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BY THE US GENERAL ACCOUNTING OFFICE

Report To The Chairman, Subcommittee On Armed Services Investigations Committee On Armed Services House Of Representatives

Naval Petroleum Reserve No. 1--An Assessment Of Production Alternatives

Under existing legislation, every 3 years the President must decide whether to shut-in or continue production of the Naval Petroleum Reserve No 1 (NPR-1) oil field at Elk Hills, California The current authorization for production expires on April 5, 1985

GAO discusses the geologic, budgetary, local economic, and national security implications of three production alternatives for NPR-1 continued production, shut-in, and partial shut-in In addition, GAO discusses the advantages and disadvantages of establishing a Defense Petroleum Reserve, a crude oil reserve for the military, using part of the revenues from continued production at NPR-1 to fund it

During the course of its review, GAO found that production rates at Elk Hills may be too high, causing problems within the reserve that could decrease ultimate recovery of oil by about 139 million barrels. The Department of Energy plans to analyze this situation and, if need be, adjust the rate

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UNITED STATES GENERAL ACCOUNTING OFFICE
WASHINGTON, D.C. 20548

RESOURCES, COMMUNITY,
AND ECONOMIC DEVELOPMENT
DIVISION

B-215489

The Honorable Bill Nichols
Chairman, Subcommittee on Investigations
Committee on Armed Services
House of Representatives

Dear Mr. Chairman:

This report, responding to your request of January 16, 1984, addresses certain geologic, national security, budgetary, and economic factors that may influence the decision on whether to continue producing oil and gas at Naval Petroleum Reserve No. 1 beyond 1985. Your question on the implication for the Naval Petroleum Reserves of the recent Supreme Court decision on congressional vetoes will be addressed in a separate letter.

As arranged with your office, unless you publicly announce its contents earlier, we plan no further distribution of this report until 30 days from the date of the report. At that time, we will send copies to the Department of Energy, Members of Congress, and other interested parties and make copies available to others upon request.

Sincerely yours,

J. Dexter Peach
Director

GENERAL ACCOUNTING OFFICE
REPORT TO THE CHAIRMAN, SUBCOMMITTEE
ON ARMED SERVICES INVESTIGATIONS,
COMMITTEE ON ARMED SERVICES
HOUSE OF REPRESENTATIVES

NAVAL PETROLEUM RESERVE NO. 1--AN ASSESSMENT OF PRODUCTION ALTERNATIVES

D I G E S T

The Naval Petroleum Reserve at Elk Hills, California (NPR-1), is the second largest oil producing field in the United States with total recoverable reserves of over 700 million barrels of crude oil. The U.S. government owns approximately 78 percent of NPR-1. Chevron U.S.A., Inc., owns the remaining 22 percent. The government, represented by the Department of Energy (DOE), and Chevron operate NPR-1 jointly and share production, revenues, and expenditures in proportion to their ownership shares.

NPR-1 was originally established by the federal government in 1912 to provide a source of liquid fuel for the military during national emergencies. Crude oil production from the field started in 1919 and continued at various levels, reaching a peak of 65,000 barrels of crude oil per day in 1945. After World War II, NPR-1 was shut-in, or produced at the minimum level necessary to prevent damage to the field.

Following the Arab Oil Embargo in 1973-74, the Congress passed the Naval Petroleum Reserves Production Act of 1976 which authorized that NPR-1 be explored and developed to its full economic and production potential, and that the field be produced for 6 years. The act further specified that the President could subsequently extend production for 3-year periods after an investigation to determine the necessity for continued production had been made.

In 1981, the President determined that continued production made both sound economic and strategic sense. This 3-year extension expires on April 5, 1985, unless the President again decides to continue production. The President must submit his decision to the Congress by October 8, 1984. The Department of Energy is conducting the required investigation to be used as a basis for the President's decision.

At the request of the Chairman of the Armed Services Investigations Subcommittee of the House Committee on Armed Services, GAO agreed to (1) assess the geologic, budgetary, local economic, and national security implications of different production alternatives: continuing full production, shutting-in NPR-1, or partially shutting-in NPR-1 and (2) examine the advantages and disadvantages of establishing a Defense Petroleum Reserve using revenues from continued NPR-1 production, as is currently being considered by DOE. Regarding national security implications, GAO focused on the amount of oil available to the Department of Defense in peacetime. (See p. 3.)

NPR-1 PRODUCTION ALTERNATIVES

GAO found that each NPR-1 production alternative has advantages and disadvantages when viewed in terms of the federal budget, local economic impact, national security implications, and geologic considerations.

Continued production

Under a continued production decision, the Naval Petroleum Reserves Production Act of 1976 requires that NPR-1 be produced at the maximum efficient rate of production, defined as that rate which will permit economic development and depletion of the reserve without decreasing the amount of oil expected to be recovered from the field. At present, NPR-1 produces 134,000 barrels of crude oil per day, plus natural gas and natural gas liquids. DOE projected that production levels will decrease by 9 to 10 percent per year as the field is depleted. (See pp. 1 and 2.)

GAO estimated that continued production of NPR-1 at the maximum efficient rate would result in about $3.2 billion to $3.6 billion in net federal revenues from sales of the government's share of production in fiscal years 1985 through 1987, the time frame for any extension of production. In addition, continued production would not disrupt the local economy where NPR-1 is located. (See pp. 20 to 21.)

From a national security standpoint, under continued production, the Department of Defense has access to NPR-1 crude oil under

the authority of the Energy Security Act and a petroleum transfer agreement between DOE and Defense. Therefore, NPR-1 under continued production represents a readily available source of oil which could be used by Defense in peacetime oil supply shortages. Currently, the government's share of NPR-1 crude oil production is 105,000 barrels per day, or 16 percent of Defense needs. However, NPR-1's value to the military will decrease in the future as the field is depleted. By the year 2000, the government's share of NPR-1 production will amount to 27,000 barrels of oil, or only 4 percent of current peacetime needs. (See pp. 14 and 15.)

In regard to geologic considerations, GAO found, based on a review of available production data and Chevron and DOE studies, that the maximum efficient rate set for NPR-1 by DOE may be too high. This improper production of the field has caused certain geologic problems, and as a result, if corrective action is not taken, ultimate expected recovery of crude oil from the field could be decreased by about 139 million barrels. (See pp. 7 to 8.)

As of June 1984, DOE had not taken any action to lower the maximum efficient rate. The Director of NPR-1 told GAO that DOE headquarters plans to hire a consultant to evaluate the current production rates before any decision is made. (See p. 8.)

Shut-in

The Naval Petroleum Reserves Production Act of 1976 also requires that when production is not authorized, NPR-1 must be operated to protect, conserve, maintain, and test the reserve. DOE currently envisions including in the alternative an oil well testing program which would produce just under 4,000 barrels of crude oil per day and some natural gas liquids, with all major facilities at NPR-1 shut down. DOE estimates that the time required to return NPR-1 to full production following a shut-in would range from 6 months to 1 year. (See p. 2.)

GAO estimated that under a shut-in, NPR-1 would provide about $514 million in net federal revenues over the next 3 years.

However, based on interviews with small refiners and an analysis of crude oil availability in California, a shut-in of NPR-1 would adversely affect the operations of the small refiners in California that use NPR-1 crude oil, as well as the operations of the two pipeline companies that transport most NPR-1 crude oil. For example, officials from NPR-1, small refiners, and pipeline companies told GAO that, all together, they would terminate or lay off 800 employees if a decision is made to shut-in NPR-1. (See pp. 21 to 23.)

From the standpoint of national security, a shut-in NPR-1 would be of limited short-term use to the military in a peacetime oil shortage; at least 6 months would be required to increase production to current levels after a shut-in. However, because of its large amount of total reserves, NPR-1 could provide a source of oil for the military in longer peacetime shortages. (See p. 15.)

In regard to geologic considerations, GAO found that DOE's plans for operating NPR-1 under a shut-in did not make it clear whether DOE had adequately addressed all the actions needed to guard against oil losses during a shut-in. While DOE could not provide GAO with documentation for some of these actions, such as those needed to correct problems caused by operating at too high a rate of production, the Director of NPR-1 told GAO that these problems would be considered if NPR-1 were shut-in. (See pp. 8 and 9.)

Partial shut-in

Another alternative which DOE is not currently considering in its investigation of NPR-1 alternatives, but which GAO was asked to examine, is a partial shut-in of NPR-1 to a production level of 25,000 to 30,000 barrels of crude oil per day. Under this alternative, NPR-1 could be kept in a fairly ready state by operating its major production facilities on a rotating basis. NPR-1 production could be substantially increased in 8 days and returned to the maximum efficient rate in 30 to 90 days. (See p. 3.)

From a budgetary standpoint, GAO estimated that under a partial shut-in, NPR-1 would provide about $884 million in net federal

revenues over the next 3 years. However, based on interviews with officials from small refiners and pipeline companies and an analysis of crude oil availability in California, a partial shut-in would also have some adverse effects on their operations. (See pp. 21 and 24.)

In terms of national security, GAO found that NPR-1, under a partial shut-in, could provide a readily available, long-term source of oil for the military. For example, under a partial shut-in to 27,000 barrels of crude oil per day, in the year 2000, NPR-1 production levels could still be increased to about 110,000 barrels per day. The government's share of this amount would be about 86,000 barrels per day, or about 13 percent of current Defense peacetime needs. (See pp. 15 and 16.)

In terms of geologic considerations, as previously mentioned, production rates at NPR-1 may be too high, causing certain geologic problems within the reserve that could decrease ultimate expected recovery of crude oil from the field. If a partial shut-in is decided upon, and DOE's analysis of the maximum efficient rate confirms that past production rates have been too high, DOE would still have to take actions to correct the geologic problems and thus maximize ultimate recovery of crude oil. (See pp. 7 and 8.)

DEFENSE PETROLEUM RESERVE

Because of the military's concern about peacetime oil shortages, DOE is considering an option of continued production of NPR-1 with development of a separate Defense Petroleum Reserve containing 100 million barrels of crude oil. DOE assumes that full production of NPR-1 would be permanently authorized and that part of the resulting net revenues would be reserved or earmarked to fund a Defense Petroleum Reserve. DOE estimated a total cost of about $5 billion from fiscal years 1985 through 1992 to establish this reserve. Over the same time period, total net revenues from continued production of NPR-1 would amount to about $9 billion. (See p. 17.)

GAO found that a separate Defense Petroleum Reserve, as being considered by DOE, has

several advantages over using NPR-1 as a source of petroleum in peacetime oil shortages. A Defense Petroleum Reserve could be drawn down at any time with little lead-time required, and thus its oil reserves would be immediately available. Second, a Defense Petroleum Reserve could be constructed such that it could be drawn down at variable rates, depending on the amount of oil needed by Defense. Finally, the option of continued production of NPR-1 with establishment of a Defense Petroleum Reserve would have less effect on federal revenues than a partial or complete shut-in of NPR-1. The major disadvantage of a Defense Petroleum Reserve of 100 million barrels, when compared with NPR-1, is its limited amount of reserves. NPR-1, because of its larger total reserves, could provide a stream of oil long after a Defense Petroleum Reserve would have been exhausted and, therefore, would be more advantageous in an extended peacetime shortage. (See pp. 17 and 18.)

GAO noted, however, that while DOE's current draft analysis of a Defense Petroleum Reserve stated that this reserve would be funded using some of the revenues from continued production of NPR-1, it was not clear whether DOE would seek approval of these funds through the normal budget process. In this regard, GAO believes that spending for a Defense Petroleum Reserve should be subjected to the normal appropriation process and thus subject to congressional oversight. (See p. 17.)

If a Defense Petroleum Reserve is considered, there are a number of alternatives for establishing such a reserve which are not analyzed in this report, including designating part of the Strategic Petroleum Reserve. Such alternatives will be discussed in an upcoming Congressional Research Service report. (See p. 19.)

VIEWS OF AGENCY OFFICIALS

No agency comments were obtained on this report. However, GAO discussed the results of its work with Department of Energy and Department of Defense officials and considered their views in the report.

Contents

ILLUSTRATIONS

ABBREVIATIONS

DOD	Department of Defense
DOE	Department of Energy
DPR	Defense Petroleum Reserve
GAO	General Accounting Office
MER	maximum efficient rate
NPR	Naval Petroleum Reserve
SPR	Strategic Petroleum Reserve

CHAPTER 1

INTRODUCTION

The Naval Petroleum Reserves at Elk Hills, California (NPR-1), is the second largest oil producing field in the United States. According to Department of Energy (DOE) information, original recoverable reserves were estimated at 1.5 billion barrels of crude oil. At present, average daily production is about 134,000 barrels per day. The U.S. government owns approximately 78 percent of NPR-1. Chevron U.S.A., Inc. owns the remaining 22 percent because it originally owned land within the area of the reserve. The government, represented by DOE, and Chevron participate jointly in the operation of NPR-1 through a unit plan contract, which specifies how the ownership and the operation are shared. Under this contract, Chevron and the government share production, revenues, and expenses in proportion to their ownership shares.

The NPR-1 crude oil production comes primarily from two geologic zones--the Stevens and Shallow Oil Zones. The crude oil from the Stevens Zone is light, high-quality crude oil. The oil from the Shallow Oil Zone is heavy, lower quality crude. About 83 percent of the total production comes from the Stevens Zone. In addition, the field produces natural gas and natural gas liquids.

NPR-1 was originally established in 1912 to provide a source of liquid fuel for the Armed Forces during national emergencies. Crude oil production from the field started in 1919 and continued at various levels, reaching a peak of 65,000 barrels of crude oil per day in 1945. After World War II, NPR-1 was shut-in, or produced at the minimum level necessary to prevent damage to the field. Following the Arab Oil Embargo in 1973-74, the Congress passed the Naval Petroleum Reserves Production Act of 1976 (the Production Act) which authorized that NPR-1 be explored and developed to its full economic and production potential and that the field be produced for 6 years. The act further specified that the President could extend production for 3-year periods after an investigation had been made to determine the necessity for continued production. The President must submit a report to the Congress certifying the necessity of continued production 180 days before the expiration of the current extension.

In 1981, the President determined that continued production of NPR-1 made sound economic and strategic sense. This 3-year extension of production expires on April 5, 1985, unless the President decides to continue production. The President must submit his determination to the Congress by October 8, 1984.

NPR-1 OPTIONS

The Department of Energy was conducting the investigation required by law to determine the necessity of continued production of NPR-1. As of June 1984, the final report was not yet complete. However, according to a draft of this report, DOE

studied two production level alternatives: continued production and shut-in to a production level of 3,863 barrels of oil per day. In addition, DOE was examining the use of part of the revenues under the continued production option to develop a Defense Petroleum Reserve, a crude oil reserve for the Department of Defense (DOD). This alternative is discussed in chapter 3. Another alternative, which was studied prior to the 1981 decision to continue production of NPR-1, is a partial shut-in of 25,000 to 30,000 barrels per day.

Under DOE's continued production option, the Production Act requires that NPR-1 be produced at the maximum efficient rate (MER) of production. The act defines MER as the maximum sustainable daily oil or gas rate from a reservoir which will permit economic development and depletion of that reservoir without detriment to its ultimate recovery (the total expected amount of crude oil and/or gas which can be produced from a field). If production is continued in fiscal 1985, the MER designated by DOE for NPR-1 should result in daily production of an estimated 131,000 barrels of crude oil; 348,000 cubic feet of natural gas; and 640,000 gallons of natural gas liquids which include butane, propane, and natural gasoline. Except for about 16,500 barrels per day of crude sold to DOD, and approximately 50 percent of the natural gas which would be injected back into the reservoir to maintain pressure, the government's share of production would be sold competitively on the open market. At current MER, crude oil production levels are projected by DOE to decrease at an estimated 9 to 10 percent per year as the oil and gas reserves are depleted. Therefore, total crude oil production would be about 97,000 barrels per day by 1989 and 34,000 barrels per day by the year 2000.

DOE's proposed shut-in option would involve both reducing production of the field and "mothballing" or shutting down various processing facilities. The Production Act requires that when production is not authorized, NPR-1 must be operated to protect, conserve, maintain, and test the reserve. To accomplish this, DOE's shut-in scenario includes a well testing program in which wells would be produced on a rotating basis. Production from this testing program would amount to about 3,863 barrels of crude oil per day. The small amount of natural gas produced would be processed in a Chevron plant to extract the natural gas liquids and then returned to NPR-1 to be reinjected into the reserve to maintain pressure. The natural gas liquids, amounting to about 42,000 gallons per day, would also be sold. Water produced would be reinjected. NPR-1's three gas processing plants and other facilities would be mothballed. The estimated time to reduce production from MER to this shut-in level is 90 days; yet, mothballing the facilities would require an estimated 6 months. DOE estimates to initiate full production of NPR-1 following shut-in range from 6 months to a year, depending on the mechanical problems encountered after a long shut-in and the availability of qualified personnel to open up the reserves.

To address geologic issues, we interviewed DOE geologists and petroleum engineers and Chevron petroleum engineers. In addition, we reviewed technical engineering reports prepared by DOE, Chevron, and consultants and supporting documentation. We also reviewed historical engineering data for the field, DOE's estimates of ultimate recovery, and pertinent geologic literature on NPR-1 and similar fields. (For more details on geologic issues, see app. I.)

In determining the impact of NPR-1 shut-in, partial shut-in, and continued production on the federal budget, we reviewed various budget documents and supporting information. Projected production levels of crude oil, natural gas, and natural gas liquids for the various production scenarios were based on forecasts developed by the engineering staff at Elk Hills. To project gross revenues from the sale of crude oil under the various scenarios, we used both the Chase Econometrics' (dated Feb. 14, 1984) and Data Resources, Inc.'s (dated spring 1984) long-term, moderate-growth world crude oil price projections. We computed a price path through fiscal year 1992 based on the percent annual increase of the average of these two price projections. Assuming that NPR-1 prices will follow the same price path as world oil prices, we applied this price path to the weighted average of NPR-1 crude oil prices for September and October 1983 to project NPR-1 prices. Projected natural gas liquids (propane, butane, and natural gasoline) prices were based on the same price path as crude oil prices. We used the weighted average sales price for natural gas liquids for contracts from July 1, 1983, to October 31, 1984, as a base price. Natural gas price projections were based on forecasts prepared by Chase Econometrics and Data Resources, Inc. For a base price, we used the average NPR-1 natural gas sales price under contracts from October 1, 1983, to March 31, 1984.

We assessed the potential impact of a NPR-1 shut-in and partial shut-in on small refiners, pipeline companies, local employment, and purchasers of oil and gas. We interviewed officials from the 13 small refiners in the San Joaquin Valley and the California coastal areas that use NPR-1 crude. In addition, we collected information on refining and crude oil availability from a variety of sources, such as the National Petroleum Refiners Association, DOE's Energy Information Administration, Williams Brothers Engineering Company (the prime contractor at NPR-1), Pervin and Gertz, Inc., the California Energy Commission, the Oil and Gas Journal, and the Conservation Committee of California Oil Producers. We also interviewed management officials from the Chevron and ARCO Four Corners pipelines, the major transporters of NPR-1 crude. From DOE, Williams Brothers Engineering Company, small refiners, and the pipeline companies, we obtained estimates of the numbers of persons whose jobs would be lost if a shut-in decision was made. We obtained information on past, present, and future employment trends from various documents and reports published by the State of California Employment Development Department. We also interviewed the current purchasers of NPR-1 gas to

determine the impact of a potential shut-in. Due to time limitations, we did not attempt to quantify indirect local economic impacts such as unemployment that would result from the drop in the general need for goods and services.

To assess the national security implications of NPR-1 production options and the Defense Petroleum Reserve, we interviewed Department of Defense officials in Energy and Transportation Policy, the Joint Chiefs of Staff, and officials from the Defense Fuel Supply Center. In addition, we interviewed officials in DOE's Strategic Petroleum Reserve and Energy Emergencies Offices. We also reviewed documentation on defense peacetime and wartime needs. We reviewed DOE and DOD studies on establishing a Defense Petroleum Reserve. We obtained domestic oil supply information from DOE's Energy Information Administration. Finally, we reviewed current laws and the legislative history to determine the intended use of NPR-1, especially in relation to national defense.

At the request of the Chairman's office, we did not obtain official Department of Energy or Department of Defense comments on this report. However, we did discuss our findings with DOE and DOD officials and considered their comments in preparing our report. Except for the above, our work was performed in accordance with generally accepted government auditing standards.

CHAPTER 2

GEOLOGIC IMPLICATIONS

NPR-1 is an oil field which contains many productive oil pools and is geologically complicated. Thus, geologic considerations are important when assessing the future operation of NPR-1 under either a continued production or shut-in scenario. Of particular importance to the continued production scenario is the rate of production, or MER, which is established by DOE for periods of time when production is authorized. On the other hand, given a decision to shut-in NPR-1, certain actions would be needed to prevent movement of oil into areas from which it may not be recoverable.

With respect to the continued production scenario, we found, based on DOE engineering studies and our own analysis, that the MER currently designated for NPR-1 is too high. As a result, about 139 million barrels of oil could become nonrecoverable over the life of the field if corrective action is not taken. As of June 1984, DOE had not lowered MER but was in the process of hiring a consultant to study it further.

DOE's plans for operating NPR-1 under a shut-in scenario did not make it clear whether DOE had adequately addressed all the actions needed to guard against oil losses during a shut-in. While DOE could not provide us with documentation for some of these actions, such as those needed to correct problems caused by operating at too high a MER, the Director of NPR-1 told us that these problems would be considered if NPR-1 were shut-in.

Finally, we noted that remaining recoverable reserves are about 39 million barrels of oil less than the 788 million barrels officially estimated, possibly as a result of uncontrolled water movement or earlier optimistic projections of recovery. Still, NPR-1 is capable of producing significant amounts of oil through this century. (See app. I for a more detailed discussion of geologic implications of shutting-in versus continuing production at NPR-1.)

OIL AND GAS PRODUCTION FROM NPR-1

Commercial deposits of crude oil and natural gas are always found underground and are contained in the water-coated pore spaces of various types of rock. The water, gas, and oil are arranged in layers, with gas filling the pores at the highest levels of the container. Such a container is called a trap, and the portion of the trap that holds the oil or gas is called a reservoir. A single deposit of petroleum is a pool; if several pools are located on a single geologic feature or are similarly related, the group of pools is called a field, such as NPR-1.

Efforts to recover oil must take advantage of the forces that trap oil in the reservoir rock pore spaces. Oil in a pool will

usually flow through a well to the surface unassisted at the time of discovery. The oil in this case is driven out by natural pressures within the reservoir and by expansion of gas dissolved in the oil. Typically, this method, called "primary recovery," removes only 10-20 percent or less of the oil originally in place. Injection of gas or water into the reservoir to maintain pressures and displace oil into wells has been used since the 1940's as a "secondary recovery" method to produce up to an additional 20 to 50 percent of the oil in place in the reservoir. Flooding a reservoir with injected water (water flooding) now accounts for about one-half of all oil production in the United States. Sometimes special chemicals added to water, steam, or carbon dioxide gas may be injected into the reservoir.

When producing oil and gas from a reservoir, petroleum engineering practices dictate that distribution of fluids and pressure levels within the reservoir should be maintained in a particular way. Producing at too high an MER and from particular wells that produce too much gas in preference to oil, could cause pool fluid distributions and pressures at NPR-1 to become inconsistent with these criteria, or imbalanced. These imbalances, in turn, can cause oil to move into areas of the reservoir from which it may be more difficult to recover, and thus ultimate recovery may be decreased. On the other hand, if a field is shut-in, certain actions must be taken to prevent the movement of oil into areas from which it is more difficult to recover. If these actions are not taken during a shut-in, ultimate recovery may again be decreased.

MER MAY BE TOO HIGH

As previously mentioned, if the President decides to continue production at NPR-1, the Production Act requires NPR-1 to be produced at MER, the maximum sustainable rate which will permit economic development of the reservoir without detriment to ultimate recovery of oil. MER, however, is often an elusive number. Even with the best engineering analyses, the MER designated for a field is only an estimate.

DOE is responsible for determining the level of MER for NPR-1. The Director of NPR-1, on the basis of production rates for each well, consultant reports, and engineering staff reports, makes an MER recommendation to DOE headquarters. The Secretary of Energy makes the final decision on MER.

Recently, a controversy concerning MER for NPR-1 arose between Chevron and DOE. In October 1983, Chevron officials indicated that DOE was not producing NPR-1 at its maximum potential and that the Stevens Zone could be produced at a higher rate without detriment to ultimate recovery. Chevron recommended, using June 1983 production data, that production be increased by about 13 percent. Later, in December 1983, the Director of NPR-1 recommended to DOE headquarters that MER be lowered by about 10 percent, based on October 1983 production data, to maximize ultimate recovery of oil from the field. The DOE engineering staff

at NPR-1 and Chevron have both performed engineering analyses to support their positions. As of June 1984, DOE headquarters had not taken action to lower the MER. However, the Director of NPR-1 told us that headquarters planned to hire a consultant to perform a thorough analysis of the MER before any decision would be made.

Our review and analysis of available geologic information, production data, and Chevron and DOE studies tended to confirm DOE engineers' contention that the current MER is too high and should be reduced by about 10 percent. For example, MER should have been about 120,000 barrels per day in April 1984, compared to the actual rate of 134,000 barrels per day.[1] Based on DOE engineering studies and consultant reports, producing the field at too high a rate and not taking into consideration the likely geologic interconnection of certain pools at the field have caused imbalances in the distribution of reservoir gas and oil, and in pressures within the reservoirs. This improper production of the field, according to DOE, could have serious implications for ultimate oil recovery. According to the DOE analysis, if the MER is not lowered, about 139 million barrels of oil could become nonrecoverable over the life of the field. Our own analysis tended to confirm this potential loss. Further, although Chevron's suggested MER would lead to a spurt in oil production, expensive secondary recovery procedures would have to be used much sooner than currently planned, with the likelihood that not as much oil would ultimately be recovered.

Although some oil has most likely already been lost, DOE could correct fluid and pressure imbalances and enhance ultimate recovery by lowering production rates and selectively injecting water and/or gas into the reservoirs. Likewise, under a partial or complete shut-in, similar corrective steps could be taken.

DOE's PLANS FOR SHUT-IN ARE UNCLEAR

Management personnel at NPR-1 have designed the shut-in scenario based on procedures used during a previous NPR-1 shut-in from 1945 to 1976 and a shut-in of oil fields in Texas in the 1960's. As previously discussed, the shut-in scenario being considered by DOE includes a rotating well testing and production program. About 3,863 barrels of oil would be produced per day; all water and natural gas extracted would be reinjected into the reservoir.

Based on our analysis of geologic conditions at NPR-1, we identified a number of specific steps the shut-in scenario should include to prevent losses of oil. First, water is currently entering the Shallow Oil Zone along the periphery of the field.

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[1]As a field's resources are produced, production rates decrease. NPR-1 production rates are currently decreasing at a rate of 9 to 10 percent per year. Therefore, MER is also decreasing over time as the field depletes.

This water could move oil into areas of the reservoir from which it could not be recovered. Second, as mentioned above, reservoir fluid distributions and pressures at NPR-1 are out of balance. Because of this, we believe a shut-in would most likely benefit ultimate recovery of the field by allowing some natural equalization of these fluids and pressures. However, the imbalances need to be further corrected, and ultimate recovery thus enhanced, by producing oil, gas, and water at variable rates and by injecting gas and water into selected wells and pools as required. Finally, in the parts of the field in which water flooding is being used as a secondary recovery technique, oil is being moved by a front of water toward producing wells. If these wells are shut-in prematurely, the water could move oil past them into areas of the reservoir from which the oil could be more difficult to recover. Therefore, the shut-in scenario must include provisions for capturing oil moving ahead of water-flood fronts before shutting-in these wells.

Based on our analysis of DOE's shut-in scenario and other available documentation, it appears that DOE has adequately considered the potential problems associated with uncontrolled water movement by making provisions in its shut-in scenario for removing water entering the Shallow Oil Zone. However, it was unclear whether DOE had adequately considered the need for correcting reservoir fluid and pressure imbalances, or capturing oil moving ahead of water-flood fronts. DOE could not provide us with any documentation or analysis to show how either of these factors had been considered. However, the Director of NPR-1 told us that through the proposed rotating well testing and production program, all wells at the field will be monitored and pools selectively injected with water or gas to correct pressure imbalances. In addition, he told us that provisions would be made to capture oil moving ahead of water-flood fronts before the affected wells would be shut-in. While these assurances are adequate at present, if a shut-in is mandated, DOE should develop a detailed plan for operating NPR-1 under a shut-in which includes all necessary actions to ensure maximum ultimate recovery.

NPR-1 RESERVE POTENTIAL WILL CONTINUE TO BE SIGNIFICANT

Original official DOE Engineering Committee estimates, last revised in 1980, placed original recoverable reserves for NPR-1 at about 1.5 billion barrels of crude oil. Total production from the field has been about 686 million barrels of oil, thus theoretically leaving 788 million barrels of oil in recoverable reserves as of April 1984.

However, recent independent examinations by a DOE contractor and DOE engineering staff indicate that remaining ultimate oil recovery will likely be below earlier estimates. We estimate, based on geologic analysis of oil production decline, that about 749 million barrels remain, a reduction of about 39 million barrels. This reduction is possibly a result of oil lost because of uncontrolled water movement or early optimistic projections of recovery.

Even with this decrease, NPR-1 is still considered one of the giant petroleum fields of the world. Compared with other oil fields, NPR-1 has the potential to produce relatively large amounts of oil throughout the remainder of this century.

CHAPTER 3

NATIONAL SECURITY CONSIDERATIONS

DOD is concerned about its ability to obtain adequate amounts of petroleum supplies in peacetime petroleum shortages, such as the 1973 Arab Oil Embargo and the 1979 Iranian oil export reduction. NPR-1 represents one supply source which DOD could tap in such an emergency. For this reason, how NPR-1 will be operated in the future will have an effect on DOD's ability to deal with future peacetime petroleum shortages. We found that under continued production or a complete shut-in, NPR-1 could provide only limited help to DOD in a peacetime shortage. However, under a partial shut-in, an option not currently being considered by DOE, NPR-1's usefulness in meeting DOD petroleum needs in a peacetime shortage would be enhanced.

Because of DOD's concern about peacetime shortages, DOE is considering an option of continued production of NPR-1 with development of a separate Defense Petroleum Reserve (DPR). We believe a separate DPR has merit given the limitations associated with using NPR-1 as a source for DOD petroleum supplies during a peacetime shortage. However, we noted that while DOE's analysis of the DPR option stated that a DPR would be funded using part of the revenues from continued production of NPR-1, it did not specify how this would be done. In this regard, we believe that spending for a DPR should be subjected to the normal appropriation process and, thus, subject to congressional oversight. Also, we believe there may be other alternatives for establishing a DPR--such as designating a portion of the Strategic Petroleum Reserve (SPR) as a DPR--which need to be examined.

DOD PETROLEUM ACQUISITION PROBLEMS IN PEACETIME SHORTAGES

According to DOD officials responsible for energy and transportation policy within the Office of the Secretary of Defense, DOD is primarily concerned about meeting its petroleum product requirements during peacetime oil import interruptions such as the 1973-74 Arab Oil Embargo and the 1979 Iranian oil export reduction. Historically, DOD has encountered difficulties in obtaining sufficient oil supplies in these kinds of shortages. DOD is less concerned about wartime scenarios because it believes that the Defense Production Act (DPA), which authorizes the President to allocate materials to DOD in national emergencies, will guarantee it sufficient oil supplies.

Military petroleum requirements are generally small compared to overall civilian consumption. In peacetime, the military consumes about 500,000 barrels of petroleum products per day. This is roughly equivalent to 650,000 barrels of crude oil per day, or about 4 percent of total domestic crude oil available.

In the context of a peacetime petroleum shortage, NPR-1 is important to the military because it currently represents a potential supply source of about 105,000 barrels per day. Although DOD

has a number of other alternatives for obtaining petroleum in a peacetime shortage, DOD sees problems with each of them. These alternatives include invocation of the Defense Production Act, traditional military suppliers, additional appropriations for fuel purchases, peacetime and wartime stocks, and the Strategic Petroleum Reserve.

Invocation of the DPA

The DPA, as amended, is the primary authority for developing and maintaining emergency priorities and allocation systems to support national defense requirements. Under this authority, the President could allocate petroleum supplies to DOD from general domestic supplies or direct refining production to ensure that the proper products are available for national defense needs. However, the invocation of the DPA in the 1973 Arab Oil Embargo demonstrated the inadequacy of this procedure. DOD recommended invocation in August 1973; however, it took 3 months before any products were delivered, and deliveries were not completed until the following April. In addition, as fuel grew scarcer, the President directed DOD to divert part of its allocation to the commercial airlines. As a result of these problems, DOD was forced to reduce use of mobility fuels and heating fuels by 15 percent and reduce heating in warehouses and administrative buildings by 25 percent.

Traditional suppliers

During past shortages, DOD has also had problems with obtaining adequate supplies from its usual suppliers. For example, Iran's reduction of its crude oil exports in mid-1978 and the following disruption of world oil markets had a severe impact on DOD efforts to procure petroleum. By early 1979, some DOD suppliers were not delivering products in accordance with their contracts. Others were reducing the quantities they were offering for sale or declining to offer for sale any products at all.

A recent DOD study[1] on national defense aspects of a DPR attributed these problems, in part, to the complexity of the Defense Acquisition Regulations (DAR)[2], which govern defense procurements. The DAR requires, in addition to the normal contract terms, a large number of conditions, such as wage, price, and cost accounting standards, and complex bidding requirements, thus making the government a relatively unattractive customer to

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[1]National Defense Aspects of a Defense Petroleum Reserve, October 1983 (Revised).

[2]As of April 1, 1984, the DAR was replaced by the Federal Acquisition Regulation (FAR) in the DOD FAR supplement.

the domestic oil industry. Therefore, in tight markets, these conditions tend to discourage suppliers from responding to military fuel solicitations.

The DOD study also attributed DOD's petroleum acquisition problems to dependence on small and foreign suppliers. Small refiners supply about 40 percent of DOD's JP-4 jet fuel requirements. However, because these refiners do not have a guaranteed source of crude, they are the first to suffer in a shortage. In addition, DOD buys about 27 percent of its petroleum products from foreign suppliers for use in its overseas locations. According to DOD officials in Energy and Transportation Policy, those suppliers terminated their contracts with DOD during previous shortages.

Additional appropriations for fuel purchases

DOD could lessen the impact of peacetime oil shortages by requesting additional appropriations for fuel purchases during such shortages, thus allowing it to compete better for available supplies by paying higher than prevailing market prices. Although there is no guarantee that DOD would receive additional appropriations for fuel when oil prices rise, the Congress has approved them in the past. However, because DOD as an entity purchases large amounts of fuel, DOD believes it could become a "price leader" by bidding higher prices and thus driving overall petroleum prices up further. Also, because DOD is required under the Defense Acquisition Regulations (now Federal Acquisition Regulation) to pay a "fair and reasonable" price, DOD officials believe it may be illegal for them to set a new market price in this way. DOD is currently studying the legal ramifications of high price bidding.

Peacetime and wartime stocks

Pre-positioned war reserve stocks are petroleum product reserves located strategically around the world. These stocks are in addition to regular peacetime petroleum product inventories. These peacetime inventories and wartime stocks could be used temporarily to alleviate peacetime shortages. In the 1979 Iranian crisis, DOD drew from its war reserve stocks rather then constrain peacetime training and exercises which DOD believes are essential to maintain readiness. DOD believes that if a war had followed, the ability of the military to mobilize for it might have been impaired.

Strategic Petroleum Reserve

The Strategic Petroleum Reserve, developed to alleviate the impact of domestic oil shortages, also may not be a practical supply source to the military during a peacetime shortage, as currently established. The SPR currently contains over 400 million barrels of crude oil and has a drawdown rate of 2.1 million barrels per day. However, the SPR has been designated as a domestic (civilian) reserve, and therefore DOD needs are not specifically addressed in the drawdown plan. The plan directs

that 90 percent of any drawdown is to be sold competitively; the Secretary of Energy may direct the sale of the other 10 percent at his discretion. Theoretically, this amount could be directed to DOD. However, in recent hearings before the House Government Operations Subcommittee on Environment, Energy, and Natural Resources, the Assistant Secretary for Environmental Protection, Safety and Emergency Preparedness at DOE said that DOE would propose to sell all of the SPR oil by competitive bid during a drawdown. Therefore, it is uncertain whether any SPR oil would be designated for the military.

Although DOD's suppliers could compete for the SPR oil, there is no guarantee that they could obtain sufficient supplies to meet DOD needs. In addition, because the SPR Drawdown Plan is quite flexible in that it contains only general guidance on when the SPR will be drawn down and the rate of drawdown, there is no way to predict how much oil would be available for DOD. DOD itself could bid on the SPR oil but may again be constrained by its acquisition regulations to pay a "fair and reasonable" price. DOD officials believe that because of these uncertainties in SPR distribution, it cannot be counted on to provide direct help to DOD in a peacetime shortage.

NATIONAL SECURITY IMPLICATIONS OF THE NPR-1 PRODUCTION OPTIONS

Because of the military's problems in obtaining petroleum products in peacetime shortages, how NPR-1 will be operated in the future has some implications for national security. NPR-1, under each of the production level scenarios being considered by DOE, could provide varying but limited amounts of help to DOD in a peacetime oil import disruption. Under continued production, NPR-1 could provide a source of oil to DOD in the short term, but this ability will decrease in the future as the field is depleted. Under a shut-in scenario, NPR-1's use would be limited in the short run because of the lengthy start-up time needed to reestablish full production after a shut-in. In a partially shut-in state, NPR-1 would be more useful to the military in a peacetime shortage than under continued production or a shut-in. Under a partial shut-in, NPR-1 could be largely saved for emergencies while being maintained in a fairly ready state.

Continued production

Under continued production, NPR-1 could provide only limited help to the military in a peacetime petroleum shortage. At the current MER, the government's share of production would be about 105,000 barrels per day, or 16 percent of current defense peacetime needs. Under the Energy Security Act and the Petroleum Transfer Agreement between DOD and DOE, DOD has access to NPR-1 crude oil during any period in which production is authorized. NPR-1 crude oil could be diverted to DOD fairly quickly since all current sales contracts contain 10-day cancellation clauses. DOD could then exchange this crude oil with suppliers for finished petroleum products such as jet fuel. Because of its problems during the 1979 shortage, DOD ran this type of exchange in 1981-82 and therefore already has expertise in this area.

However, the value of NPR-1 under continued production to the military is limited by its projected depletion. The field has already passed its production peak and will decline rapidly in the future. By the year 2000, the government's share of NPR-1 production will amount to approximately 27,000 barrels per day, or only 4 percent of current defense peacetime needs.

In addition, use of NPR-1 under continued production would not increase the amount of petroleum supplies available to the domestic economy. DOD could, at best, only divert NPR-1 from the civilian sector. Therefore, DOD's use of NPR-1 under continued production may only translate a military petroleum shortage into a civilian one.

Shut-in

Under a shut-in, NPR-1 could be saved for peacetime emergencies. Following a shut-in, the Secretary of Energy, with the approval of the President, could resume production for national defense purposes at NPR-1 with authorization by a joint resolution of the Congress. However, 6 months to 1 year would then be required to return the field to full production after a shut-in. Therefore, a shut-in would provide only limited help in the initial stages of a shortage, a period of time which DOD believes is critical. It could, however, provide significant amounts of oil in longer shortages. In addition, the amount of increased production following a shut-in would increase the amount of oil available to the domestic economy. Therefore, use of NPR-1 oil after a shut-in would not involve diverting oil supplies from the civilian sector.

Partial shut-in

Another production option is a partial shut-in where production would be 25,000 to 30,000 barrels of oil per day. From the standpoint of creating a reserve for the military, a partial shut-in is more advantageous than continued production or complete shut-in. The principal advantage of a partial shut-in is that the field can be kept in a high state of readiness. Under this option, sufficient amounts of natural gas would be produced to rotate operation of the gas plants, and therefore these plants would not be mothballed. As a result, production could be substantially increased in 8 days and returned to MER in 30 to 90 days. There is no way to determine how long a partially shut-in field would last; however, according to the Director of NPR-1, it could possibly be productive for 30 to 40 years in a partially shut-in state. Although the potential amount of increased production would gradually decrease as the field depleted, production could be increased significantly at any point during that time period. For example, at a production rate of 27,000 barrels of oil per day for 15 years, NPR-1 production could be increased to about 110,000 barrels per day in the year 2000. The government's share of this amount would be about 86,000 barrels per day, or about 13 percent of current defense peacetime needs. In addition,

the increased amount of production following a partial shut-in would represent a new source of oil. Therefore, use of this oil would not involve diverting oil from the civilian sector.

Both the Department of the Navy and the Joint Chiefs of Staff have recommended that the Secretary of Defense support a partial shut-in. In both cases, the basis for this recommendation was that if NPR-1 were shut-in, its production could be increased to meet a substantial portion of DOD needs in a future oil shortage. Both the Joint Chiefs of Staff and the Department of the Navy noted that if production is continued, NPR-1 would no longer be able to provide significant amounts of oil for defense purposes beyond the year 2000.

We note that a partial shut-in is not authorized for NPR-1 except for national defense purposes.[3] Section 7422(c) of Title 10 of the United States code directs that NPR-1 should be produced at MER during the initial 6-year period beginning in 1976 and during any subsequent extensions. Section 7422(b)(1), which authorizes shut-in production, provides that the Naval Petroleum Reserves, which include NPR-1, shall be used and operated to protect, conserve, maintain, and test the reserves when production is not authorized. Since a partial shut-in is at neither MER nor a shut-in level, it could be authorized only if needed for national defense purposes.

DPR ADVANTAGES AND DISADVANTAGES

Because of DOD's concerns about peacetime shortages, DOE is considering an option of continued production of NPR-1 with development of a separate Defense Petroleum Reserve. We believe a separate DPR has merit given the limitations associated with using NPR-1 as a supply source during peacetime shortages. However, we noted that while DOE's current draft analysis of the DPR option stated that a DPR would be funded using part of the revenues from continued production of NPR-1, it was unclear whether DOE would seek approval of these funds through the normal budget process. In this regard, we believe that spending for a DPR should be subjected to the normal appropriation process and thus subject to congressional oversight. In addition, we believe there may be other alternatives for establishing a DPR which should be examined.

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[3]Section 7422 (b)(2) allows production of petroleum "whenever and to the extent that the Secretary [of Energy], with the approval of the President, finds that such production is needed for national defense purposes, and the production is authorized by a joint resolution of Congress."

DPR under consideration by DOE

DOE has defined a DPR as a crude oil reserve which would be stored permanently in salt caverns in the Gulf Coast area, similar to the Strategic Petroleum Reserve. The Secretary of Defense would be given authority, with the concurrence of the Secretary of Energy, to direct drawdown of the DPR as he determines necessary to meet defense needs. Although DOD initially studied a DPR containing 341 million barrels, DOE is currently considering a size of 100 million barrels.

According to DOE's current draft analysis, a DPR of about 100 million barrels would cost about $5 billion. DOE envisions that a DPR could be developed over the time period of 1985 through 1992. Expenditures would be small until 1990 through 1992 when the storage caverns would be filled. Outlays in these last 3 years would average about $1 to $2 billion per year, primarily for oil purchases. DOE further assumes that full production of NPR-1 would be permanently authorized and that part of the resulting net reserves from fiscal years 1985 through 1992 would be reserved to fund establishing a DPR. DOE's option did not specify any mechanism for reserving the funds; however, whatever mechanism is selected would most likely have to be established by law.

Because DOE's current draft analysis of the DPR option did not state how funds from continued production of NPR-1 would be reserved to fund a DPR, it was unclear whether spending for the DPR would be included in the federal budget. However, we believe that spending for a DPR should be subjected to the normal appropriation process, that is, included as an element of budget authority, and subjected to congressional budget spending targets and ceilings. In this regard, the Director, Energy and Transportation Policy, Office of the Secretary of Defense, told us that a DPR was not a high enough priority within DOD to warrant requesting a budget appropriation to fund it.

DPR versus NPR-1 production options

From the standpoint of meeting DOD petroleum requirements in a peacetime shortage, we believe a DPR has merit, especially given the limitations of using NPR-1. In general, a DPR represents a flexible reserve which would be immediately available to meet DOD petroleum needs. In addition, a DPR would have less effect on federal revenues than a partial or complete shut-in.

In analyzing the DPR, we compared the capabilities of the DPR being considered by DOE with those of NPR-1 under the various production scenarios. In addition, we compared federal budget receipts under the DPR option with the revenues that the federal government would realize under each of the NPR-1 production scenarios for fiscal years 1985 through 1992, the time period in which a DPR could be established.

Compared to a shut-in, the DPR being considered by DOE would provide a larger, more flexible reserve. A shut-in NPR-1 would require at least 6 months to gradually return it to full production and, therefore, could provide only about 29 million barrels of oil during a 1-year shortage. In comparison, a DPR would be immediately available and could provide its entire capacity of 100 million barrels, if needed. A DPR could also be constructed to have a drawdown rate of 2 million barrels per day or more, while NPR-1 could produce a maximum of about 134,000 barrels per day, or perhaps slightly more if needed.[4] On balance, a shut-in NPR-1 would be more advantageous than a DPR in an extended peacetime shortage. While a shut-in NPR-1 can provide only a limited amount of oil in a year, it has the capability to continue to provide additional oil in the following years after a DPR would have been exhausted.

In addition, the DPR option would have a less traumatic effect on federal revenues than shutting-in NPR-1. We estimated that from fiscal years 1985 through 1992, continued production of NPR-1 would result in net revenues of about $9 billion. According to DOE, funding a DPR would consume about $5 billion of this total, leaving $4 billion in net revenues. In comparison, if NPR-1 were shut-in, the Treasury would receive about $600 million in net revenues during the same time period.

Both NPR-1 under a partial shut-in and a DPR could provide a source of oil to DOD fairly quickly in a peacetime shortage. However, the DPR could be drawn down at whatever rate was required, while NPR-1 can be produced at MER or perhaps slightly higher. Also, the DPR option would have less effect on Treasury receipts than would a partial shut-in. Under a partial shut-in, net Treasury receipts from fiscal years 1985 through 1992 would amount to about $1.6 billion, compared to about $4 billion under the DPR option.

Developing a DPR is also more attractive to the military than continuing NPR production. Under continued production, DOD can readily gain access to the government's share of production; however, NPR production levels will rapidly decrease in the future. NPR-1 can currently provide about 105,000 barrels per day, or 16 percent of defense peacetime needs; by the year 2000, it will be able to provide 27,000 barrels per day, or about 4 percent of current peacetime needs.

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[4]According to a 1982 DOE plan for temporary rate of production at NPR-1, production rates could be temporarily increased or "surged" for 90 days. However, ultimate recovery would be decreased by about 1 million barrels of oil.

Alternatives to the DPR

Although we acknowledge that the DPR option being considered by DOE has merit, our analysis of the DPR was limited to comparing its capabilities to those of NPR-1. We believe there may be alternatives for establishing a DPR, such as designating part of the SPR as a DPR, which should be examined in conjunction with any decision on a DPR. A number of these alternatives will be discussed in a study being done by the Congressional Research Service which will be made available to the House Subcommittee on Armed Services Investigations.

CHAPTER 4

FEDERAL BUDGETARY AND LOCAL ECONOMIC CONSIDERATIONS

Continued production of NPR-1 for the next 3 years, the time period of any extension of production, would produce between $3.2 and $3.6 million in net federal revenues. On the other hand, a complete shut-in of NPR-1 would result in net revenues of about $500 million over the next 3 years. In addition, a shut-in would adversely affect the local area in which NPR-1 is located. Finally, a partial shut-in would result in about $880 million in federal revenues over the next 3 years and would adversely affect the local economy, but to a lesser extent than a complete shut-in.

IMPACT OF NPR-1 PRODUCTION LEVELS ON FEDERAL BUDGET RECEIPTS

Over the next 3 years, NPR-1 production of crude oil and other hydrocarbons at MER would net approximately $3.6 billion. In contrast, if NPR-1 were shut-in and operated at a minimum level of production, net revenues would drop to about $514 million for the same time period. In other words, a shut-in would decrease federal revenues by about $3.1 billion over the next 3 years. A partial shut-in at a production level of 25,000 to 30,000 barrels per day would decrease net federal revenues by about $2.7 billion. (See app. II for details of costs and revenues.)

Between fiscal years 1985 and 1987 at DOE's current MER, the government's share of production of NPR-1 would average 96,000 barrels of crude oil per day, 125,000 cubic feet of natural gas per day, and 494,000 gallons of natural gas liquids (propane, butane, and natural gasoline) per day. Gross government revenues from the production of these hydrocarbons alone would result in a yearly average of $1.3 billion, or $4 billion for fiscal years 1985 to 1987. This amount includes about $597 million which the government would realize in windfall profit taxes.[1] Additional revenues will come from scrap sales, pipeline fees, and Chevron's reimbursement to the government for operating costs. After expenditures, which will average over $200 million per year, NPR-1 production will net an estimated average of $1.2 billion annually, or a total of $3.6 billion for the 3-year period.

As discussed in chapter 2, DOE engineers have determined that present production practices and excessive production rates may jeopardize ultimate recovery from NPR-1. If MER is lowered

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[1]Windfall profit taxes are paid by purchasers of domestically produced crude oil. The amount of the tax is included in the NPR-1 sales price.

by 10 percent as these engineers have recommended, gross revenues would average over $1.2 billion per year for crude oil, natural gas, and natural gas liquids sales, or a total of $3.7 billion for fiscal years 1985 through 1987. Operations costs would remain at approximately the same level as with current MER, yielding net revenues of $3.2 billion. This represents a $400 million decrease from revenues under current MER. Of course, if MER were increased by 13 percent as recommended by Chevron, short-term net revenues would be increased, but as previously stated, we believe ultimate recovery would be decreased.

Under the shut-in option, production would continue at current levels until early April 1985 when the shut-in would take effect. In fiscal years 1985 through 1987, the U.S. government would receive over $514 million in net revenues, primarily from the 6 months of full production in fiscal year 1985 and natural gas liquids sales. This amount includes $121 million in windfall profit taxes. The net revenues also reflect the $31 million cost of shutting-in the reservoir and mothballing the gas processing plants as discussed in chapter 1.

In a partial shut-in of NPR-1 to a production level of 25,000 to 30,000 barrels per day, gross revenues, including windfall profit taxes, would be roughly $1.5 billion over the next 3 years. Expenditures would remain approximately equal to those under MER production because of the need to retain qualified personnel in the interest of readiness. Therefore, a partial shut-in would net revenues of about $884 million over the next 3 years.

LOCAL ECONOMIC IMPACT

A shut-in of NPR-1 would cause major problems for small refiners and pipeline companies that rely on NPR-1 production. In addition, it would cause additional unemployment in an area where unemployment in refining and crude oil production is already increasing. Finally, a shut-in would not adversely affect purchasers of NPR-1 natural gas. A partial shut-in would cause similar effects but to a lesser extent than a complete shut-in.

Effect on small refiners

We identified 13 small refiners that use NPR-1 crude oil as input to their operations, 6 located in the Bakersfield-San Joaquin Valley (where NPR-1 is located) and 7 located on the California coast. Because of the complex oil exchange relationships among refiners,[2] we were unable to quantify the exact

[2]Refiners often exchange or trade crude oil to acquire crude of a certain quality or at a particular location. It is difficult to determine the shipper or destination of crude once it leaves the NPR.

amount of NPR-1 crude oil handled by these small refiners. Under the small refiners preference authorized by the NPR Production Act, DOE currently guarantees that 25 percent of the NPR-1 crude offered for sale will be awarded to small refiners at market price. Under current contracts, small refiners are buying 23,100 barrels per day. In total, they handle approximately 86,000 to 99,000 barrels per day, buying additional NPR-1 crude from traders and acquiring some through exchanges.

The small refiners in the Bakersfield-San Joaquin Valley do not have access to significant sources of light crude other than NPR-1. Other than NPR-1 oil, only about 15,000 barrels per day of light crude are available in the immediate area. In addition, most California crude is produced or controlled by major oil companies. The small refiners in the Bakersfield-San Joaquin Valley also do not have access to imported crude, which includes Alaska crude, because they are located inland and there are no incoming crude oil pipelines from the coast. Therefore, should NPR-1 be shut-in, of the six small refiners in the Bakersfield-San Joaquin Valley, three would most likely shut down, two would reduce their operations, and one would be only minimally affected because it uses only a small amount of NPR-1 crude.

Further, refinery equipment upgrading is not a solution for small refiners who are dependent on NPR-1 crude. Upgrading would allow these refiners to process heavier crudes more efficiently and, therefore, reduce their need for light crude. However, upgrading requires a multi-million-dollar investment that would not pay off in the short run. According to several small refiners, the demand for refined products is not strong enough to justify major investments in upgrading. One small refiner explained that banks would not be interested in making multi-million-dollar loans to small refiners who do not have guaranteed sources of crude. Another small refiner who had invested about $200 million to upgrade his refinery stated that because he could not compete with the major oil companies and because the product market was soft, his refinery went into bankruptcy.

The remaining seven small refiners are located in coastal areas and, given an NPR-1 shut-in, would be affected to a lesser degree than those in the Bakersfield-San Joaquin Valley. According to several of these small refiners, other sources of light crude are available. They indicated that Alaskan North Slope and Indonesian light crude are accessible to those small refiners who could afford to purchase them. One small refiner explained that imported crude must be purchased by the tanker. A small tanker holds between 350,000 and 500,000 barrels of crude oil. We were told by one small refiner that payment is due about 5 days after delivery compared to about 50 days for NPR crude. He added that some small refiners could not afford to purchase crude in such large volumes nor would they have storage facilities. All seven of these small refiners told us that they would be forced to reduce their operations if NPR-1 light crude was not available.

Pipeline companies

The loss of NPR-1 crude would adversely affect the Chevron and ARCO Four Corners pipeline operations by reducing their combined daily crude oil volume by approximately 57 percent. According to DOE, the two companies transported about 128,000 barrels per day of NPR-1 crude in May 1984. In addition, an official from one pipeline company told us that the NPR-1 light crude is also used as a pipeline blender, which facilitates the movement of heavy crude through his company's two unheated pipelines. Officials from both pipeline companies said that a loss of the light crude would mean a reduction in the amount of heavy crude that could be transported out of the valley. (See app. IV.)

Employment effects

The direct impact of a shut-in would result in approximately 800 people being laid off or terminated. The three small refiners in the Bakersfield-San Joaquin Valley who said that they would shut down currently employ about 270 people. According to these refiners, they would shut down and either lay off or terminate their employees. Williams Brothers (the prime contractor and operator of NPR-1) would reduce its work force by 429 people. An official from one pipeline company informed us that at least 100 employees would be terminated if NPR-1 was shut-in; the other pipeline company would not terminate any employees. According to a DOE official, federal employment would not be reduced initially. He added that at some point, the administrative and clerical staff may be reduced slightly. The seven small refiners on the coast would lay off or terminate a small, undetermined number of workers.

It should be pointed out, however, that while about 800 jobs would be lost in the local area as a result of an NPR-1 shut-in, the net loss of jobs to the national economy may be less. Because a shut-in would reduce the amount of oil available to the national economy, suppliers of oil located in other geographic areas may increase their operations to make up the difference. As a result, new jobs may be created in other areas, thus reducing the unemployment impact from an NPR-1 shut-in.

Due to time constraints, we did not assess secondary employment effects on other employees and businesses in the area. However, economic research indicates that higher unemployment causes reduced purchasing power. Workers terminated or laid off, or those fearing possible layoff, tend to curtail spending, thus causing a ripple effect. Declining sales mean less hiring in other industries and in adjacent localities.

Purchasers of natural gas

NPR-1 natural gas sales represent about 14 percent of California natural gas production. In fiscal year 1983, NPR-1 sold an average of 137,000 cubic feet per day of natural gas

under contracts to six major oil companies and one utility company. Officials from three of these companies told us there are alternative sources and adequate supplies of natural gas in the State of California. Therefore, they believed an NPR-1 shut-in would not adversely affect their operations.

Partial shut-in

Partial shut-in of NPR-1 would result in some of the same negative local economic impacts as a complete shut-in. The 13 small refiners that we interviewed told us that they needed 86,000 to 99,000 barrels per day of NPR-1 crude (for input to their refineries or exchange) to maintain their present level of operations. Therefore, reduction to a production level of 25,000-30,000 barrels per day would be likely to negatively affect their operations. Similarly, a partial shut-in would reduce the combined daily throughput of the two pipeline companies by 46 percent. In addition, a partial shut-in would cause the loss of some jobs, but not nearly as many as associated with a complete shut-in. Most of the employees at the NPR-1 facility would be retained to maintain readiness; according to officials there, only about 140 jobs would be lost. Because pipeline and small refiner operations would be reduced, some additional unemployment would result, but we were unable to quantify the specific amount because of uncertainties as to how the available production would be distributed.

CHAPTER 5

CONCLUSIONS

CONCLUSIONS

Clearly, there are advantages and disadvantages associated with each of the NPR-1 options. The basic trade-offs in the decision of whether to continue production at NPR-1 are budgetary and local economic issues versus national security considerations. Our analysis of geologic conditions at NPR-1 did not identify any factors that would make one option more attractive than another. However, regardless of which option is chosen, geologic considerations must be factored into the future operation of the field to ensure maximum recovery of oil from the field.

Under continued production, NPR-1 could provide more net revenues than under any other option, approximately $3.2 to $3.6 billion for fiscal years 1985 through 1987. In addition, the local economy in which NPR-1 is located would not be disrupted. From a national security perspective, under continued production, NPR-1 could provide a significant source of oil to DOD in a peacetime shortage. However, NPR-1's value to DOD will continually decline in the future as production levels decrease.

With respect to a shut-in, NPR-1 would provide about $514 million in net revenues over the next 3 years. However, a shut-in would adversely affect the local economy, particularly small refiners and pipeline companies who are dependent on NPR-1 crude oil. In addition, a shut-in NPR-1 could provide little immediate help to DOD in a peacetime shortage because of the 6-month time frame required to return the field to full production following a shut-in. Under a shut-in, however, NPR-1 could provide significant amounts of petroleum during longer shortages.

Under a partial shut-in, NPR-1 net revenues would amount to about $884 million over the next 3 years. In terms of national security considerations, a partial shut-in would be more advantageous than continued production or a shut-in. Under a partial shut-in, NPR-1 production could be increased to current levels within 30 to 90 days. In addition, under a partial shut-in, NPR-1 would be depleted at a much slower rate than under continued production and thus could represent a longer-term reserve for DOD.

In regard to geologic considerations, indications are that MER may be too high and, as a result, that ultimate recovery could be decreased by about 139 million barrels over the life of the field. Thus, we believe, regardless of which production option is chosen, DOE should work toward a timely resolution of this problem in order to minimize any damage to ultimate recovery. In addition, if shut-in is mandated, DOE should ensure that all necessary steps to maximize ultimate recovery are adequately addresed in its plans to operate the field during a shut-in.

With respect to the DPR option being considered by DOE, we believe a DPR would be a more effective means of ensuring adequate amounts of petroleum products for DOD during peacetime shortages than NPR-1 under any of the production options under consideration. However, we noted that while DOE's current draft analysis of the DPR option specified that the DPR would be funded using some of the revenues from continued production of NPR-1, it does not specify how this will be done. In this regard, we believe that spending for a DPR should be subject to the normal appropriations process and thus subject to congressional oversight.

GEOLOGIC IMPLICATIONS OF SHUTTING-IN OR CONTINUING PRODUCTION AT NPR-1

The analyses which follow were prepared in order to provide a geologic perspective of the following questions:

--How much longer will the Naval Petroleum Reserve at Elk Hills, California (NPR-1), have remaining potential as a reserve?

--What are the geologic implications of a shut-in versus continued production alternative for NPR-1?

--Are there geologic factors that would favor continued production at the maximum efficient rate, or perhaps some lesser rate of production?

In order to assess these issues, this review was conducted at the administrative offices of the Naval Petroleum Reserve in California. We interviewed officials of the Department of Energy (DOE), Chevron, and Williams Brothers Engineering and reviewed agency documents, correspondence, and files related to the geology and petroleum engineering practices used to operate NPR-1.

To answer the question of NPR-1's remaining potential as a reserve, we examined estimates of recoverable oil for the field, the history of production from the individual oil and gas pools at the reserve, and a decline curve analysis of those pools.

In order to analyze the geologic implications of a shut-in versus continued production scenario, we reviewed technical reports and correspondence and solicited the views of DOE's petroleum engineers and geologists and Chevron's petroleum engineers to determine the potential impacts of virtually stopping production from the field. We also interviewed personnel at the Department of Interior's Minerals Management Service on the subject of shut-ins.

Regarding the question of whether production should be at the maximum efficient rate or some lesser rate, we reviewed and analyzed the written recommendations of DOE, Chevron, and engineering consultants to the unit operation. We compared production practices recommended by these parties with historical engineering data for the individual producing pools and made observations about the proper rate for NPR-1 production.

REMAINING RESERVES

The NPR-1 oil and gas field lies in the San Joaquin Valley of California (see figure 1) and currently is the largest producing field in the United States, exclusive of Alaska. The field produces oil and gas from formations ranging in age from Miocene to Pleistocene (table 1). Although not structurally complicated,

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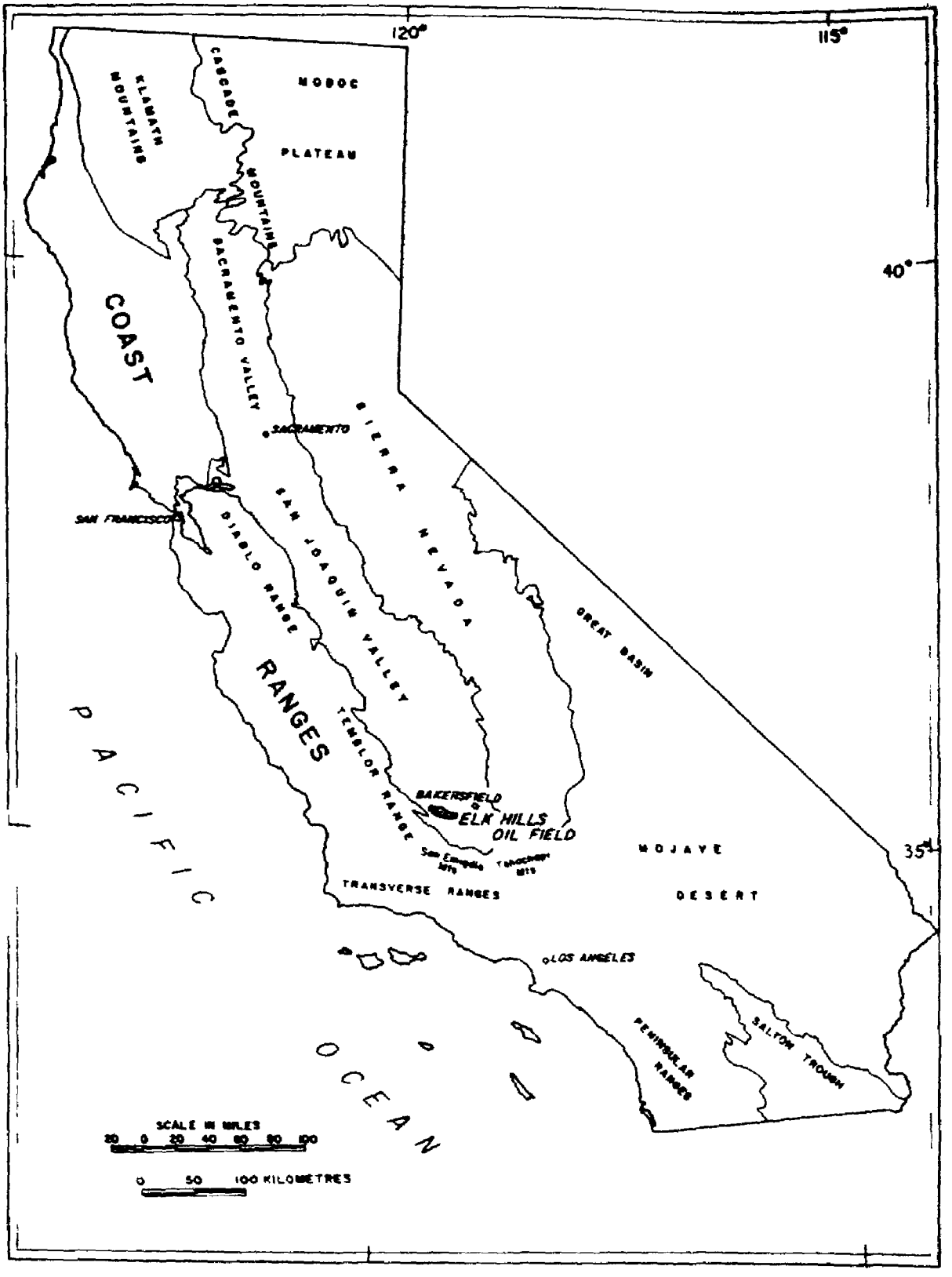

FIGURE 1.—Location of the Elk Hills oil field, San Joaquin Valley, Calif.

Source: U.S. Geological Survey Professional Paper 912, Petroleum Geology of Naval Petroleum Reserve No. 1, Elk Hills, Kern County, California.

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Table 1

Principal Oil and Gas Reservoirs, Producing Zones, of Elk Hills NPR-1

Oil and gas zones	Oil and gas production zones of Elk Hills Engineering Committee	Stratigraphic position		
		Member	Formation	Series
			Tulare	Pleistocene
Mya sand zone	Dry Gas Zone		San Joaquin Formation	Pliocene
Scalez sand zone Mullnia sand zone, Wilhelm sand zone, Gusher sand zone, Calitroleum sand zone Olig sand zone	Shallow Oil Zone	Carman Sandstone Member Tupman Shale Member	Etchegoin Formation	
			Reef Ridge Shale	
N zone (24Z sand), A zone (26R sand), B zone (B sands), C zone D zone	Stevens Oil Zone	Elk Hills Shale Member	Monterey Shale	
		Gould and Devil water Shale Members		Miocene
		Media Shale Member		
Carneros oil zone	Carneros Oil Zone	Carneros Sandstone Member	Temblor Formation	
Santos oil zone	Santos Zone (Railroad Gap field only)	Santos Shale Member		

Source: Modified from Professional Paper 912, p. 86. U.S. Geological Survey.

the stratigraphy is complex and not yet completely understood. Production is obtained from sandstones draped over the two major anticlines of the eastern and western portions of the field, lens-shaped sandstones situated along the flanks of the anticlines, and areas of fractured shales occurring mostly along the crest of the folds. The estimated original recoverable reserves of the field included approximately 598.6 million barrels of oil from the productive Pliocene oil zone referred to as the Shallow Zone; 870.3 million barrels from the several productive Miocene sandstone and shale reservoirs of the Monterey Shale referred to collectively as the Stevens Zone, and 4.9 million barrels of oil from the deepest producing zone at the field called the Carneros Zone, also of Miocene age. This yields an estimate of original recoverable reserves of 1.47 billion barrels of oil. Reserve estimates for all reservoirs of natural gas have not been published although they are well in excess of a trillion cubic feet. (See fig. 2 for limits of producing oil zones.)

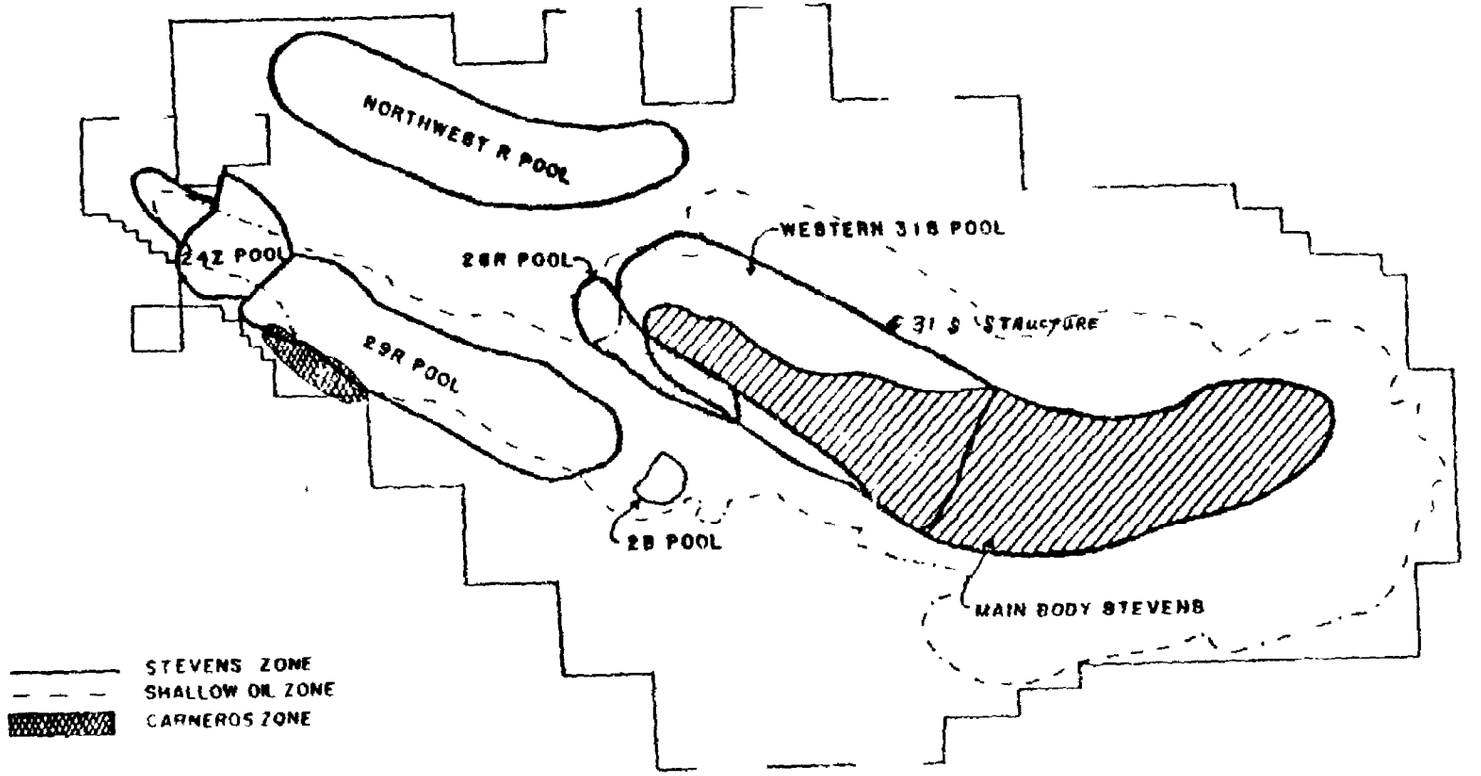
Oil produced at NPR-1 prior January 1, 1976, amounted to 284.5 million barrels, leaving 1.19 billion barrels recoverable. Between January 1976 and April 1984, an additional 401.4 million barrels of oil were produced. Remaining reserves would then equal approximately 787.9 million barrels of oil as of April 1, 1984. Production at NPR-1 peaked in July 1981 at nearly 182,000 barrels per day; the current rate is 134,000 barrels per day; declining at a rate of approximately 10 percent per year.

Independent examinations by Scientific Software, Inc. (a DOE contractor), and the engineering staff at DOE have found that over 135 million barrels of oil originally believed to exist in place in the Shallow Oil Zone are not present--the result of early optimistic projections of recovery or possibly water influx from the nearby acquifer moving oil within the petroleum reservoir. Decline curve projections, assuming primary production of the zone by depletion gas drive, confirm internal DOE lowered primary production estimates. We estimate that ultimate recovery will likely be 38.6 million barrels below earlier estimates, reducing recoverable reserves at Elk Hills to 749.3 million barrels.

A conflict has arisen at NPR-1 between the Department of Energy and Chevron staff engineers over the proper rate and means of producing the individual reservoirs at the field. This disagreement will be discussed below under the section on MER; however, it does have implications for ultimate recovery of oil from the field. Chevron was unable to provide any figures to us; however, DOE staff believes that an additional 139 million barrels of oil may be lost from ultimate production if present operating rates and practices continue. Assuming that there is no change, this could further reduce recoverable reserves to approximately 610 million barrels of oil. In any event, NPR-1 should continue to provide relatively large amounts of oil for use through this century.

Figure 2

Major Producing Oil Zones and Structures of Elk Hills



Source: Modified from DOE FY 1984 Annual Operating Plan, Naval Petroleum Reserves in California.

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SHUT-IN

As a result of constraints placed in Public Law 94-258 which opened up NPR-1 production in 1976, the managements of DOE and Chevron have had to be prepared for the possibility of shutting down their operation to conserve the remaining petroleum. This has influenced equipment purchases and operation practices, such as the use of peripheral rather than a pattern waterflood for sandstones of the 31 S structure. (See fig. 2 for locations of structures of the field.)

According to the Director of NPR-1, the present shut-in scenario is based on procedures utilized at NPR-1 during the shut-in from 1945 to 1976, and in Texas in the 1960's by the Texas Railroad Commission. The procedures proposed by DOE assume the use of a rotating well testing and production program to avoid equipment damage fron non-use. The shut-in scenario allows for total production from all pools of 3,863 barrels per day of oil, whereas all water and gas produced would be reinjected back into productive formations. Analysis of the scenario indicates that provisions have been made for removing water which is entering the Shallow Oil Zone along the periphery of the field; during the shut-in period following World War II, the loss of oil from ultimate recovery by uncontrolled water influx, selective gas injection that repressured only certain areas of the reservoir, and uneven stages of production and pressure depletion within the reservoirs, was thought to have occurred. The dewatering program proposed by NPR-1 personnel is set at a level of 20,000 barrels a day. Seasonal influx of up to 25,000 barrels a day is possible, however, and this should be considered in any shut-in scenario developed by DOE. The dewatering program will most likely protect that pool from lost recovery of oil.

Production fom Carneros, Stevens, and Shallow Zone wells should be sufficient to offset drainage of federal oil and gas from wells on private lands.

From the available data in documents of the NPR-1 Engineering Committee and consultants reports, it is apparent that imbalances currently exist in both the distribution of reservoir gas and oil and the pressure maintenance programs of nearly all producing pools at NPR-1. Although Chevron believes that premature termination of production would result in a loss of 5 to 15 percent of recoverable oil, we believe a shut-in would most likely benefit the recovery of petroleum by allowing some equalization of reservoir fluids within the pools. With the exception of the 29 R area, no other Stevens Zone pools currently have active water drives that could cause problems similar to that encountered in the Shallow Zone during a shut-in. However, according to DOE staff, the rebalancing of individual reservoirs needs the injection of variable amounts of water or gas into selected wells and parts of the reservoirs during the shut-in period to maximize and guide fluid movements. As long as a shut-in is flexible and allows for variations in production and injection rates, the pools could be pressure maintained.

With respect to waterflood projects, considerable controversy has developed in industry over the effects of shut-in on ultimate recovery or flood performance. However, DOE's selection of a peripheral rather than a pattern waterflood on the basis of potential for shut-in should allow for minimization of oil losses should a shut-in actually occur. In this case the time frames for shutdown must consider recovery of oil entrained in the flood fronts, effects of gravity segregation, and structural features of the reservoir in order to avoid movement of oil into areas where it may be more difficult to recover in the future.

Discussions with personnel at the Department of Interior's Minerals Management Service and the experience at NPR-1 show that some well workovers are necessary following a shut-in to restore production to pre-shut-in levels. The amount of workover for each well is dependent on a variety of factors including location of a well on a producing structure, drive mechanism for oil production in the pool, type and nature of producing formation rock, and mechanical conditions of the well.

The Director of NPR-1 was unable to provide us with a documented analysis on time frames for a shut-in to account for flood front movement in waterflood project areas, or for reinjection within specific pools of either gas or water to solve problems related to the existing pressure imbalances. Although the managers at NPR-1 have told us that they have considered these problems and would deal with them at the time of a shut-in, the issue should be addressed in a more detailed written contingency plan than is currently available, if a shut-in is decided upon.

MER

Public Law 94-258 which established the opening up of NPR-1 in 1976 requires that the field be produced at the maximum efficient rate (MER) which is defined as "the maximum sustainable daily rate from a reservoir which will permit economic development and depletion of that reservoir without detriment to the ultimate recovery." DOE determines MER for each producing pool at Elk Hills after considering productive capacities for all wells in the field, consultants' reports, and DOE and Chevron engineering staff recommendations.

Within the past year Chevron has indicated that DOE is not producing NPR-1 at its maximum potential and that the Stevens Zone could be produced at a higher rate without detriment to ultimate recovery. According to Chevron's member of the Operating Committee, DOE's lowered time and rate of oil and gas production were affecting Chevron's revenues; as well, he stated that DOE was not providing Chevron access to its decisions on MER. As a result, Chevron has refused to drill new wells in some pools or convert some producing wells to water injectors.

Many DOE engineering personnel believe instead that MER for the field should be at a significantly lower value than suggested by Chevron to maximize ultimate recovery of oil and gas. Both DOE's Engineering Division at NPR-1 and Chevron have submitted

separate engineering analyses regarding recommended MER's for each Stevens Zone pool at the field. The disagreement between DOE's engineering staff and Chevron pertains not only to production rates, but to methods of producing individual pools. The Chevron-recommended MER as of October 1983 was about 13 percent above the existing production rate (using June 1983 production data) while the DOE Engineering staff recommended a rate of approximately 10 percent below the existing production rate (based on October 1983 production data).

According to the Director, NPR-1, it was decided early on in the life of the field that pressure maintenance would be the overriding control on the field's MER; pools would be maintained at or above the bubble point.

When a well begins to extract fluids from a petroleum reservoir, pressure around the well intake is lowered. A gradient is then formed between the original reservoir pressure under the ground and a minimum pressure at the surface. At some point, the fluid pressure drops and natural gas dissolved within the oil or water comes out of solution and bubbles out (the bubble point). If reservoir pressure is maintained either above or slightly below the bubble point, the majority of produced well fluids will be oil with gas dispersed in it as small bubbles. However, if the reservoir pressure drops below this critical point, gas comes out of solution and expands so that it is found in most of the pore space at the intake of the well. In this case most of the produced fluid is gas, resulting in a high ratio of produced gas to oil. Too rapid a rate of production can permit a channeling of gas or water into the well in preference to oil, resulting in the isolation of substantial quantities of nonrecoverable oil in channels or patches within the reservoir.

As of March 1983, pool pressures were too low in the pools known as the Main Body B and Western Sands of the 31 S structure, the A1-A6 sands of the Northwest Stevens structure, and the 2 B. Also, higher numbers of wells in the 26 R sand, and N, A, and B shales of the 31 S structure are currently producing more gas in preference to oil than would be expected with a balanced pressure maintenance program. Chevron has disputed the threshold point at which wells should be shut down due to high gas production and has asked for greater production and more wells in the field.

Overall, we tend to believe that DOE has demonstrated a need for reducing the present rate of production by approximately 10 percent to a rate of approximately 120,000 barrels a day as of April 1, 1984, to maximize ultimate petroleum recovery of the field based on analysis of pool conditions and generally accepted production methods for gravity, depletion gas drive, and water drive systems. Pressure maintenance should be restored to the 31 S, Northwest Stevens, 2 B, and 24 Z structure sands and shales to preclude expensive losses of oil or needs for premature secondary recovery.

Based on the available evidence, it is highly likely that the turbidite sands of the 31 S structure are not sealed off from the fractured N, A, and B shales, and oil and gas may be moving between them without being stopped by zone boundaries. Consequently, overproduction or failure to maintain high pressure in shale zones could force petroleum to move from highly permeable sandstones to much less permeable shales, resulting in lower recovery. Considering that the 31 S structure contains over 50 percent of all the recoverable oil left at NPR-1, it is important that reservoir engineering practices be designed to treat the geology of the 31 S structure N, A, and B intervals as an interrelated pressure system and not as a series of individual producing pools.

The nature of the Monterey Shale formations will probably continue to cause problems in reservoir pressure maintenance for the 24 Z and Northwest Stevens structures as well. The lack of homogeneous sands and shales, and zone boundaries that do not confine reservoir fluids, may continue to cause disagreements over proper recovery methods to be utilized for NPR-1.

Until pressure maintenance programs are restored and the geology of the 31 S structure better understood, the use of higher MER and higher gas to oil ratios before well shutdowns, as recommended by Chevron, are not in accordance with generally accepted engineering practices or most consultants' recommendations for NPR-1. Production of most individual pools at the rates and methods recommended by Chevron would result in increased extraction of natural gas in order to recover increasingly smaller amounts of oil. Although this would lead to a spurt in oil production, it would mean that expensive secondary recovery methods (waterflooding, steam flooding, polymer flooding, well fracturing or acidization) would have to be employed much sooner than currently planned with the likelihood that less oil would be recovered ultimately. Even though Chevron officials recognize the possibility that the 26 R sand may be in communication with the N, A, and B shales, their production scenario fails to take this into account.

OBSERVATIONS

--Depending upon production methods, NPR-1 may have reserves of from 610 to 749.3 million barrels of oil. The field should continue to produce relatively large amounts of oil well through this century.

--A properly designed and operated shut-in program which would take into account waterflood project flood front movements, rebalance reservoir conditions, offset drainage, and control water influx from the acquifer will not cause lost ultimate oil recovery at NPR-1.

--The present production rate for oil and gas and methods for production have caused reservoir fluid and pressure imbalances in most producing structures at the field and could result in lost ultimate oil recovery. Therefore, DOE should work toward a timely resolution to this problem in order to minimize any damage to ultimate recovery.

APPENDIX II

PROJECTED REVENUES FROM NPR-1

AT CURRENT MER, DECREASED MER, AND SHUT-IN

(In Millions of Dollars)

MER	FY 1985	FY 1986	FY 1987	3-Year totals	FY 1988	FY 1989	5-Year totals
U.S. share crude production (barrels/day)	102,180	96,813	89,822	288,815	82,903	75,933	447,711
Gross government revenue[a]	$1,346	$1,414	$1,425	$4,185	$1,427	$1,431	$7,044
Less: expenditures	$ 113	236	260	609	263	294	1,166
Net revenues to U.S.G.	$1,234	$1,178	$1,165	$3,576	$1,164	$1,138	$5,879
Decreased MER							
U.S. share crude production (barrels/day)	90,220	86,841	83,461	260,522	80,081	76,701	417,304
Gross government revenues[a]	$1,228	$1,288	$1,330	$3,846	$1,377	$1,440	$6,662
Less: expenditures[b]	113	236	260	609	263	294	1,165
Net revenues to U.S.	$1,115	$1,052	$1,070	$3,237	$1,114	$1,146	$5,497
Shut-In							
U.S.G. share crude production (barrels/day)	55,029	3,013	3,013	61,055	3,013	3,013	67,081
Gross government revenues[a]	$765	$61	$53	$879	$57	$61	$997
Less: expenditures	235	88	42	365	44	(6	455
Net revenues to U.S.	$530	$27	$11	$514	$13	$15	$542

[a]Includes revenues from hydrocarbon production and miscellaneous revenues.

[b]Assumes that expenditures at decreased MER will not be significantly different than expenditures at current MER.

APPENDIX III

CALIFORNIA SMALL REFINERIES' CRUDE CAPACITY

	Thousands of barrels per stream day[a]
Bakersfield-San Joaquin Valley:	
Anchor Refining Co., Inc.	11,000
Beacon Oil Co.	18,646
Coast Petroleum	10,000
Paromont	30,000
Kern Oil and Refining	23,000
Sunland Refining Corp.	17,000
Coastal refineries:	
Edgington Oil Co., Inc.	44,000
Fletcher Oil and Refining Co.	31,700
Golden West Refining Co.	42,300
MacMillian Ring Free Oil Co., Inc.	12,000
Powerline Oil Co.	46,000
Lundy-Thagard Oil Co.	14,000
USA Petroleum	30,000

[a]Stream day - the amount a refinery can process at full capacity under optimal crude and product slate conditions.

NPR-1 DISTRIBUTION AS OF MAY 1984

Company	Destination	Quantity (barrels per day)
Chevron	Bakersfield	19,000
Arco/Four Corners	Bakersfield	30,000
Chevron	Richmond	34,300
Union & Truck	Hanford	5,600
Arco/Four Corners	Los Angeles/Long Beach	35,000
Arco/Four Corners	Texas-New Mexico	10,000
Total		133,900

Source: Department of Energy.

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Another option for NPR-1 is a partial shut-in with daily crude oil production of 25,000 to 30,000 barrels. Although DOE did not evaluate this option in its current draft study, it made an extensive study of a partial shut-in in its 1981 study of continued production versus shut-in. Under this option, sufficient quantities of natural gas would also be produced which would provide for operation of the three gas plants on a rotating basis, and therefore these plants would not be mothballed. If NPR-1 was operated under the partial shut-in option, production could be substantially increased in 8 days and returned to MER in 30 to 90 days. In 1981, DOE concluded that a partial shut-in was not an economical means for creating a reserve for short-term energy emergencies. For this reason, DOE determined that it was not necessary or appropriate to study the issue again.

OBJECTIVES, SCOPE, AND METHODOLOGY

We conducted this review at the request of the Chairman, Investigations Subcommittee of the House Armed Services Committee. Based on our discussions with his office we agreed to focus our work on

--assessing the geologic, budgetary, local economic, and national security implications of NPR-1 shut-in versus continued production and

--examining the advantages and disadvantages of establishing a Defense Petroleum Reserve, using revenues from continued NPR-1 production to finance it.

With the exception of geologic implications, our assessment of the implications of shut-in versus continued production also included an assessment of a partial shut-in, an NPR-1 option DOE considered in 1981. Although DOE concluded in its 1981 study that a partial shut-in was not an economical means for creating a reserve, this option offers certain national security benefits which we believe should be pointed out. In addition, we agreed to provide a separate legal response on the implications of the recent Supreme Court decision (Immigration and Naturalization Service v. Chadha) on congressional veto of the administration's proposal for NPR-1 production.

We conducted our review primarily at Department of Energy headquarters in Washington, D.C., from February through July 1984. We interviewed officials with the Office of Naval Petroleum and Oil Shale Reserves at headquarters and the Naval Petroleum Reserve at Elk Hills, California. In addition, we reviewed DOE's 1981 study on shut-in versus continued production of NPR-1. Finally, we reviewed a draft of the current DOE study on shut-in versus continued production and interviewed representatives from Systematics General Corporation, the consulting firm that prepared the study.