USSR

CENTRAL INTELLIGENCE AGENCY
WASHINGTON, D.C. 20505

22509

15 September 1977

MEMORANDUM FOR: Bill Milam
Office of Fuels and Energy
Department of State

SUBJECT : Contribution to "Petroleum Supply Vulnerability Assessment"

Attached is our contribution to the Petroleum Supply Vulnerability Assessment on the Soviet Union's requirements for Western oil field equipment which we discussed earlier. Comments or questions are welcome and may be directed to me [redacted]

[redacted]
Office of Economic Research

Attachment:
as stated

[redacted]

ER M 77-10580
15 September 1977

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Date impossible to determine

The Soviet Need for US Oil Field Technology

We believe that oil supplies will become a critical problem for the USSR and its client states over the next several years. Oil production in the USSR will soon peak -- perhaps as early as next year, but not later than the early 1980s -- and then will probably decline rapidly. The USSR has been importing large amounts of US and other Western equipment for its oil and gas industries. Of its current output of about 10.8 million b/d, at least 1 million b/d is producable only because of past imports of US pumps.

The USSR will need substantial additional Western oil field technology and equipment to stave off or slow the expected production decline. Although some of this equipment is available in Western Europe and Japan, the United States is the only source for much of this equipment and know-how. The following pages examine key areas where US equipment and expertise could mitigate the anticipated near-term decline in the USSR's oil production.

The Technology Gap

Rapid growth in oil production in the USSR during the 1950s and 1960s was made possible mainly by the discovery of large and accessable oil fields in the Urals-Volga region. This oil was relatively shallow and the fairly rudimentary indigenous technology and capital supplies were sufficient

to allow production to grow rapidly. By the late 1960s, however, production from these regions was threatening to decline, and the Soviets began to greatly increase the resources devoted to oil production. Large resources were committed to the development of West Siberia, and the USSR began massive purchases of Western technology and large diameter pipe in the early 1970s. (See table.)

Acquisition and Use of Western Technology

Imports of equipment have contributed greatly to the continued expansion of Soviet oil production since 1970. High volume US pumps have staved off a decline in output in the Urals-Volga and added at least 1 million b/d to output. Even so, much Western equipment is often not as productive in a Soviet setting as it is on native ground. In the petroleum industry this is probably particularly true of exploration equipment.

The major means of acquiring Western technology is by purchasing machinery and equipment. Other channels include the acquisition of turnkey plants, technical data, contacts with Western firms and scientists, and formal arrangements for joint research and exchange of scientific and technical information. Science and technology agreements already exist with three American firms in the areas of geology, geophysics, petrochemicals, and petroleum processing.

None of these means have lived up to Soviet expectations.

USSR: Orders of Western Oil and Gas Equipment[1/]

(Million US $)

	1972	1973	1974	1975	1976	Total 1972-76
From the West	236.0	193.8	558.4	500.3	1,617.0	3,105.5
of which:						
US Equipment	16.1	76.6	76.2	76.4	304.4	549.7
% US Equipment	6.8	39.5	13.7	15.3	18.8	17.7

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1. Excludes imports of large-diameter pipe, which totaled an additional $4 billion during 1972-76.

Soviet industry is slow to get foreign technology into operation and even slower to spread it throughout a given industry. Soviet labor is unfamiliar with complex foreign machinery, spare parts for foreign equipment are often in short supply, and maintenance programs are frequently inadequate. The presence of Western technicians on site during the installation and shake down of new equipment could alleviate many of these problems, but the Soviets have been reluctant to allow it.

From a US leverage standpoint, straight equipment sales are preferable to other forms of technology transfer. Through the acquisition of production machinery, know-how, and turnkey plants, the USSR could achieve a significant degree of independence and flexibility which it otherwise would not have. Even from a Soviet standpoint, the purchase of complete plants is not the ideal solution because of disproportionately large expenditures and very long lead times inherent to such transactions.

Impediments to Technology Transfer

Until 1971, much of the oilfield equipment now being purchased by the USSR were trade control items. Since that time, the major impediments to increased Soviet acquisition of US oilfield technology have been a scarcity of hard currency on the part of the USSR, and since 1973, tight supplies for

some types of oilfield equipment in Western markets.

In three of the equipment areas most crucial to Soviet needs -- downhole submersible pumps, drill bits, and rotary drilling rigs -- there is little or no idle capacity and order backlogs are high. The production capacity of US companies has been largely based on US demand, with some allowance for exports based on historical experience. US companies are reluctant to invest in expensive plant and equipment to supply an uncertain export market. If the USSR expects to obtain large amounts of this equipment, it probably will have to be prepared to make commitments in the next few years for long-term purchases of equipment in the 1980s.

Soviet Equipment Needs

By almost any measure, the Soviet oil industry lags seriously behind US and Western state-of-the-art. For example, seismic exploration equipment currently in use is vintage US 1950s, inadequate for mapping deep-faulted structures and stratigraphic traps. In Siberia, digital field computers for seismographic mapping of prospective structures and for logging test wells are virtually nonexistent.

The drilling picture is even bleaker. In 1975 the US drilled more meterage than the USSR did during 1971-75 with about the same number of rigs. American made drill bits last at least 4 to 5 times longer than Soviet-made bits. The Soviets have

no scientific drilling fluid program. Multizone well completion equipment is scarce. The most obvious deficiency in Soviet equipment manufacture is the lack of modern offshore technology. At present the USSR has two modern and two obsolete jack-up drilling platforms, all operating in the shallow waters of the Caspian Sea.

The following is a detailed evaluation of equipment and technology needed by the USSR.

High Volume Deep Well Pumps

Because of severe water encroachment in fields accounting for the bulk of Soviet oil production, increasingly large volumes of water must be lifted for each barrel of oil produced. To increase total fluid (oil and water) recovery, large numbers of high capacity submersible pumps and/or other fluid lifting equipment must be used in the important Urals-Volga region and in newer fields in West Siberia. Although the USSR and some West European countries produce oil well pumps, the only pumps adequate to deal with the Soviet lifting problems are produced in the US and are in relatively short supply. During the past 4-5 years the USSR has bought more than 1,000 of these pumps from the United States and is trying to get a US firm to agree to build a sumbersible pump manufacturing plant in the USSR that will produce 5,000 units per year.

Given the rapid rise in fluid lifting requirements, US pumps are absolutely critical to the USSR. By year-end 1976, US high-volume pumps in the USSR added a combined lifting capacity of about 5,000,000 b/d of fluid. The average water cut in the Urals Volga and West Siberia was probably at least 50 percent in 1976. These US pumps could have added as much as 2.0-2.5 million b/d to Soviet oil production capacity. However, since only about 80 percent of the pumps would be in service at any one time and, in the absence of US pumps, the Soviets would probably have used much smaller capacity units, the net gain to output attributable to the pumps in 1976 was at least 1.0-1.5 million b/d.

The Soviets purchased 200 pumps in 1976 and can buy a maximum of 1,100 more for delivery during 1977-80. They have options for 180 pumps from the Byron Jackson division of Borg Warner, and the Reda pump division of TRW anticipates orders for 300 pumps a year during 1978-80.

In general, the pumps the Soviets are now buying are of still larger capacity than those purchased during 1971-75. Total lifting capacity of pumps under option or available during 1977-80 totals 8.5 million b/d to 15.0 million b/d. Most of this capacity is accounted for by the 900 Reda Pump units (7,500-15,000 b/d) that could be delivered at the rate of 300 per year in 1978, 1979, and 1980. Even if the average water cut rises to 80 percent by 1980, these new pumps will add

1.7 to 2.4 million b/d to oil output in 1980, assuming an 80 percent in-service rate. Without receipt of the pumps now on order, Soviet output would quickly slump. Total 1980 output would probably not exceed 9 to 10 million b/d.

Gas Lift Equipment

As an alternative to high-capacity submersible pumps, the Soiets are negotiating for large-scale purchases of US gas-lift technology for use in two of the largest oilfields in West Siberia -- Samotlor and Fedorov. They hope to sign a contract for about $1 billion worth of equipment for this project from US, West European, or Japanese suppliers by the end of 1977.

The technology to produce the downhole gas lift equipment does not exist outside the US. Consequently, all equipment for the proposed gas-lift project other than compressors (valued at $400 million) must be bought from US firms or licenses. Given the long lead times involved in design, production, and installation of such equipment, it is doubtful that the USSR could have all the units installed before the early to mid-1980s. By 1985, however, if all 3,000-4,000 units under negotiation are installed and operating, total fluid lifting capacity could be increased by roughly 30 million b/d.

Drilling Equipment

The Soviet Oil Ministry plans to increase total drilling to 75 million meters in 1976-80, a goal unlikely to be achieved unless they increase development drilling at the expense of exploratory drilling. In 1976, drilling by the Oil Ministry totaled 12 million meters; only 2 million were for exploration, while 10 million went for development.

The Soviets use three types of drilling equipment: turbo-drills, rotary drills, and electric drills. About 80 percent of Soviet drilling rigs are turbo equipment initially produced in the 1940s and early 1950s. Almost all the others are rotary drill. The third type of rig, the electric drill, is essentially experimental. Although the Soviets have tested electric drills extensively, technical problems have not been solved.

Despite the obvious shortage of drilling rigs, the Soviet rig park has remained essentially unchanged at 1,800 deep-well rigs. Meeting the plan for both exploratory and development drillinggoals would require increasing the number of active rigs (of Soviet design) by nearly 50 percent. No evidence is available, however, to show that the Soviets have planned for or have the capacity to boost their rig supply or would be able to provide trained crews for the additional rigs.

Modern US rotary drilling equipment would be a distinct asset to the Soviets in searching for and developing new

fields. In the US, wells can be drilled to 3,000 meters in about one month, compared with a 3-6 months in the USSR. As the average depth of drilling increases in the USSR, rotary drilling would be still more efficient. Soviet wells deeper than 3,000 meters usually take more than a year to drill. According to a recent Soviet report, 5,000 meter wells average about 2½ years each to drill. Although investment costs will be great, the USSR probably would gain greatly from converting to modern rotary drilling technology for exploratory drilling.

Bits

The USSR manufactures an estimated 1 million rock bits of all types annually, compared with only about 400,000 in the entire Western world. Their quality, however, is poor compared with Western bits.

Large numbers of a narrow selection of bits are used in the USSR. Most Soviet bits are specified for drilling according to depth and not according to the type of strata being drilled. With the extensive use of the turbodrill system, the weight of the drill string is not placed on the bit and, short of raising the entire drill string to inspect the bit, there is no way of determining bit wear. As a result, many bits are replaced prematurely.

The Soviets recognize that better quality bits would improve drilling efficiency and would permit wells to be drilled

more rapidly. They have purchased small quantities of US drill bits, and have been trying for 3 years to buy a turnkey plant to produce US-design bits. However, as the price of the plant escalated during the negotiation period, the Soviets decided to seek lower-cost US assistance to re-equip an existing Soviet plant to produce these bits. Negotiations for the re-equipment deal ($170 million) are in the final stages, and a contract is expected to be signed this year.

Drill Pipe

The supply of drill pipe in the USSR is not adequate in sizes, quantities, and quality required, especially in cold climates and difficult well conditions. Soviet drill pipe is either of heavy wall construction, which requires much heavier drilling rigs to support the additional weight, or is made of expensive aluminum alloys, costing three times as much as Western pipe. Because of its poor metallurgical composition and the torque of the downhole turbine, Soviet drill pipe is easily sheared, causing costly delays and sometimes abandonment of the well if the drill pipe becomes lodged in the borehole.

As the requirement to drill to greater depths increases, both onshore and offshore, the USSR will need large amounts of high-quality drill pipe. For the next several years at least, it will have to come from the West. US companies

onto drill pipe
control the technology for flash welding tool joints/and are pre-eminent in the production of drill pipe that can take the high stresses of deep rotary drilling.

Drilling Fluid Technology

Scientifically planned drilling-mud programs are almost unknown in the USSR. There is not enough prepared mud available and most drilling crews use local clay, regardless of its condition, mixed with water and additives. To prevent blowouts, drillers add hematite or anything else hardy to make muds heavy. In situations where circulation of mud is lost, drillers pour down straw, wood chips, and the like to solidify the mud sufficiently to recondition the hole and restore circulation. After a well is completed, mud is stored in barrels for the next well, no matter what conditions may require. Such practices, especially in deep drilling, cause extensive formation damage and invasion problems in possible petroleum-bearing formations that render log interpretations almost useless and can cause wells to be abandoned needlessly.

US drilling fluid technology is highly advanced and complex. Many chemical additives and fluids are mixed in scientific proportions to tailor the mud precisely to local drilling conditions in order to remove cuttings effectively and coat the well-bore surface to prevent the sloughing of rock chips and pebbles into the hole. US drilling fluid

technology could greatly improve Soviet drilling efficiencies in both exploration and production.

Multizone Completion Equipment

Multizone completion equipment is relatively scarce in the USSR, necessitating the drilling of separate holes for each producing zone in many fields. The Soviets now buy this equipment from the US, acquisition of additional multizone completion equipment would permit important economies in reduced drilling costs, as well as savings in casing, tubing, flow lines, and pumping equipment.

Cement

A related problem is the need for better cement and cementing practices to improve well completion and to seal the well bore against the entry of ground water. The Soviets have indicated interest in US technology in these areas.

Exploration Equipment

For the long-run, finding new oil reserves is even more important than increasing the yield of existing fields. In the present five-year plan, sizable reserves must be found, to maintain production at or near current levels as output declines in the older fields.

Seismic and Well-Logging Equipment

Soviet seismic and well-logging instruments lag their US counterparts by at least ten years, largely the result of the enormous gap between US and Soviet electronics technologies.

Poor seismic and well-logging equipment often prohibits the collection and recording of good data. Compounding the problem is a severe shortage of digital processors of minicomputers for on-site evaluation and analysis of the data. These deificiencies make the USSR unable to map accurately deep-faulted formations, permafrost structures, and stratigraphic traps. Likewise, well-logging suffers because of the lack of capability to digitally analyze data from test wells. Although some seismic and digital processing equipment is available in Western Europe and Japan, the best for Soviet needs -- especially portable field computers -- is made in the US.

Offshore Equipment

The most obvious deficiency in Soviet oil field operations is the lack of modern offshore equipment and technology. Soviet offshore experience thus far has been limited chiefly to relatively shallow waters of the Caspian and Black Seas, wehre operations are conducted chiefly from trestles extending from the shore or from man-made islands. The USSR now has only four mobile offshore drilling rigs (jack-up types), all in the Caspian Sea, and only one is capable of drilling in water as deep as 90 meters.

For the USSR to move to deeper water in the Caspian, or to the Arctic Seas or the Sea of Okhotsk off Sakhalin, Westerr

experience, technology, and equipment will be essential. Although the US is the world leader in this technology, Dutch, French, Norwegian, British, and Japanese firms can supply some offshore equipment and know-how. The Soviets recently concluded a contract with a US firm and a West European company to build a yard on the shores of the Caspian Sea to produce offshore mobile drilling rigs. The first domestically built semi-submersible rig in the USSR is due to begin operations in 1980.