan by tanker.

Conclusions

61. The USSR has very large resources of petroleum, but many are located far from the major consuming areas, in permafrost regions of Siberia and the Far North where exploitation will be difficult. Exploration and development of these reserves and transport of the petroleum to consumers will require not only sizable allocations of investment but also modern technology and equipment, much of which is not available in the Soviet Union. Some of the required equipment and technical data are primarily of US origin and subject to trade controls, although numerous exceptions have been made to permit export.

62. Producing Soviet fields are being depleted more rapidly than expected, in part because poor extractive practices have made large quantities of reserves impossible to recover. Such practices are continuing and almost certainly will impair future recovery of oil.

63. The USSR is the world's second largest producer of oil. Its output is expected to reach 350 million tons in 1970, and the 1975 goal of 450 million tons appears to be attainable. Production at this level in 1975 would be adequate to provide for all domestic needs, to satisfy East European demand for Soviet oil, and still leave substantial quantities for export to other Communist countries and to the Free World. At the same time, small quantities of oil -- perhaps some 10 million tons -- might be procured from Free World sources for shipment to other countries on Soviet account.

64. By 1980, because of the rapid decline in output from the major producing fields of the Urals-Volga region and the probable underfulfillment of production goals in West Siberia, production is expected to fall below plan and to reach only 500 million tons. This level of output probably would be more than adequate to cover domestic demands, but

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exports from domestic resources would be sharply reduced. If the USSR continues to provide most of the oil required by Eastern Europe and maintains other exports near present levels, it may have to procure about 80 million tons from Free World sources. The most likely sources are the Middle East and North Africa, areas from which the USSR and Eastern Europe are already beginning to procure small amounts of oil.

65. Eastern Europe also is expected to increase its annual imports of oil from the Free World, to some 15 million tons in 1975 and perhaps 30 million tons by 1980. Thus combined Soviet and East European procurement of oil from the Middle East and North Africa by 1980 may total about 110 million tons. Although this is a significant amount of oil, the major market for Middle East and African oil will continue to be Western Europe which now takes over half of the oil produced in those areas. Communist purchases will lay claim to a relatively small share of Middle East and North African production, probably no more than 6% or 7% in 1980.

66. Substitution of natural gas cannot be expected to relieve the pressures on the Soviet oil industry created by growing domestic and East European demand and by the desire to earn foreign exchange by exporting to the Free World. Despite the publicity given to large Soviet reserves of gas and to recent Soviet sales of gas to Western Europe, the problems of expanding the gas industry are even more serious than those of the oil industry, and it is unlikely that gas production goals can be met during the next decade.

67. The USSR is becoming increasingly interested in participating in the development of petroleum in the Middle East through assistance to the national oil companies. This policy will be aided by Soviet willingness to become virtually the sole supplier of sophisticated arms to the Middle East. Another means of payment for oil would be the increased supply, on long-term credits, of industrial goods needed for economic development of the Middle Eastern countries.

68. In the long run, if the USSR is able to acquire the necessary modern technology -- especially exploration, drilling, and transport equipment -- the need for Free World oil may be only temporary. It

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could disappear -- as a requirement -- in the late 1980s if the large oil deposits that the USSR unquestionably possesses are developed. However, the USSR would almost certainly regard any arrangements made to procure Middle East oil, or to serve as a broker in its sale, as valuable economic and political assets worth perpetuating.

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APPENDIX A

US and Soviet Definitions of Reserves

United States

Proved reserves (American Petroleum Institute concept) include only the crude oil, natural gas liquids, and natural gas recoverable from known deposits under existing economic and operating conditions. Proved reserves are both drilled and undrilled, but to be included, the undrilled reserves must be so close and so related to the drilled reserves that there is every reasonable probability that they can be recovered by drilling.

USSR

Category A -- includes reserves of crude oil and natural gas fully outlined by wells with proved production capability.

Category B -- includes reserves of oil and gas presumed to exist in undrilled parts of a structure adjacent to drilled parts of the same structure containing at least two wells.

Category C₁ -- includes reserves of oil and gas presumed to exist in undrilled parts of a structure in which one well has been drilled and where geophysical and geological information indicates favorable conditions for the presence of petroleum.

Category C₂ -- includes reserves of oil and gas presumed to exist in completely undrilled structures where geophysical information, supported by geological data from similar drilled structures nearby, indicates favorable prospects for the presence of petroleum.

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APPENDIX B

Annual Drilling Rates and Ratios of Reserves
to ProductionCase 1Continuation of Present Level of Annual
Drilling Through 1975

	<u>Crude Oil (Billion Metric Tons)</u>	<u>Natural Gas (Trillion Cubic Meters)</u>
Estimated "proved" reserves as of 1 January 1969	4.5	2.5
Additions to reserves 1969-75 <u>a/</u>	2.3	2.7
Total reserves available during 1969-75	6.8	5.2
Estimated cumulative production during 1969-74 <u>b/</u>	2.3	1.4
Net reserves available in 1975	4.5	3.8
Planned production in 1975	0.45	0.3
Ratio of reserves to production	10:1	13:1

a. Assumes: (1) continued total drilling of 10 million meters per year as planned for 1970, with a total of 71 million meters drilled during 1969-75; (2) 60% of total drilling will be for oil and 40% for natural gas; (3) 85% of total drilling for natural gas will continue to be exploratory drilling, as it was during 1965-68, and the remainder will be developmental drilling; (4) continuation of discovery rates of 55 tons of oil per meter drilled for oil and 110,000 cubic meters of gas per meter of exploratory drilling for gas achieved during 1961-68.

b. Assumes achievement of planned production of 450 million tons of crude oil and 300 billion cubic meters of natural gas in 1975.

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Case 2An 80% Increase in Annual Drilling by 1980

	Crude Oil (Billion Metric Tons)	Natural Gas (Trillion Cubic Meters)
Estimated "proved" reserves as of 1 January 1969	4.5	2.5
Additions to reserves 1969-80 <u>a/</u>	5.8	6.6
Total reserves available during 1969-80	10.3	9.1
Estimated cumulative production during 1969-79 <u>b/</u>	4.7	3.4
Net reserves available in 1980	5.6	5.7
Planned production in 1980	0.55	0.55
Ratio of reserves to production	10:1	10:1

a. Assumes: (1) an 80% increase in total annual drilling during 1969-80, as proposed by Shashin, which would result in a total of 176 million meters drilled during 1969-80; (2) 60% of total drilling will be for oil and 40% for natural gas; (3) 85% of total drilling for natural gas will continue to be exploratory drilling, as it was during 1965-68, and the remainder will be developmental drilling; (4) continuation of discovery rates of 55 tons of oil per meter drilled for oil and 110,000 cubic meters of gas per meter of exploratory drilling for gas.

b. Assumes: (1) achievement in 1975 of planned production of 450 million tons of crude oil and 300 billion cubic meters of natural gas; (2) production in 1980 of 550 million tons of oil and 550 billion cubic meters of gas, the lower limits of the goals for that year.

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Case 3Continuation of Present Level of Annual
Drilling Through 1980

	<u>Crude Oil (Billion Metric Tons)</u>	<u>Natural Gas (Trillion Cubic Meters)</u>
Estimated "proved" reserves as of 1 January 1969	4.5	2.5
Additions to reserves 1969-80 <u>a/</u>	4.7-5.0	3.4-3.7
Total reserves available during 1969-80	9.2-9.5	5.9-6.2
Estimated cumulative production during 1969-79 <u>b/</u>	4.5-4.6	2.8
Net reserves available in 1980	4.7-4.9	3.1-3.4
Estimated production in 1980	0.45-0.50	0.35
Ratio of reserves to production	10:1-10:1	9:1-10:1

a. Assumes: (1) continued total drilling of 10-11 million meters per year, with a total of 121 million to 131 million meters drilled during 1969-80; (2) 70% of total drilling will be for oil and 30% for natural gas; (3) 85% of total drilling for natural gas will continue to be exploratory drilling, as it was during 1965-68, and the remainder will be developmental drilling; (4) continuation of discovery rates of 55 tons of oil per meter drilled and 110,000 cubic meters of gas per meter of exploratory drilling for gas.

b. Assumes: (1) production of 450 million tons of crude oil and 275 billion cubic meters of natural gas in 1975; (2) production in 1980 of 450 million to 500 million tons of oil and 350 billion cubic meters of gas.

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