BY THE COMPTROLLER GENERAL

Report To The Chairman, Committee On Energy And Natural Resources United States Senate

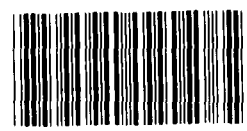
OF THE UNITED STATES

Selectively Reducing Offshore Royalty Rates In The Gulf Of Mexico Could Increase Oil Production And Federal Government Revenue

The U.S. government leases large areas in the Outer Continental Shelf in the Gulf of Mexico for the development of oil resources and receives royalties on the oil produced. Conventional methods of oil recovery have recovered or are expected to recover about half of the 16 billion barrels of oil discovered in this area. Other oil recovery methods, collectively known as enhanced oil recovery (EOR), could potentially increase production by about 1 billion barrels of oil.

EOR in the Gulf is expensive and does not appear to be economically justified in most cases. Under existing economic conditions and federal policies, GAO's review indicates that utilizing EOR methods will probably produce only about 10 percent of the additional recoverable oil. However, financial incentives in the form of royalty reductions could increase both oil production and federal government revenue if applied on a project-by-project basis. Universal applications of royalty reduction for EOR, however, while achieving increased oil production, would not increase federal government revenue.

GAO recommends that the Department of the Interior's Minerals Management Service initiate action that would allow for selective royalty reductions for EOR projects in the Gulf in instances where both total oil production and federal government revenue will increase.



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COMPTROLLER GENERAL OF THE UNITED STATES
WASHINGTON D.C. 20548

B-214429

The Honorable James A. McClure
Chairman, Committee on Energy
and Natural Resources
United States Senate

Dear Mr. Chairman:

As requested by Senator Lowell P. Weicker, Jr., former Chairman, Subcommittee on Energy Conservation and Supply, Senate Committee on Energy and Natural Resources, we examined steps the federal government could take to encourage environmentally sound enhanced oil recovery (EOR) in the Outer Continental Shelf in the Gulf of Mexico. However, because of recent changes to Subcommittee and Committee jurisdictions, and as arranged with the legal counsel for your Committee, we are addressing our report to you. This report responds to Senator Weicker's request and analyzes how royalty reductions could be used to encourage industry to initiate EOR in the Gulf. By initiating action to reduce royalties in certain instances, both domestic production and federal government revenue could be increased.

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As arranged with your office, the distribution of the report will be restricted for a period of 7 days, unless released by the Committee. After this time, we will send copies to appropriate House and Senate committees; the Departments of the Interior, Energy, and Treasury; and other interested parties. We will also make copies available to others upon request.

Sincerely yours,

Charles A. Bowsher

Comptroller General
of the United States

COMPTROLLER GENERAL'S REPORT TO THE COMMITTEE ON ENERGY AND NATURAL RESOURCES UNITED STATES SENATE

SELECTIVELY REDUCING OFFSHORE ROYALTY RATES IN THE GULF OF MEXICO COULD INCREASE OIL PRODUCTION AND FEDERAL GOVERNMENT REVENUE

D I G E S T

The U.S. government leases large areas in the Outer Continental Shelf (OCS) in the Gulf of Mexico for the development of oil resources. As part of the lease agreements, the federal government receives royalties on each barrel of oil produced.

According to the Department of the Interior's Mineral Management Service (MMS), conventional methods of oil recovery (using natural reservoir[1] pressure and/or injected water to displace oil trapped underground) have recovered or will recover about half of the estimated 16 billion barrels of oil discovered in the OCS.

Other oil recovery methods, collectively known as enhanced oil recovery (EOR), could produce approximately an additional 1 billion barrels. (This additional recoverable oil is shown in the figure on page ii.) EOR uses heat, chemicals, or gases to help displace the oil underground and make it flow more easily.

EOR methods in the OCS are expensive, however, and undertaking EOR production does not now appear to be economically justified in most cases. Unless the economic feasibility of these methods changes, many oil fields in the OCS may not produce this additional recoverable oil.

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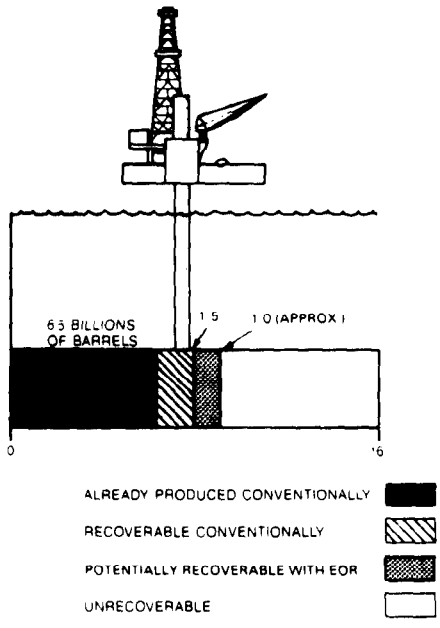
[1]A reservoir is an underground formation consisting of porous rock containing oil and is sealed by other layers of surrounding rock. In this report it refers to an individual, sealed formation containing oil.

FIGURE 1
OIL PRODUCTION IN THE GULF OF MEXICO

(BILLION BARRELS)



Many reservoirs amenable to EOR methods lie in areas that have been producing since the late 1950's, and conventional production may soon cease. Federal regulations require that oil production platforms be removed within 1 year after production stops. If this occurs before EOR production is started, Minerals Management Service and industry officials agree that it would not be economically feasible to replace the platform for the recovery of EOR oil. In addition, physical reservoir conditions may make EOR projects less attractive later if conventional production has ceased and oil is no longer moving freely.

WHY THE REVIEW WAS MADE

The former Chairman of the Subcommittee on Energy Conservation and Supply, Senate Committee on Energy and Natural Resources, requested that GAO examine steps the federal government could take to encourage environmentally sound EOR in the OCS in the Gulf of Mexico. In accordance with this request, and as further agreed with the Committee's office, GAO addressed the following issues:

--The likelihood that oil production platforms on sites suitable for potential EOR on federally leased areas[2] in the OCS in the Gulf of Mexico will be abandoned by the year 2000.

--The impact of platform abandonment on potential EOR production until the year 2000.

--Whether the federal government could provide financial incentives for EOR that would improve production.

--The associated impact of incentives on federal government revenue.

--The environmental implications of increased offshore EOR.

SCOPE AND METHODOLOGY

To analyze these issues, GAO obtained data from a study entitled Enhanced Oil Recovery in the Gulf of Mexico (Jan. 1983), prepared for the Department of Energy (DOE) by the consulting firm Lewin and Associates, Inc. According to government and industry officials, these data are the most up-to-date, detailed information available on both platform abandonment and EOR production in the OCS of the Gulf of Mexico. The Lewin study, using various assumptions on oil prices and technology, analyzed reservoirs containing about 20 percent of the oil discovered in the OCS.

GAO adjusted the crude oil price assumptions used in the Lewin study downward to reflect more recent projections, used three technology assumptions, and derived new platform abandonment and EOR production estimates. GAO then (1) extrapolated these results to the entire OCS in the Gulf, (2) evaluated the influence of federal incentives, and (3) estimated the potential federal government revenue from EOR production with and without incentives. GAO also reviewed current government and industry practices with regard to EOR, and assessed information pertaining to the environmental implications of EOR.

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[2]A lease authorizes the exploration, development, and production of minerals within a given area (up to 5,760 acres). Usually, several oil production projects are ongoing under a given lease.

WHAT GAO FOUND

Platform abandonment by the year 2000 and its impact on production and federal revenue

According to GAO's analysis, about 60 to 75 percent of existing platforms on sites suitable for EOR are likely to be abandoned and removed by 2000, depending on future oil prices and the development of EOR technology. If this occurs, GAO estimates that only about 100 million barrels (MMB), or about 10 percent of the recoverable EOR oil, is likely to be produced. This would leave at least 870 MMB of technically recoverable oil in the ground and associated federal royalties uncollected.

Across-the-board incentives could increase production, but reduce federal revenue

GAO evaluated how financial incentives ranging from $1 to $5 per barrel, applied to all EOR projects, would affect EOR production and federal government revenue. Incentives ranging from $1 to $4 per barrel increased cumulative production most when considered for both moderate and high oil price assumptions. Production with these incentives ranged from about 55 MMB to 725 MMB of oil depending on oil prices and technology development. A $5 incentive increased production only slightly above a $4 incentive and was, therefore, less effective per dollar. Across-the-board incentives to all EOR projects did not, however, appear to be cost-effective. Although these incentives could increase oil production, some EOR projects will be profitable and are likely to be initiated without an incentive. As a result, the federal government would forego revenue for each barrel produced by these projects. (See pp. 11 to 16.)

Incentives on a project-by-project basis could increase both EOR production and federal government revenue

On the other hand, project-by-project royalty reductions by the Minerals Management Service could increase both production and federal government revenue. In this type of program, royalty reductions would be granted only for those projects where it would otherwise not be profitable to produce EOR oil. Allowing a reduction only on additional oil gives the

federal government a financial share in the increased production that otherwise would not have occurred. The amount of additional EOR oil and the associated government revenue from such a program cannot be predicted with certainty because negotiations between industry and the federal government would be necessary in order to agree on the projects that qualify and the size of the royalty reduction needed. (See pp. 19 to 24.)

According to both the Minerals Management Service and industry representatives, agreement can generally be reached on the amount of oil remaining to be produced by conventional methods in Gulf reservoirs because a long history of oil production is available to both parties. They therefore believe that it is possible to estimate the amount of EOR oil that could be produced and the incentive needed to offset additional EOR production costs. Although GAO did not perform an analysis of the resources needed to carry out such a program, according to Minerals Management Service officials, the administration of project-by-project royalty reductions could probably be handled through its ongoing operations. (See pp. 19 to 24.)

The principle of reducing government revenue to encourage increased production when project economics dictate is not new. Louisiana recently authorized severance tax reductions on incremental EOR oil[3] on a project-by-project basis. Officials involved in that process are confident that their state agencies can administratively apply severance tax reductions on a project-by-project basis. (See p. 22.)

In addition, GAO has previously recommended the selective use of different royalty rates to maximize oil production and/or government revenue.[4] (See p. 22.)

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[3]Incremental oil is the amount above what would have been produced with conventional production had it continued until the economic limit of the reservoir was reached.

[4]Interior Should Continue Use of Higher Rates for Offshore Oil and Gas Leases (RCED-83-30, Dec. 20, 1982).

Authority to reduce royalties exists but has not been used

Royalty reductions are authorized by federal law and regulation. Minerals Management Service officials told GAO that companies can apply for reduced royalties when they undertake new methods or add to existing ones. However, GAO's review of the royalty reduction regulations revealed no specific guidance describing how or when companies could apply for reduced royalties to offset increased EOR cost. (See pp. 19 and 23 to 24.)

GAO questioned oil industry representatives on why there had been no applications for reduced royalties in the Gulf. Although responses varied, most centered on how industry officials perceived that the Minerals Management Service would evaluate a royalty reduction request. Oil industry representatives believed that reduced royalties would have to be evaluated on a project-by-project basis to be practical. But, since the Minerals Management Service generally establishes royalties based on an entire lease area, oil representatives were doubtful that the Service would reduce royalties on an individual EOR project basis, particularly if other oil production on the lease is still profitable. (See pp. 23 to 24.)

Potential environmental implications appear to be minimal

EOR tends to extend and expand environmental impacts associated with conventional oil recovery. On the basis of limited offshore and more extensive onshore experience to date, expanded EOR production is not expected to introduce major environmental impacts.

Industry consensus indicates that carbon dioxide has the greatest growth potential for EOR in the OCS in the Gulf. Carbon dioxide is a relatively benign substance, and the environmental experts GAO spoke with agreed that it is not expected to affect the Gulf environment adversely.

Existing environmental laws apply to EOR in the OCS. Minerals Management Service and Environmental Protection Agency officials believe these laws are adequate to deal with environmental problems that might occur on any

specific project. These agencies have jurisdiction over the OCS in the Gulf and review exploration/development plans and inspect oil production platforms annually. (See pp. 25 to 27.)

RECOMMENDATION TO THE SECRETARY OF THE INTERIOR

GAO recommends that the Secretary of the Interior have the Director of the Minerals Management Service initiate action that would allow for royalty reductions on EOR projects in the OCS in the Gulf of Mexico where it would result in both increased production and increased federal government revenue. In doing this, the Director should establish guidelines that

--facilitate industry preparation of royalty reduction proposals and government evaluation of these applications;

--permit timely evaluation of royalty reduction proposals (i.e., early enough in the productive life of a well or reservoir to permit industry to implement EOR effectively, but late enough for the federal government to have sufficient data to evaluate the need for royalty reduction, usually during the last few years of conventional production); and

--allow royalty reductions on a project-by-project basis while maintaining the existing royalty for the remainder of the lease area.

AGENCY COMMENTS

The Departments of Energy and the Interior commented on a draft of this report; their comments are included in appendix I. DOE pointed out that GAO had taken a conservative approach in estimating the recoverable oil using EOR methods. The potential, according to DOE, may well be greater than that calculated by GAO if reservoirs that are known, but currently undeveloped, are included in the area from which GAO's estimates are derived. However, DOE agreed, in general, with the report and noted that maximum recovery of this country's petroleum resources is in the national interest--a goal that can be furthered by GAO's recommendation.

Unlike DOE, Interior noted that GAO's estimates of EOR potential may be optimistic. However, Interior, although noting a number of concerns, commented that GAO's recommendation is of sufficient importance to merit consideration. Furthermore, Interior agreed that its regulations now in effect may need refinement and clarifying guidelines and that these are now under study. Although both Departments expressed concerns about the administrative process involved with a royalty reduction program, they agreed that such a program could provide an opportunity to produce oil that might otherwise remain in the ground. (See pp. 29 to 34.)

Contents

ILLUSTRATIONS

ABBREVIATIONS

B/D	barrels per day
CFR	Code of Federal Regulations
DOE	Department of Energy
EIS	environmental impact statement
EOR	enhanced oil recovery
EPA	Environmental Protection Agency
ERA	Economic Regulatory Administration
MMB	million barrels
MMS	Minerals Management Service
OCS	Outer Continental Shelf

GLOSSARY

Advanced technology	Assumes that an injectant moves through a reservoir at the rate of a unit of carbon dioxide followed by a less costly, less dense gas.
Base technology	Assumes that an injectant moves through a reservoir at the rate at which carbon dioxide displaces a mixture of carbon dioxide and crude oil.
Conservative technology	Assumes that an injectant moves through a reservoir at (1) either the rate at which carbon dioxide displaces water or (2) the rate at which carbon dioxide displaces crude oil, whichever is slower. This technology recovers as much oil as base technology but at a slower pace and at greater cost.
Conventional oil recovery	Oil production using natural reservoir pressure (primary recovery) and/or injected water (secondary recovery).
Economically recoverable	The amount of oil that will be produced with current oil prices and production costs.
Economic limit	The end point of profitable oil production from a given reservoir.
Enhanced Oil Recovery	Enhanced oil recovery, sometimes called "tertiary recovery," involves the use of heat, chemicals, or gases to thin oil, increase oil volume, decrease the pressure holding the oil in reservoir rock, and/or help it flow more easily. This generally increases the amount of oil recovered.
Severance tax	A tax on the recovery and use of potential resources imposed at the time the resource is extracted from the earth.
Technically recoverable	The amount of oil that is recoverable from a given reservoir when cost is not a factor.

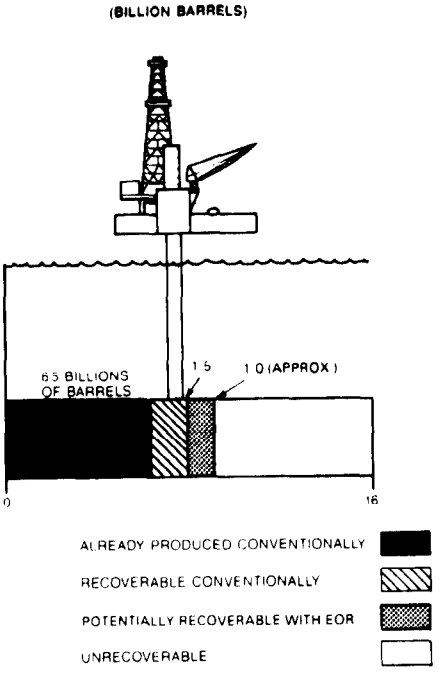
CHAPTER 1

INTRODUCTION

The U.S. government has leased large areas in the Outer Continental Shelf (OCS) in the Gulf of Mexico for the development of oil resources. As part of the lease agreements, the federal government receives royalties on oil production. The federal government is also concerned with this production as an important domestic energy resource. To date about 16 billion barrels of oil have been discovered. About half of this oil has been or can be produced by conventional oil recovery methods--those using natural reservoir[1] pressure and injected water. Of these 8 billion barrels, about 6.5 billion have already been produced.

About 8 billion barrels will be left after conventional production. Other methods, collectively called enhanced oil recovery (EOR), work by injecting heat, chemicals or gases into an oil reservoir to help the oil flow more easily. These methods using known technology or technology under development could recover an additional estimated 970 million barrels (MMB) to 1.2 billion barrels of the remaining oil. Figure 1 shows the oil that can be produced with conventional methods and the estimated contribution from EOR.

FIGURE 1
OIL PRODUCTION IN THE GULF OF MEXICO



[1]A reservoir is an underground formation consisting of porous rock containing oil and is sealed by other layers of surrounding rock. In this report, it refers to an individual, sealed formation containing oil.

Conditions in the OCS in the Gulf of Mexico are such that many of the reservoirs amenable to EOR methods lie in areas that have been producing since the late 1950's and may soon be abandoned. EOR methods are expensive, and undertaking EOR production does not now appear to be economically justified in most cases.

OBJECTIVES AND METHODOLOGY

The former Chairman, Subcommittee on Energy Conservation and Supply, Senate Committee on Energy and Natural Resources, requested that we examine steps the federal government could take to encourage environmentally sound EOR in the OCS in the Gulf of Mexico. However, because of recent changes to subcommittee jurisdiction, we have addressed the report to the Chairman, Senate Committee on Energy and Natural Resources. Pursuant to the request, and as further agreed with the Subcommittee's office, we addressed five specific issues:

--The likelihood that production platforms on sites suitable for potential EOR on federal leases in the OCS of the Gulf of Mexico would be abandoned by the year 2000.

--The impact of platform abandonment on potential production until the year 2000.

--Whether the federal government could provide financial incentives for EOR that would improve production.

--The associated impact of incentives on government revenue.

--The environmental implications of increased offshore EOR.

To analyze these issues, we obtained data from a study entitled Enhanced Oil Recovery in the Gulf of Mexico (DOE/ET/14010-1, Jan. 1983) prepared for the Department of Energy (DOE) by the consulting firm Lewin and Associates, Inc. We used these data because government and industry officials said that they were the most up-to-date, detailed information available on both platform abandonment and EOR production in the Gulf of Mexico. We adjusted crude oil price data downward to reflect more recent projections and derive new platform abandonment and EOR production estimates, extrapolated these results to the entire OCS in the Gulf, evaluated the influence of federal incentives on production, and estimated the potential federal government revenue from EOR production with and without incentives.

The Lewin study focused on reservoirs on federal OCS leases in the Gulf and contained detailed data on a sample of 176 reservoirs. The sample reservoirs originally contained 3.28 billion barrels, or about 20 percent of the oil discovered in the federally owned portion of the Gulf. About 51 percent of the oil in sampled reservoirs was projected by Lewin to be recovered by conventional methods, leaving 1.6 billion barrels as a potential target for EOR.

The study estimated oil production and reservoir conditions using conventional recovery for the 176 reservoirs. Conventional oil recovery continued until it was projected to be no longer profitable, at which point these individual reservoirs would either be abandoned or become targets for EOR. When all reservoirs being produced by a platform were abandoned, the platform was also projected to be abandoned.

Technical analysis for each reservoir was then made under conservative, base, and advanced technology assumptions to determine the amount of oil recoverable with EOR. Base technology represents the Lewin study's "best guess" because it most closely reflects current EOR technology expectations. The other two cases represent either more conservative or optimistic assumptions about technology and for the availability of more effective and less expensive means. This analysis found that between 240 million and 300 million barrels (15 to 19 percent of the 1.6 billion barrels) remaining after conventional recovery in sample reservoirs could be produced depending on EOR technology. Carbon dioxide flooding[2] is considered by industry to be the most likely technology choice for offshore EOR. This is because the economic feasibility and technical application of EOR methods favor carbon dioxide as having the greatest growth potential for offshore EOR in the Gulf of Mexico.

DOE noted in its comments that the state of knowledge about EOR and offshore recovery costs may have changed since the Lewin study. However, only a limited number of new EOR projects have been initiated in the Gulf of Mexico over the last few years. Given this limited experience to date offshore, it is too early to determine if the state of knowledge has changed sufficiently to improve the economic feasibility of EOR. Several large-scale carbon dioxide projects are underway onshore, however, and the experienced gained should improve the understanding of this EOR method.

Offshore recovery cost has declined over the past couple of years as lower prices reduced the demand for production-related equipment and drilling services. While declining production costs tend to improve the economic feasibility of EOR projects, declining oil prices reduced revenue to more than offset this cost reduction. Therefore, EOR methods in the Gulf may be somewhat less economically feasible due to declining oil prices.

An economic analysis was made in the study using a discounted cash-flow model to estimate the required oil price needed to initiate a given EOR project. This price was compared with the estimated imported crude oil price in the year the platform was

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[2]Carbon dioxide is an incombustible gas which, under the right conditions, mixes with oil and facilitates its displacement from a reservoir.

projected to be abandoned to determine which EOR projects would be economically feasible. In cases where the oil price was too low for profitable production, the study projected that the platform would be abandoned. The Lewin study found that because many EOR projects were not economically feasible many platforms could be abandoned by the year 2000. This would reduce the potential for EOR production because the cost of replacing the platforms would be prohibitive.

The data generated in the Lewin study from the sample of reservoirs was reviewed by the Department of the Interior, which did its own technical analysis of selected reservoirs. Interior's review analyzed a subset of the data and confirmed the overall study results. Further, industry officials believed that the basis for the Lewin analysis was sound.

Adjustments to the Lewin study

We adjusted the Lewin study's assumption of imported crude oil prices downward to reflect changed market conditions and more recent estimates made by Data Resources Incorporated.[3] Reducing this price projection led to new results for projected platform abandonment and production. We then used the revised production projections to estimate government revenue collected through royalties.[4] Because offshore royalty rates generally constitute 16 2/3 percent of each barrel of oil produced, we used about $5 (per $30 barrel of oil) as the revenue collected by the federal government. These calculations establish a reasonable projection of platform abandonment, oil production, and federal government revenue over the next 10 to 15 years, given no changes in federal government policy.

In agency comments, both DOE and Interior noted that recently declining oil prices may further influence the economic feasibility of EOR methods. Overall, if oil prices continue downward or remain low, fewer EOR projects will be initiated. In effect, this will also make incentives such as royalty reductions less

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[3]Data Resources Incorporated is an econometric modelling firm with up-to-date energy data and projections.

[4]Although oil companies pay windfall profit and corporate income taxes, we calculated only royalty revenue. No windfall profit tax on oil from enhanced methods is expected to be collected after about mid-1986. In effect, inflation adjustments to the base price of enhanced oil, stipulated by legislation, are projected to increase its price to the current selling price of oil. Consequently there will be no "windfall profit" to tax (i.e., the difference between the selling price of oil and the adjusted base price). In the case of corporate income taxes, if companies did not undertake EOR projects, they could make alternative investments with comparable tax implications for the federal government.

effective because fewer projects would become economically feasible with the same royalty reduction. Regardless of oil prices, however, royalty reductions on a project-by-project basis can still be used to improve the economic feasibility of potential EOR projects.

These results for EOR production and federal government revenue were extrapolated from the sample reservoirs to the entire OCS in the Gulf to provide an overall view of potential EOR in this area. This extrapolation is inherently less certain than results derived from analysis of sample reservoirs and provides an upper-bound estimate of EOR potential. We based this extrapolation on a ratio between projected production in the sample reservoirs and the Minerals Management Service's (MMS) production estimates of actual oil-in-place in these reservoirs. This ratio was then applied to other known reservoirs in the OCS in the Gulf that were not studied in detail to estimate the total production potential for EOR.

Evaluating the impact of federal incentives on platform abandonment and production

After evaluating platform abandonment and its impact on production and associated federal revenue under current conditions in the Gulf, we considered the effect that federal financial incentives of $1 to $5 per barrel would have on platform abandonment, production, and associated federal government revenues. Platform abandonment and production were estimated in the same way as earlier estimates. Federal government revenue was re-estimated differently; net revenue for each incentive considered the cost of the incentive.

How an incentive could be provided

We examined ways the federal government might make financial incentives available. We decided to focus on royalty reductions after considering programs and laws currently in effect. MMS already has authority to reduce royalties. We considered whether royalty reductions on a project-by-project basis could provide sufficient incentive to increase EOR production and federal government revenue and whether it was administratively feasible. However, because there was no way to determine how many EOR projects would be initiated on a project-by-project basis, we do not estimate the revenue associated with this program.

Industry and government views

In addition to performing quantitative analysis and a review of royalty reductions, we discussed our results with senior industry and government officials and with technical experts. We sought their views on platform abandonment, EOR production, and asked about their plans to develop reservoirs with these methods. These

discussions helped us verify estimates of platform abandonment and ensure that we did not overlook practical factors which could change our results.

Environmental issue evaluation

We evaluated possible environmental implications of increased EOR. To do this, we reviewed environmental studies of the Gulf by the Office of Technology Assessment, the Department of Energy, and the National Petroleum Council. We also interviewed knowledgeable officials at the Environmental Protection Agency (EPA), oil companies, and the Louisiana Department of Natural Resources and held discussions with a consulting environmentalist known for his expertise in EOR and with various environmental groups.

We conducted our review in accordance with generally accepted government auditing standards. Our review took place between September 1983 and February 1984.

CHAPTER 2

EOR IN THE GULF OF MEXICO: PLATFORM ABANDONMENT, PRODUCTION, AND FEDERAL GOVERNMENT REVENUE

About 8 billion barrels of oil under the Gulf of Mexico will remain unrecovered by conventional techniques unless technology and current oil prices change. EOR could recover about 970 MMB to 1.2 billion barrels of this oil, but it is expensive to implement. At issue is the amount of oil that might be recovered with EOR as a result of changes in royalty policies. To place the resource in perspective, potential EOR oil in the Gulf of Mexico is equivalent to about 10 percent of the recoverable oil from Prudhoe Bay, Alaska.

The amount of oil that is estimated to be economically recoverable by EOR methods ranges from about 55 MMB to 455 MMB, depending on technology and oil price assumptions. These estimates would still leave about 745 MMB to 915 MMB of technically recoverable oil unrecovered.[1]

Initiating EOR in a timely fashion, as a means of producing as much of the technically recoverable oil as possible, is becoming critical because postponing offshore EOR until it becomes economically feasible is usually not possible. Federal regulation requires that oil production platforms be removed within 1 year after production ceases. High platform replacement costs, combined with high operating costs, practically ensures that the amount of remaining oil recoverable by EOR will not justify a replacement platform and the redrilling of wells. As a result, timing is important because for offshore EOR to be used, the original platform must be in place.

The objective of this chapter is to analyze the likely rate of platform abandonment in the OCS in the Gulf and its impact on EOR production and related federal government revenue. On the basis of our analysis, if current leasing practices in the OCS in the Gulf and oil prices remain within the expected range, a substantial percentage of the platforms on possible EOR sites could be abandoned by the year 2000.

NO CHANGE IN POLICY RESULTS IN HIGH PLATFORM ABANDONMENT, REDUCED OIL PRODUCTION, AND POSSIBLY LOST FEDERAL REVENUE

Platform abandonment, EOR production, and federal government revenue are discussed below. These projections represent what could occur in the OCS in the Gulf of Mexico if no incentives are given to influence the economic feasibility of EOR. Our results

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[1]These figures are derived as follows: 1.2 billion barrels less 455 MMB equals 745 MMB, and 970 MMB less 55 MMB equals 915 MMB.

are derived from the analysis of two oil price paths (moderate and high)[2] as well as for conservative, base, and advanced EOR technology.

Platform abandonment

Under base technology and moderate oil price assumptions --our best estimate--about 52 percent of the platforms on the sample reservoirs would be abandoned by 1991. This rate of abandonment did not change when we considered higher oil price assumptions or improved technology. By the year 2000, platform abandonment, under moderate oil prices, could range from 70 to 75 percent, depending on the recovery technologies used.

Table 1 summarizes and compares our findings under various technology cases, for the sample reservoirs, using the two oil price assumptions.

Table 1

Platform Abandonment for Sample Reservoirs in the Federal Gulf of Mexico by Technology Case

	Abandonment under moderate oil prices			Abandonment under high oil prices		
	Conservative[a] technology	Base[b] technology	Advanced[c] technology	Conservative technology	Base technology	Advanced technology
	(percent)			(percent)		
1981-1991	52	52	52	52	52	52
1992-2000	23	21	18	19	18	7
Total	75	73	70	71	70	59

[a]Assumes injectants used for EOR will move more slowly than under base technology.

[b]Assumes current industry thinking from ongoing field tests and production.

[c]Assumes an optimistic view of current technology and that the injectants will move faster than under base technology while costing less.

Source: GAO

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[2]"Moderate" oil prices (in 1981 dollars) start with $37.05 in 1981, decline to $24.88 by 1985, then rise to $38.56 by 2000.

"High" oil prices (in 1981 dollars) start with $37.05 in 1981, decline to $26.66 by 1984, then rise to $47.67 by 2000.

With higher oil prices, platform abandonment is estimated to be somewhat lower by 2000. Increasing oil prices raise companies' revenues, making the use of EOR techniques economically more feasible and prolonging production. As a result, fewer platforms are abandoned by the year 2000. Advanced technology and high oil prices together reduce platform abandonment considerably when compared to the conservative technology combined with moderate oil prices.

Extrapolating our results on platform abandonment to other potential EOR targets in the Gulf is difficult because of limited data on these platforms. No study has been made evaluating the economic life of all platforms in the OCS in the Gulf because individual company data would be necessary. However, on the basis of the best available information, we assumed that the abandonment rates for the sample reservoirs are representative of those in the Gulf as a whole.

EOR production

Between now and 2000, our analysis shows that the estimated amount of technically recoverable EOR oil from the sample reservoirs, regardless of economics, ranges from about 240 to 300 cumulative MMB. When extrapolated to the OCS in the Gulf, the estimate increases to between 970 MMB and 1.2 billion barrels of cumulative oil production.

Under our moderate oil price estimates, we found that cumulative EOR production could range from about 15 MMB to 35 MMB. With higher oil price assumptions, cumulative production could increase significantly from 35 MMB to 110 MMB. However, in order for EOR production to reach 110 MMB, advanced EOR technology would have to be developed.

Table 2 shows the influence of higher prices and technology on EOR production. We found that cumulative production increases from 15 MMB for moderate-priced oil with conservative technology to 110 MMB for high-priced oil with advanced technology. When extrapolating these results to all Gulf reservoirs, the estimates increase from 55 MMB to 455 MMB. Overall, advanced technology and/or high oil prices yield substantially more oil.

Table 2

Estimated Production From Reservoirs in the Gulf of Mexico by Technology Case
(all numbers rounded)

	Moderate-priced oil			High-priced oil		
	Conservative technology	Base technology	Advanced technology	Conservative technology	Base technology	Advanced technology
	(MMB)			(MMB)		
Oil estimated technically recoverable						
Sample reservoirs	240	240	300	240	240	300
Entire Gulf reservoirs	970	970	1,220	970	970	1,220
Oil estimated economically recoverable						
Sample reservoirs	15	25	35	35	40	110
Entire Gulf reservoirs	55	100	145	145	165	455

Base technology and moderate oil prices, or our best estimate, most closely represent current conditions. Under these assumptions, about 100 MMB of the 970 MMB of technically recoverable oil will likely be produced in the OCS in the Gulf. In other words, if the economic feasibility of EOR in the Gulf continues unchanged, approximately 870 MMB of potential cumulative oil production will remain unrecovered.

Federal revenue

The federal government collects revenue from oil production in the OCS through royalties and taxes. If offshore oil platforms that could be used to produce oil using EOR are abandoned, the government stands to give up future revenue on this unrecovered oil.

Without a change in policy, our analysis shows that the potential federal government revenues from the sample reservoirs could range from about $70 million to $180 million under our moderate oil price assumptions, depending on technology. Under base technology, or our best estimate, revenue will be about $120 million. When these results are extrapolated to other known reservoirs in the OCS in the Gulf, estimated federal revenue could range from about $285 million to $735 million ($490 million under base technology assumptions). However, if oil prices rise to meet our high price and advanced technology assumptions, total federal government revenue could increase to as much as $2.3 billion.

In summary if conditions in the OCS in the Gulf remain unchanged, only about 100 MMB or about 10 percent of the technically recoverable oil by EOR will be produced, leaving almost 870 MMB of potential production behind. The main reason for this loss is EOR project economics. That is, few EOR projects can produce oil for less than the current selling price. Therefore, if EOR project costs and oil prices remain unchanged, it appears that a substantial number of platforms will be abandoned and large amounts of potential production and associated federal government revenues would be lost.

ACROSS-THE-BOARD INCENTIVES WOULD SUBSTANTIALLY INCREASE PRODUCTION BUT WOULD REDUCE FEDERAL REVENUE IN ALL BUT A FEW INSTANCES

Federal incentives could be used to encourage EOR production in the sample reservoirs and in the OCS in the Gulf as a whole. We evaluated the effect of incentives ranging from $1 to $5 per barrel to determine if they would increase oil recovery without reducing federal government revenue. By providing incentives, the federal government could stimulate some companies to initiate EOR that would not otherwise have done so. On the basis of our analysis, incentives ranging from $1 to $4 per barrel increased cumulative production most--from about 55 MMB to 725 MMB of oil. However, by providing an incentive for all EOR projects, the federal government stands to lose revenue in all but a few, relatively unlikely cases. This is due primarily because the government would lose royalty revenue on that oil (55 MMB to 455 MMB as shown in table 2) which could be economically recoverable using EOR.

Platform abandonment

According to our analysis, incentives combined with high oil prices and/or advanced technology are likely to reduce platform abandonment the most. Using high oil price assumptions, we found that all incentives of $1 or more reduce platform abandonment; a $4 incentive for instance could reduce platform abandonment from 13 to 44 percent, depending on the technology. With this incentive, and assuming the most realistic or base technology, we estimate that about 54 to 64 percent of the platforms will be abandoned by the year 2000. This estimate compares with our earlier platform abandonment estimate of 70 to 73 percent by 2000, if EOR project economics remain unchanged.

Under moderate oil price assumptions, we found that incentives of less than $4 have only a small effect on platform abandonment. A $4 incentive, however, could improve platform availability by 9 to 37 percent, depending on technology. Under high or moderate oil price assumptions, increasing the incentive to $5 per barrel added little to platform availability. In fact, even under high oil prices and advanced technology assumptions, we found that

total platform abandonment was only reduced slightly when increasing the incentive from $4 to $5. Table 3 shows the affect of various incentives on platform abandonment, under moderate and high oil prices, and compares them to our best guess, or current project economics.

Table 3
Percentage of Platforms Abandoned on Sample Reservoirs
(Base technology with moderate and high oil prices)

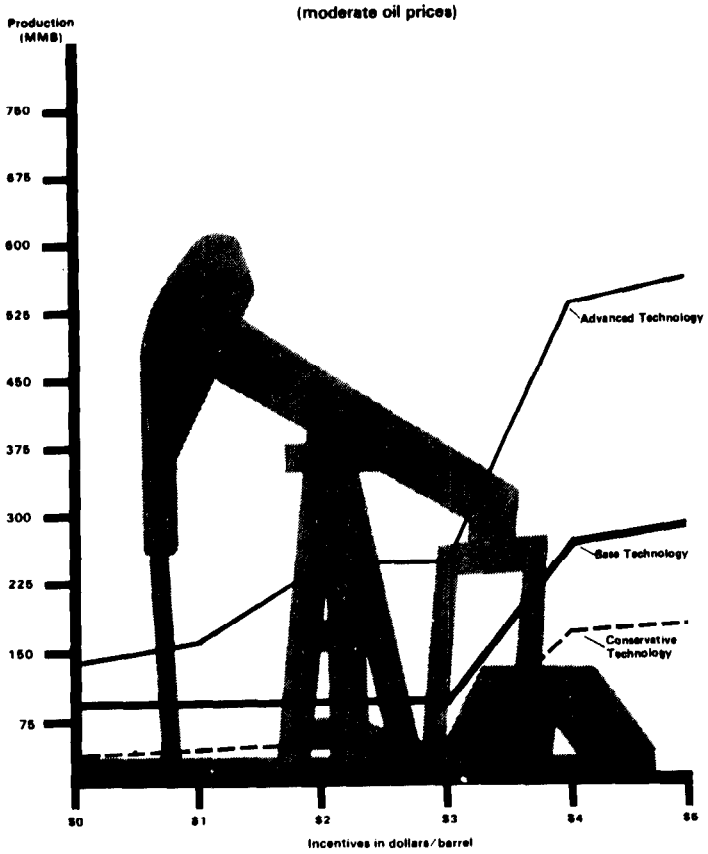
	Estimated abandonment with current project economics	GAO established incentives									
	(percent)	$1		$2		$3		$4		$5	
		High-priced oil	Low-priced oil	High-priced oil	Low-priced oil	High-priced oil	Low-priced oil	High-priced oil	Low-priced oil	High-priced oil	Low-priced oil
		(percent)									
Year 2000	70-73	66	73	63	73	58	73	54	64	54	63

SOURCE: GAO

EOR production

Using moderate oil price assumptions, we found no significant changes in production as a result of a $1-per-barrel incentive. Incentives of $2 to $3 per barrel had varying affects on production estimates, depending on the technology. However, the largest production response across all technology assumptions (per dollar of incentive) occurred at $4 per barrel. This incentive increased our base technology production estimate from the sample reservoirs from about 25 MMB to more than 65 MMB under moderate oil prices. When these base technology results are extrapolated to the entire Gulf, a $4 incentive increased production from about 100 MMB to 275 MMB as shown in figure 2. A larger incentive of $5 leads to a modest increase in production, but reduces the effectiveness of the incentive on a dollar-per-barrel basis.

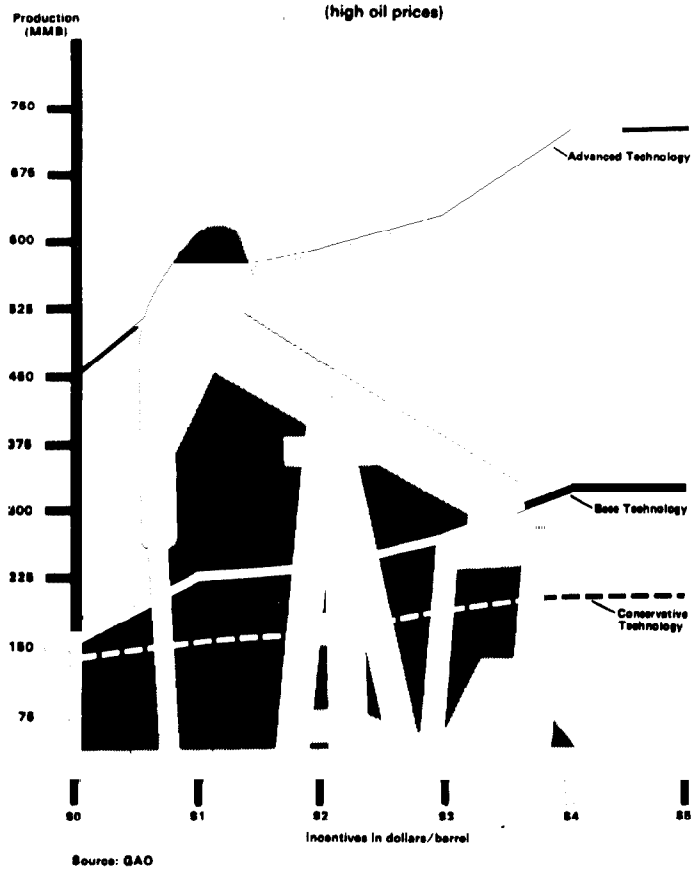
Figure 2
Production Response Per Dollar
of
Incentive
(moderate oil prices)



Source: GAO

Using high oil price assumptions, our analysis showed that in all but one case, each additional dollar of incentive increased production regardless of technology. No single incentive increased EOR production most, per dollar of incentive, for all technologies. Nonetheless, a $4 incentive increased production in our sample reservoirs (under base technology assumptions) from 40 MMB with no incentives to almost 85 MMB. Extrapolating these results to the entire OCS in the Gulf increased the cumulative EOR production estimates with no incentives from around 165 MMB to 340 MMB. A $5 incentive gave almost an identical production estimate as a $4 incentive and therefore was less effective on a per-dollar basis. Incentives under high oil prices increased production as shown in figure 3.

Figure 3
Production Response Per Dollar of Incentive (high oil prices)



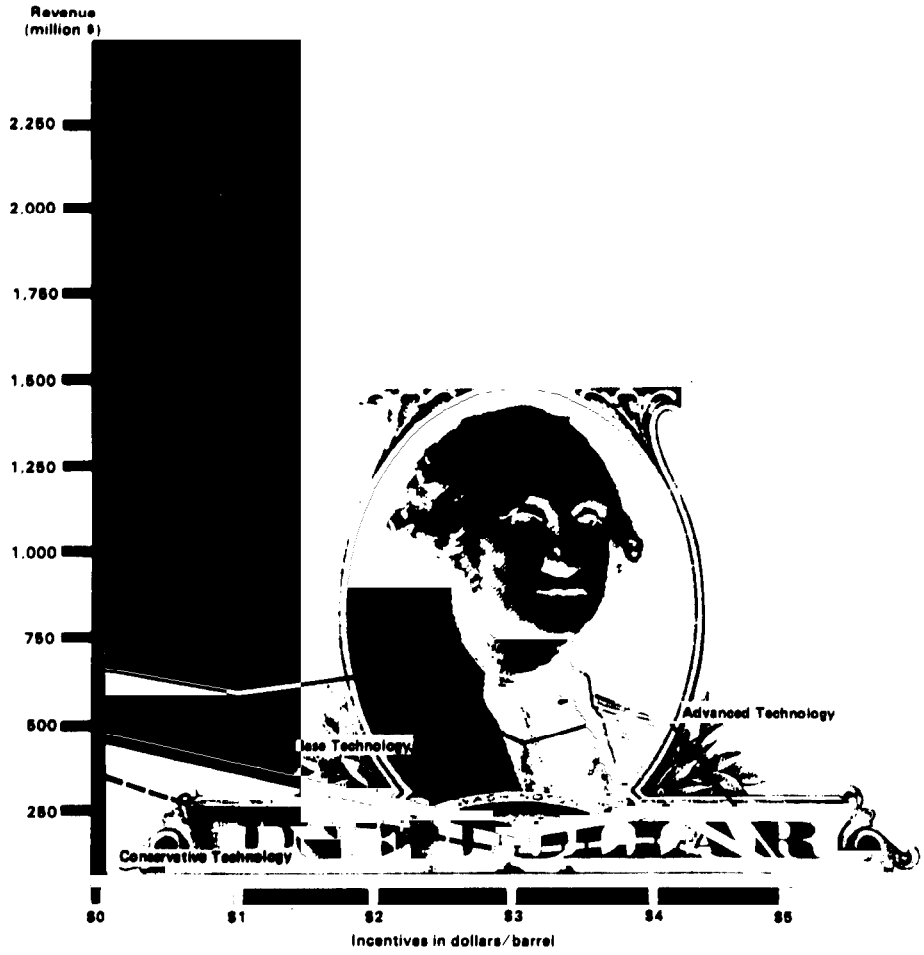
Source: GAO

Federal revenue

In estimating the revenue collected with an incentive, we subtracted the incentive's cost. In cases where additional revenue exceeds the estimated federal government revenue with no incentive, a net positive revenue is generated. Our analysis indicated that in only a few relatively unlikely cases did an across-the-board incentive for EOR make financial sense to the federal government. This occurred because some oil companies would have initiated EOR with or without an incentive; the federal government would therefore stand to lose $1 to $5 for each barrel produced by these projects. Consequently, some companies that would have started EOR anyway would pay less in royalties than otherwise.

In only three instances involving incentives is government revenue maintained or improved. With moderate oil price/advanced technology assumptions, for example, we found that a $2-per-barrel incentive produced federal revenue effects comparable to the $735 million estimated with no incentive. (See fig. 4.) Generally, however, our analysis shows that the federal government could lose more by the incentive than it gains in royalties on the increased production.

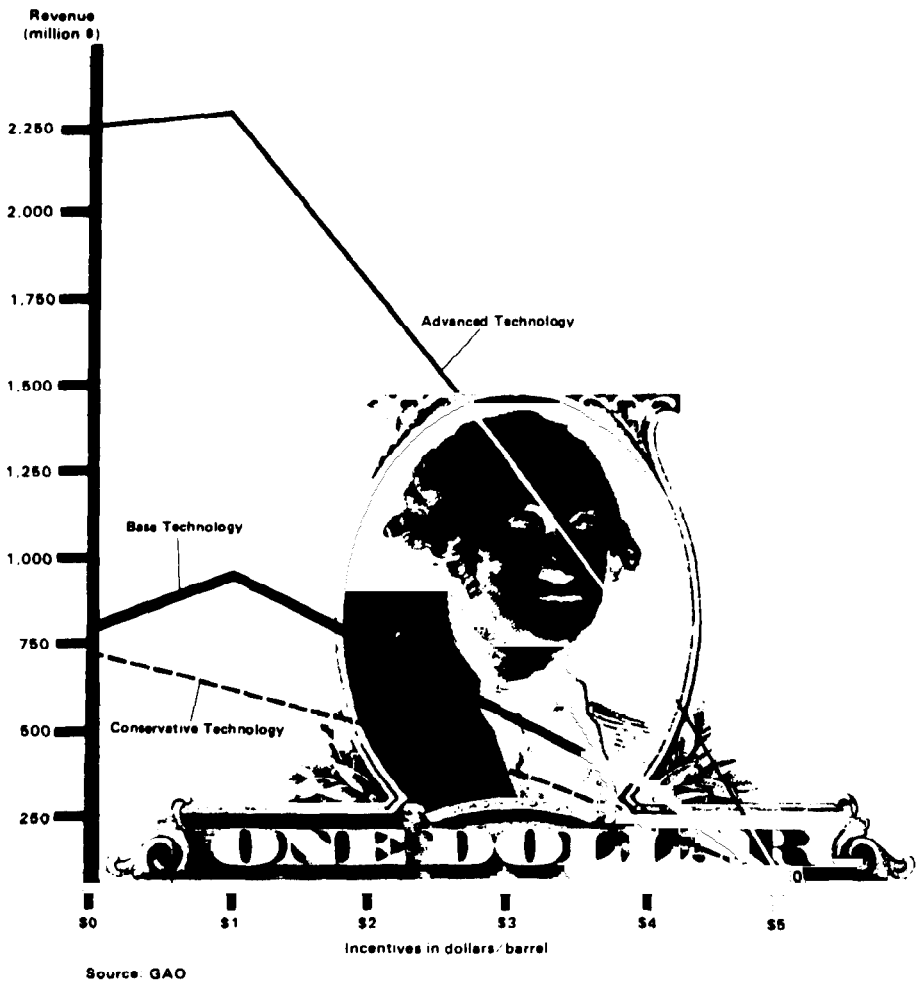
Figure 4
Affect Of Incentives On Government Revenue
(moderate oil prices)



Source: GAO

We found two other instances, both using high oil price assumptions, in which a $1-per-barrel incentive increased government revenues. Using the base technology assumption, a $1 price incentive increased estimated federal government revenue by $95 million--from $820 million to over $915 million--when extrapolated to the entire OCS in the Gulf. Likewise, a $1 price incentive/ advanced technology assumption increased estimated federal government revenue, but the change was small. As shown in figure 5, incentives of $2 or more per barrel reduce government revenue.

Figure 5
Affect Of Incentives On Government
Revenue
(high oil prices)



Source: GAO

CHAPTER 3

APPLYING FINANCIAL INCENTIVES TO EOR

This chapter discusses previous government attempts to encourage EOR and examines royalty reduction as a potential means to provide incentives. We analyzed royalty reductions only because they (1) have the potential to provide a sufficient incentive to increase production, (2) appear to be administratively feasible for implementation on a project-by-project basis, and (3) are currently authorized.

Other means do not appear to have these characteristics. For example, providing incentives through federal income tax deductions or credits would require changes to existing tax laws. Furthermore, focusing income tax on EOR in a way that could be effectively managed might be difficult. Similarly, reducing or eliminating windfall profit taxes[1] might be considered as an incentive because these taxes are currently in place and are applied on a project-by-project basis. However, because of the design of the law and projected stable oil prices, it appears that little or no windfall profit tax will be paid on EOR production after about mid-1986. Therefore, further reductions provide no additional incentive for companies to undertake offshore projects. However, if oil prices increase substantially over the next several years, thereby increasing the profit on which this tax is imposed, adjustments might make this a more viable option.

PREVIOUS EOR INCENTIVES HAVE MET WITH MIXED SUCCESS

After the oil embargo of 1973, the federal government started a program to develop technology to improve EOR after conventional production. This program attempted to promote more rapid technical and commercial advances in EOR techniques through, among other things, federal/industry cost-shared pilot tests. These tests, through field demonstrations, were designed to verify laboratory findings regarding the use of EOR methods. About 25 field demonstrations were initiated at a total cost of about $250 million; the government paid one-third of this amount. Because of budgetary constraints the cost-sharing incentives approach was terminated before a program evaluation was made.

The Energy Conservation and Production Act (Public Law 94-385), passed in 1976, authorized price incentives for EOR and specific high-cost technologies that would be uneconomic without

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[1]The Crude Oil Windfall Profit Tax Act of 1980 established a temporary excise tax (windfall profit tax) on domestically produced crude oil in conjunction with the decontrol of crude oil prices.

these incentives. Furthermore, the act provided for the adjustment of crude oil prices to encourage increased domestic production through EOR.

To meet the act's requirements, DOE's Economic Regulatory Administration (ERA) established the Tertiary Incremental Program on September 1, 1978. In this program, producers were required to prove that an EOR project would be uneconomic under oil price regulation. The most problematic aspect of this program, however, was that producers had to specify how much EOR production they expected to recover before the initiation of the project. Furthermore, producers were bound by their estimates of production and the likely date this production would begin. According to industry representatives, these inflexible and restrictive program requirements generated little interest. Between September 1, 1978, and August 21, 1979, ERA approved only six projects under the incremental plan.

Because of the limited response to the incremental program, and as a result of further public comment, DOE added the incentive or "front end" program on August 21, 1979. This program encouraged producers to undertake high-cost, high-risk technologies such as those used in EOR by allowing them to recoup, "up front," 75 percent of certain allowed expenses, up to $20 million per property. Producers could recoup their investments by selling certain oil at the market-level price instead of the controlled price. The goal was to increase domestic crude oil production and reserves.

To qualify a project for the tertiary incentive program, a producer submitted a "self-certification" report to DOE which contained detailed information demonstrating that the project satisfied the program's regulatory requirement. DOE regulations listed 10 EOR processes that were eligible for the program. "Allowed costs" for each type of EOR process were described and designed to permit recoupment of cost for EOR processes involving a high degree of risk. The greater the risk, the more costs a company could recoup.

The program was successful in initiating new projects: from August 21, 1979, through termination of the program in March 1981, DOE certified 423 projects. These pilot projects ranged from small tests costing a few hundred thousand dollars to large pilots on fieldwide projects with total investment obligations of several hundred million dollars.

Industry officials said that many of these projects, almost exclusively onshore, would have been delayed several years or never attempted without the tertiary incentives program. Although the DOE incentive program initiated many new projects, in our 1981 report, The Tertiary Incentive Program Was Poorly Designed and Administered, (EMD-81-147), we found that DOE had no way to tell if the $846 million in allowable expenses could be recovered. The program was terminated on March 31, 1981, after oil prices were decontrolled.

Overall, previous federal government incentives for encouraging EOR have met with mixed success. Some incentives were overly restrictive, requiring that industry be bound by estimates of uncertain EOR production. Other programs, such as the DOE Tertiary Incentive Program, were too broadly defined. Restrictive incentives stimulated little industry activity; more broadly defined ones increased the number of projects started but provided no way to determine if government costs were recovered.

TIMELY REDUCTION OF OCS ROYALTIES ON A PROJECT-BY-PROJECT BASIS COULD INCREASE EOR PRODUCTION AND FEDERAL GOVERNMENT REVENUE

Royalty reduction on a project-by-project basis could be attractive because it is already authorized by federal law and regulation and could provide increased federal government revenue while increasing EOR production. This procedure would be administratively possible if MMS clarified how and when royalty regulations could be applied to EOR offshore.

The Secretary of the Interior, acting through the Director, MMS, is authorized by 43 U.S.C. 1337 to adjust royalties to promote increased production. MMS has issued regulations to implement this provision. The regulation states:

> "In order to promote increased production in the lease area through direct, secondary, or tertiary recovery means, the Director may reduce or eliminate any royalty or net profit share on the entire leasehold, or on any deposit, tract, or portion thereof that is segregated for royalty purposes." (30 C.F.R. 203.150.)

An incentive program using royalty reductions on a project-by-project basis is practical

Although we found that the government stands to lose revenue if it provides incentives for all companies across-the-board, royalty reductions used as an incentive might be structured to increase, not decrease, federal government revenue. For example, MMS could use its existing authority to allow royalty reductions on the incremental oil[2] produced from EOR projects that would not have been economically feasible without this incentive. Although royalties are reduced, revenues are actually increased because the incremental oil would not have been produced otherwise. The amount and timing of the reduction can be determined for individual EOR projects.

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[2]Incremental oil is that amount above what would have been produced with conventional production had it continued until the economic limit of the field was reached.

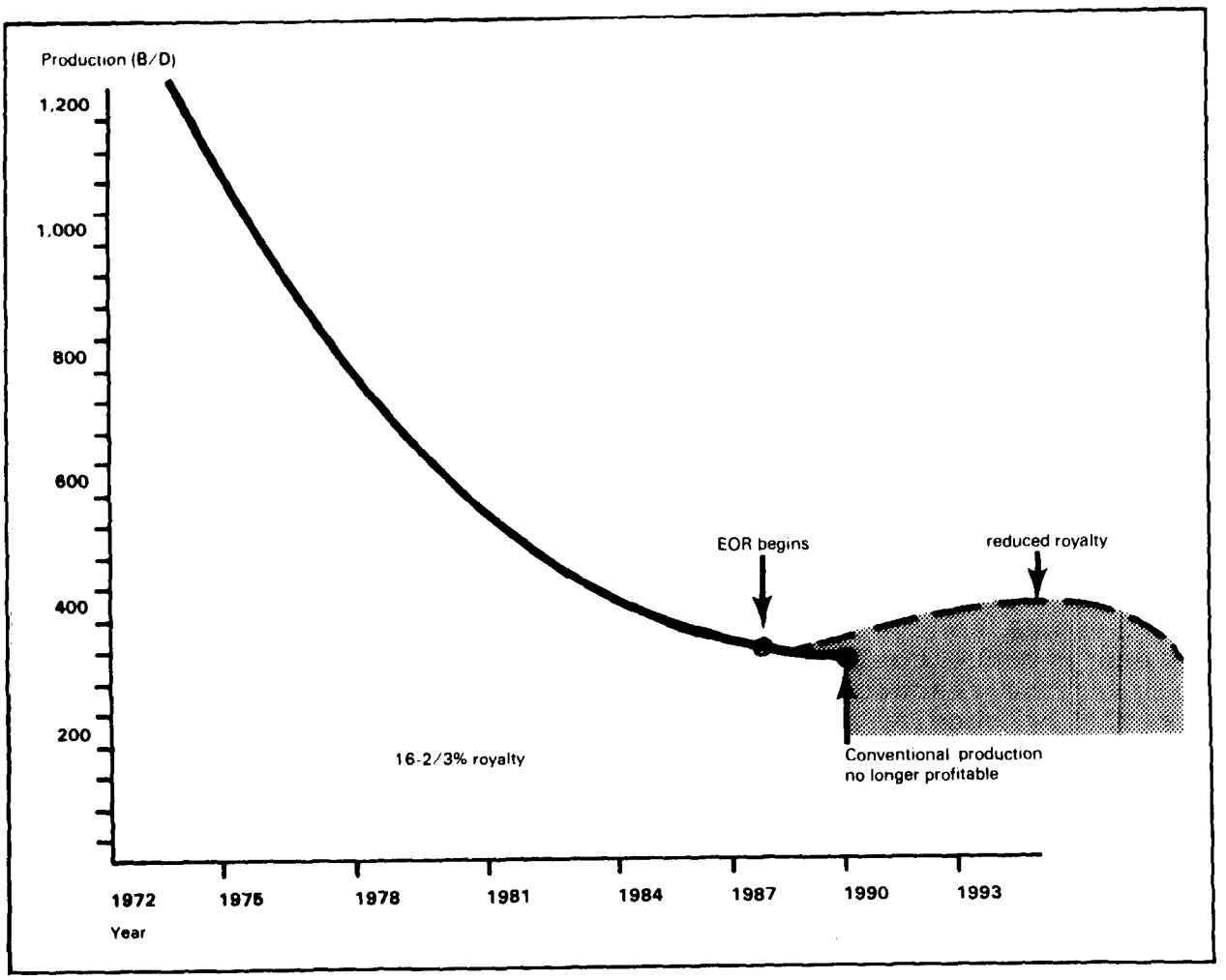
We solicited views from senior MMS executives and oil industry representatives to determine if such a proposal is administratively feasible. According to these officials, agreement would have to be reached between MMS and the industry on the amount of anticipated EOR production and the appropriate size of the royalty reduction. They said that the oil remaining in a reservoir which is expected to be produced by conventional methods can be identified within the last few years of the reservoir's useful life. This expected production can be agreed upon because reservoirs in the OCS in the Gulf have a long, well-documented production history known to both industry and the federal government. Therefore, any oil production above this would be attributed to EOR and eligible for a royalty reduction.

In addition, these officials believe enough information is available that agreement could also be reached on the economic feasibility of EOR projects, including profit, because EOR costs can be estimated and agreed upon. Since both the remaining conventional production and project cost are known or can be accurately estimated, the size of the royalty reduction can be agreed upon. On the basis of this information, we believe that reduced royalties could be applied only to the incremental oil from EOR and limited to projects for which it is economically necessary.

This concept is shown in figure 6. The figure represents the production from a typical oil reservoir, with the curve showing the normal decline in barrels of oil produced over time. At the indicated point on the curve, oil production would stop since it would no longer be profitable. The area under this curve, representing expected cumulative conventional production, can be realistically estimated. When EOR begins, the increased production is shown in the shaded area under the new dotted curve. Reduced royalties, applied to this incremental production that would not otherwise have occurred, would increase federal government revenue.

Figure 6

Reduced Royalties on Incremental Oil



Source: GAO

Consideration might be given to eliminating or significantly reducing royalty payments on this additional oil for the first year or so (subject to a preset maximum limit or project cost) to help EOR projects offset high start-up costs. In this situation royalties on conventional production would continue to be collected at the rate set in the lease until the reservoir reaches its projected economic limit through conventional means.

Agreeing on royalty reductions during the last few years before the economic limit of the reservoir is reached would help industry minimize financial and technical problems. Further, by allowing royalty reduction proposals at this time, MMS would have sufficient data to make an evaluation, while providing industry with enough lead-time to effectively implement EOR.

Louisiana has authorized an EOR incentive program

The principle of reducing government revenue on incremental EOR oil to improve production only when project economics dictate has recently been authorized by the state of Louisiana. In Louisiana, severance tax reductions are allowed on a project-by-project basis. Before this is done, however, the amount of EOR oil that can be produced and the project's economics are agreed upon during a process involving state agencies and a public hearing. We spoke with individuals involved in this process to determine if technical and economic issues could be realistically agreed upon and if severance tax reductions could be administratively applied. Although the idea is novel, those involved in the process were confident that agreement can be reached and that their state agencies can administratively apply severance tax reductions on a project-by-project basis.

From an administrative standpoint, reviewing project applications and granting reductions are not anticipated to create significant problems because the initial number of applications is expected to be small. By using a project-by-project approach, similar to that of Louisiana, MMS could provide an effective economic incentive to producers to invest in EOR projects and increase OCS domestic production. At the same time, federal government revenue could also be increased. Although we have not analyzed the resources needed to carryout such a program, it could probably be handled through ongoing MMS operations.

OUR PREVIOUS VIEWS ON SELECTIVE ADJUSTMENTS TO ROYALTIES

The idea of selectively using different royalty rates to maximize oil production and/or government revenue is an area that we have previously addressed. In our 1982 report, Interior Should Continue Use of Higher Rates for Offshore Oil and Gas Leases (RCED-83-30), we found that the Interior has selectively used higher royalty rates for areas estimated to have high resource levels and low development costs. The report concluded that:

> "An across-the-board increase in the offshore royalty rate may not be appropriate at this time, but continued use of higher royalty rates, in selective instances, based on resource potential estimates and experience with industry responses, would seem desirable."

The principle of selectively using different royalty rates, depending on the amount of oil and its development costs, is consistent with the views in this report, that is, reducing royalties where the amount of remaining oil is small and development costs are high.

CURRENT USE AND PERCEPTIONS OF ROYALTY REDUCTIONS THROUGH MMS

Although MMS is authorized to reduce royalties, this procedure has not been used. To date no offshore royalty reductions have been granted. In fact, only one formal application to reduce royalties has been submitted, and that petition was denied. We therefore examined reasons why the oil industry has not sought royalty reductions as a means to improve EOR project economics.

Why royalty reductions have not been used for EOR

MMS' Gulf of Mexico Regional Manager told us that oil companies can apply for reduced royalties when they undertake new processes or add to existing ones. However, our review of the royalty reduction regulation revealed no specific guidance describing how or when MMS will reduce royalties for oil companies to offset increased costs from expensive offshore production methods such as EOR. MMS' Deputy Associate Director for Operations and the Gulf of Mexico Deputy Regional Manager confirmed that no written guidelines are available for oil companies to determine whether they might qualify for such a reduction offshore.

Oil industry's response to royalty reductions

We asked oil industry representatives why there had been no applications for reduced royalties in the Gulf. Although responses varied, most centered on how industry officials perceived MMS would apply the royalty reduction regulation to an EOR project.[3] Oil representatives were doubtful that MMS would reduce royalties on the basis of an individual EOR project if other oil production on the lease was still profitable. Oil companies view MMS determinations of reduced royalties as being based on the economic need of the entire lease at the end of conventional recovery.

If the company waits until the entire lease is no longer profitable, however, individual EOR project economics could change considerably, and physical constraints could reduce the amount of recoverable EOR oil. An oil reservoir being considered for EOR when nearing the end of its profitable conventional production, for example, may not necessarily coincide with the economics of the entire lease area. Thus, it is important that the economic feasibility of an EOR project be evaluated individually (on a project-by-project basis) rather than against the entire lease. Physical reservoir conditions may also make EOR projects less attractive if production has ceased and oil is no longer moving freely. Overall, oil company officials believed that consideration of royalty reductions based on an entire lease is unlikely to lead to significantly increased activity.

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[3]An EOR project is usually one or more platforms producing oil on an individual reservoir or a small group of reservoirs with similar characteristics.

Additional clarification of the MMS position seems warranted, given the uncertainty surrounding the use of royalty reductions. Although the regulation appears to be aimed at improving resource recovery, it has not proved useful in practice. We believe that royalty reduction, if clarified so as to be applied by MMS on a project-by-project basis, could provide a means for the federal government to stimulate EOR in the OCS in the Gulf prior to the end of conventional production and platform removal. Used in this way, royalty reductions would improve domestic oil recovery and federal government revenue.

CHAPTER 4

EOR: POSSIBLE ENVIRONMENTAL CONCERNS

A large number of petroleum production platforms are in use in the OCS in the Gulf, and a considerable infrastructure is in place to support petroleum production. Extending the use of this infrastructure for EOR or adding additional equipment may raise questions of environmental concerns over and above those now associated with conventional oil production.

Industry consensus indicates that carbon dioxide has the greatest growth potential for EOR in the OCS in the Gulf of Mexico. This is primarily because of the economic and technical feasibility of this method compared to other methods involving heat or chemicals. While carbon dioxide has yet to be widely used offshore, onshore experience indicates that the environmental risk associated with carbon dioxide EOR should be low. Carbon dioxide is a relatively benign substance, and the consensus of environmental experts and groups indicates that it is not expected to damage the Gulf environment. The prudent use of technology and safety-minded industry operating practices, along with current federal environmental laws and regulations (if they are fully enforced), are expected to be adequate to safeguard against possible adverse environmental impacts.

The amount of EOR is likely to be quite small compared with conventional oil recovery operations already in the Gulf. For example, about 6.5 billion barrels of oil have been produced to date by conventional methods from the Gulf of Mexico. Current conventional production is over 300 MMB per year. In comparison, cumulative EOR production up to the year 2000, on the basis of our analysis, could be about 55 MMB to 725 MMB of oil. This is equivalent to, at the most, 11 percent of total conventional production to date. These differences in scale may diminish the significance of environmental concerns regarding EOR.

EFFECTS OF CARBON DIOXIDE

According to environmental groups and experts with whom we spoke, water quality in the OCS in the Gulf is not expected to deteriorate as a result of using carbon dioxide for EOR. EOR could affect water quality in two ways: by discharging water used during production to help recover the oil and by mishandling carbon dioxide.

Water is normally produced along with the oil during all phases of production, both conventional and EOR. Using carbon dioxide for EOR is not expected to change the nature of this water as it is disposed. The quality and composition of the water associated with production is monitored under existing environmental laws. The overall effect of the discharges into the OCS in the Gulf is minimal and the effects of any additional water generated from EOR are also likely to be small.

Accidental discharge of carbon dioxide into the water as a result of spills or leaks is not expected to create an environmental hazard. Carbon dioxide released deep under water will dissolve. Localized changes in the acidity of the water around the release could occur, but will diminish as the carbon dioxide disperses. If released in shallower water, the carbon dioxide will bubble up to the surface and disperse into the atmosphere.

EXISTING ENVIRONMENTAL LAWS APPLY TO EOR

Potential environmental concerns that might be associated with EOR use in the OCS Gulf are expected to be addressed by existing environmental laws including the National Environmental Policy Act, the Clean Air Act, and the Clean Water Act, which now regulate conventional oil recovery. MMS and EPA have jurisdiction over the federal environmental regulatory programs implemented under these acts. States have no jurisdiction on the OCS beyond 3 miles offshore.

MMS requires oil companies to submit plans for exploration and development in the OCS in the Gulf. Before permits are issued, MMS performs an environmental assessment from data submitted by the company requesting the permit. The environmental assessment includes air and water emissions to determine compliance with the acts. MMS' Regional Supervisor told us that under most circumstances EOR would not pose sufficient concern to warrant an additional environmental impact statement (EIS). However, if the potential for environmental impact is significant, MMS is required under the National Environmental Policy Act to prepare an EIS.

EPA has issued a general discharge permit for water discharged from production into federal waters of the Gulf. Oil companies discharging water in this area are required to provide information on the volume and composition of this water. Companies must monitor this water and submit annual compliance reports to EPA. Although EPA does not physically inspect discharge sites, it coordinates this activity with MMS, which inspects oil production platforms at least annually to monitor compliance.

REGIONAL ENVIRONMENTAL STUDIES DO NOT INDICATE SIGNIFICANT CONCERN

No detailed environmental impact studies on the effect of EOR in the OCS in the Gulf have been performed to date. However, MMS conducts regional environmental impact studies that examine the potential effects of proposed or anticipated petroleum production development in the Gulf. The two most recent environmental studies do not indicate particular concern with EOR implementation

in the OCS in the Gulf. The most recent study, Final Environmental Impact Statement Gulf of Mexico, Proposed OCS Oil and Gas Lease Offerings (1984), states that increased oil production can be accomplished in the area without a significant impact to the natural and human environment. In preparing this statement, MMS evaluated oil production impacts by estimating the maximum potential production of an area, including EOR production.

Bringing large quantities of carbon dioxide to platforms in the OCS may require the construction of additional pipelines. The other study entitled Regional Environmental Assessment, Gulf of Mexico, Pipeline Activities (Aug. 1983) was prepared as an evaluation of pipeline impacts on the environment of the Gulf. The report indicated that pipeline construction, operation, and maintenance on the OCS caused minimal impacts to onshore air quality. It also stated that, although water quality might be adversely affected during pipeline construction, such effects would be localized and of short duration. Finally, although animal and plant life might be adversely affected during pipeline construction, the nonburied pipelines furnish a substrate for encrusting organisms and promotes increased biological diversity.

CHAPTER 5

CONCLUSIONS AND RECOMMENDATION

After conventional oil recovery methods have been exhausted, about 8 billion barrels of oil will remain in identified oil fields in the OCS in the Gulf of Mexico. As much as 1 billion barrels of the remaining oil could potentially be recovered using enhanced oil recovery methods. Failure to produce this oil will result in lower revenues to the federal government and less domestic energy for the nation.

We found that if nothing changes to affect the economic feasibility of EOR projects in the OCS, the number of existing platforms available to service suitable fields for EOR is likely to be substantially reduced. It appears that about 60 to 75 percent of the platforms currently used for conventional recovery in the sample reservoirs could be abandoned and removed by the year 2000 and would thus be unavailable for EOR. Furthermore, if the sampled reservoir abandonment rates are suggestive of the OCS in the Gulf in general, EOR potential for the whole area may also be jeopardized.

If no steps are taken to change the economic feasibility of EOR in this area and the projected number of platforms are removed, cumulative EOR production could range from about 55 MMB to 455 MMB of oil, depending on technology and oil price assumptions. This represents approximately 6 to 37 percent of the 970 million to 1.2 billion barrels of oil which is estimated to be recoverable by EOR.

Providing across-the-board federal incentives would increase EOR production. Incentives of $1 to $4 per barrel would probably be most effective on a dollar-per-barrel basis. Our extrapolated results for incentives in this range show that cumulative oil production could range from 55 MMB to 725 MMB, depending on oil price and technology assumptions. However, by providing these incentives for all EOR initiated in the OCS, the federal government stands to lose revenue in all but a few instances. These few instances are associated primarily with high oil prices and/or advanced technology, neither of which is considered likely.

This result occurs because providing incentives to all companies initiating EOR allows some companies that would have started projects, regardless of the incentives, to pay less in royalties. Therefore, unless incentives can be given on an EOR project-by-project basis rather than across-the-board, the federal government could lose revenue even though production could increase.

Previous federal government incentives to spur EOR have met with mixed success: some were too restrictive, others too broadly defined. While restrictive incentives stimulated little industry interest, more broadly defined incentives stimulated many projects

but provided no way of determining if their cost could be recovered. Project-by-project royalty reduction through MMS, on the other hand, could provide a means to encourage EOR in the OCS in the Gulf without losing federal government revenue. This procedure is currently authorized. It is capable of providing sufficient incentives to improve EOR production and is administratively feasible on a project-by-project basis.

If the use of royalty reductions can be clarified and specific guidelines established, incentives could effectively encourage EOR production. By using incentives selectively on a project-by-project basis for otherwise uneconomic projects, the federal government stands to increase its revenue and improve the domestic recovery of a potentially lost resource. Thus, such an approach could be initiated cost-effectively.

Extending the use of petroleum production platforms in the OCS in the Gulf for EOR may raise questions about its environmental implications. On the basis of limited offshore and more extensive onshore experience to date, expanding EOR production is not expected to introduce major environmental impacts. Existing laws apply to offshore EOR, and their enforcement by MMS and EPA is expected to protect the environment.

RECOMMENDATION

We recommend that the Secretary of the Interior instruct the Director of the Minerals Management Service to initiate action that would allow for royalty reduction on EOR projects in the OCS in the Gulf of Mexico where it would result in both increased production and increased federal government revenue. In doing this, the Director should establish guidelines that

- --facilitate industry preparation of royalty reduction proposals and government's evaluation of these applications;
- --permit timely evaluation of royalty reduction proposals (that is, early enough in the productive life of a well or reservoir to permit industry to implement EOR effectively, but late enough for the government to have sufficient data to evaluate the need for royalty reduction, usually during the last few years of conventional production); and
- --allow royalty reductions on a project-by-project basis while maintaining the existing royalty for the remainder of the lease area.

AGENCY COMMENTS

The Departments of Energy and the Interior commented on a draft of this report; their comments are included in Appendix I. Most of the comments from DOE and Interior addressed the amount of production likely to be associated with EOR and the administrative

process involved with royalty reductions. Other clarifying suggestions, which were offered separately, have been incorporated in the report, where appropriate.

DOE pointed out that we had taken a conservative approach in estimating the recoverable oil using EOR methods. The potential, according to DOE, may well be greater than that calculated by GAO if reservoirs that are known, but currently undeveloped, are included in the area from which our estimates are derived. However, DOE agreed, in general, with the report and noted that maximum recovery of this country's petroleum resources is in the national interest--a goal that can be furthered by GAO's recommendation.

Unlike DOE, Interior noted that our estimates of EOR potential may be optimistic. However, Interior, although citing several concerns, commented that our recommendation is sufficiently important to merit consideration. Furthermore, Interior agreed that its current regulations may need refinement and that it may need to establish clarifying guidelines; these are now under study. Nonetheless, both departments agree that royalty reductions could provide an opportunity to produce oil that might otherwise remain in the ground. Moreover, a royalty reduction program will give industry an opportunity to gain valuable experience in using EOR offshore. Both Departments noted that recently declining oil prices may further influence the economic feasibility of EOR methods. We agree that if oil prices continue downward or remain low, few EOR projects will be initiated. (See pp. 4 and 5.)

Both agencies pointed out, to varying degrees, that the administrative process for a project-by-project review of royalty reductions could encounter considerable problems in connection with agreeing on production costs, production estimates, future oil prices, and the remaining reserves in a reservoir. They also pointed out that such a program would require time, skilled personnel, and access to data.

Although the agencies expressed concern about the availability of information to evaluate project applications for royalty reductions, we found in talking with Interior and Minerals Management Service officials and industry representatives that the necessary information was available and could be agreed upon. Production costs in the Gulf are well known and EOR would tend to use pipelines and equipment similar to conventional production. The cost of carbon dioxide or other injectants for EOR could be reasonably estimated because supplies would probably be purchased from known sources. Further, the remaining oil which is expected to be produced by conventional methods can also be identified, particularly within the last few years of a reservoir's useful life. This expected production can be agreed upon because reservoirs in the OCS in the Gulf have a long, well documented production history known to both industry and the federal government. As for production and future oil price estimates, Interior currently makes similar estimates for its lease offerings and sliding

scale royalty rates. Nonetheless, if fewer EOR projects are initiated as Interior suggests, the administrative requirements to handle a limited number of applications should be small. If EOR potential is greater than our estimates, as DOE suggests, the administrative requirements could be increased, but so would the benefits to industry and government. We continue to believe that the program can be made available now and that experiences gained over time will shed more light on the administrative requirements.

Other agency comments

DOE and Interior, in addition to commenting on production and the administrative process, offered comments on other aspects of the report. For example, DOE suggested the use of a competitive bidding process, similar to that used in offshore leasing, as perhaps an efficient way to provide a royalty reduction incentive to industry. Under this type of program, industry would be invited to bid for the right to receive royalties from a federal lease in return for a lump sum payment to the federal government. This bidding process would be initiated once a company determined that an EOR project could be economically feasible if royalties were reduced. The company winning the bid would then negotiate a royalty reduction with the platform operator/lease owner. DOE noted in its clarifying suggestions that the cost of organizing and administering an auction could be lower than negotiating project-by-project.

We did not assess the use of a competitive bidding process for royalty reductions because we limited our analysis to programs that are currently authorized. Furthermore, while such a process might be another way a royalty reduction incentive could be provided for EOR, there may be problems associated with the exchange of confidential data between companies and with antitrust laws. Nonetheless, we encourage DOE to assess further the potential for using such a program for royalty reductions.

DOE noted that by restricting our recommendation to actions that would result in both increased production and increased federal government revenue we might ignore a broad range of benefits that would accrue to consumers, taxpayers, and the United States through increased taxes, economic activity and decreased dependence on oil imports. We acknowledge that there may be additional benefits associated with EOR oil other than additional production and royalty revenue. (We assume corporate income taxes will remain roughly the same (see p. 4).) We did not attempt to quantify these potential, additional benefits. Since these projects would not have been undertaken otherwise, if additional benefits such as those suggested by DOE are to be considered in approving royalty reductions that do not meet the criteria in our recommendation, a convincing case should be made that these benefits outweigh the costs.

According to the Interior, our report indicates that

> ". . . approximately 1.0 billion barrels of oil are technically recoverable with EOR techniques. The report also states that a substantial portion of this oil can be recovered through the implementation of the measures recommended by the GAO. These estimates reflect the most optimistic assumptions with regard to technical recoverability and costs."

We do not specifically estimate how much oil will be recovered with the use of royalty reductions because negotiations between industry and government would be necessary. Additionally, Interior's comment does not recognize the fact that our analysis provides a range of possible oil recovery depending on oil prices and technology assumptions. We found that about 55 million barrels (MMB) to 725 MMB of oil could be recovered with EOR methods if royalty rates are reduced between $1 and $4 per barrel. (See figures 2 and 3, pp. 13 and 14.) This range includes about 55 MMB to 455 MMB of EOR oil that could be produced without any change in royalties. Our "best estimate," assuming moderate oil prices and technology, is that about 100 MMB will be produced, if royalty rates are not reduced, and about 100 MMB to 275 MMB with various royalty rate reductions. (See figure 2, p. 13.) This "best estimate" does not reflect the most optimistic assumptions. In addition, these estimates were limited to known reservoirs currently involved in conventional (primary or secondary) recovery. DOE pointed out that this conservative approach may underestimate the actual potential of EOR methods if other known, but currently undeveloped reservoirs are not considered.

Interior does not believe that a $4 reduction in royalty rates, depending on oil price and technology assumptions, could produce up to an additional 725 MMB of oil through EOR. By way of comparison, Interior pointed out that a reduction in Windfall Profit Tax from 70 to 30 percent for EOR projects has produced only one project (with another recently initiated) in the Gulf of Mexico. In addition, Interior noted that

> "the price of crude oil has dropped to a current price of $27 per barrel and is predicted to drop another $2 in the near future. At $25 per barrel, granting a royalty reduction equal to $4.00 would yield producers a revenue per barrel roughly equivalent to that which they received without a royalty reduction when the price was $29. However, since the latter price was not particularly effective in stimulating EOR activity in the Gulf, it is not expected that the $4.00 incentive will result in the incremental recovery suggested in the GAO report under current low price expectation[s]."

Our analysis does not indicate that an additional 725 MMB of oil could be produced with a $4 incentive. In order to produce a

total of 725 MMB of oil with a $4 incentive, advance technology and high oil prices must be assumed. (See figure 3, p. 14.) We also note that, even under these optimistic circumstances about 455 MMB of EOR oil would have been produced even without the royalty reduction. We do not support this optimistic estimate as most likely, but use it to show the range of possible production from EOR depending on assumptions. Our "best estimate" assumes moderate oil prices and base technology, or a total of about 275 MMB with a $4 incentive, not 725 MMB of additional EOR oil as Interior indicates. Further, royalty reductions could be a more effective incentive than windfall profit taxes for two reasons. First, royalties are a claim on gross revenue from an EOR project as opposed to Windfall Profit Taxes, which are a claim on income after expenses. Therefore, royalties are paid "off the top" regardless of profitability. Windfall Profit Taxes are paid only to the extent that a profit is made and, furthermore, are subject to a net income limitation. Secondly, according to tax experts we spoke with at the Department of Treasury, the Congressional Budget Office, and industry, no Windfall Profit Tax is expected to be collected on EOR projects after about mid-1986. (See p. 4.) Royalties, however, continue to be a substantial cost to industry. In addition, we recognize that falling oil prices can influence EOR production and have incorporated comments in the report where appropriate. (See pp. 4 and 5).

Interior also noted that additional oil could be produced if royalty rates were reduced for conventional production when production is no longer economically feasible at conventional royalty rates. Further, Interior concludes

> "It is likely that, in a significant number of case, the remaining recovery which can be economically undertaken will be achieved through the use of conventional production techniques and not tertiary techniques."

We have previously advocated the use of a flexible royalty policy to maximize oil production and/or government revenue. In our 1982 report, Interior Should Continue Use of Higher Rates for Offshore Oil and Gas Leases (RCED-83-30), we point out the principle of selectively using different royalty rates for conventional production depending on the amount of oil and its development cost (see p. 22). This previous report addresses royalty rates on conventional production, while the focus of this report is on EOR methods. We advocate the use of royalty reduction on a project-by-project basis only where both increased production and increased federal government revenue result. However, we do not generally agree that royalty reductions on conventional production are likely to result in the same amount of recoverable oil as that associated with using EOR. Conventional methods use natural reservoir pressure or injected water to displace oil. At a point during conventional production, the injected water can no longer physically displace additional oil. EOR methods, such as those using carbon dioxide addressed in this report, can mix with the

oil remaining after conventional production and allow a considerable amount of additional oil to be recovered. Nonetheless, if Interior believes it can provide royalty reductions on conventional production following the criteria in our recommendation, the idea merits further consideration. We encourage Interior to follow-up on this suggestion.

Interior did not agree that the abandonment of existing platforms would pose a problem if the oil is to be recovered later by EOR methods. It cites three primary reasons: (1) the vast majority of the large oil fields are in the Miocene trend--a large, deep basin which has not been fully explored--and as deeper production in the Gulf is developed, the new platforms required could be used for future EOR projects, (2) many of the current platforms are old and may not be in the best position for EOR projects, so it is likely that lessees would choose new platforms for many EOR methods, and (3) as industry moves to deeper waters it will dictate the design of mobile platforms that could be used for EOR.

Our analysis of offshore platforms as well as extensive interviews with industry and government experts indicates that if existing platforms, on sites suitable for EOR, are removed, it would not generally be economically feasible to replace a platform for the purpose of an EOR project. Platform replacement and operating costs are extremely high in the Gulf of Mexico. Given the fact that the remaining amount of oil recoverable by EOR methods is relatively low, compared to conventional production, these costs will not be justified in most cases. Companies pointed out that they would retrofit and/or add to their present platforms first, then, if necessary, build additional platforms that could be used in conjunction with their present platforms. In addition to the financial problem of replacing a platform, physical reservoir conditions may make EOR projects less attractive later if conventional production ceases and oil is no longer moving freely. Finally, no oil company we surveyed that was operating in the Gulf was considering the use of a mobile platform for possible future EOR projects. The consensus was that mobile platforms do not lend themselves well to EOR methods because of practical and technical considerations involved with these methods.

APPENDIX I

Department of Energy
Washington, D.C. 20585

JAN 29 1985

Mr. J. Dexter Peach
Director, Resources, Community and
Economic Development Division
U.S. General Accounting Office
Washington, D.C. 20548

Dear Mr. Peach:

The Department of Energy (DOE) appreciates the opportunity to review and comment on the General Accounting Office (GAO) draft report entitled "Selectively Reducing Offshore Royalty Rates Could Increase Oil Production and Federal Government Revenue In the Gulf of Mexico."

DOE generally agrees with the report and is pleased to see the subject of enhanced oil recovery (EOR) in the Gulf of Mexico is receiving your attention. Although DOE does not have direct responsibility for implementing GAO's recommendations, those recommendations involve the development and production of U.S. oil resources and directly affect the national energy objectives to which DOE is committed. Maximum recovery of this country's petroleum resources is in the national interest, and it is a goal that can be furthered by GAO's recommendations. There are, however, four areas in the report that should be expanded on in order to provide the reader with a better understanding of the costs, benefits, and uncertainties involved.

1. The Lewin and Associates study used as the basis of the report reflects 1980-81 data. Oil prices, offshore recovery costs, and the state of knowledge about EOR have all changed since then. These factors are working to shorten platform economic lifetimes and perhaps increase the technical potential of EOR. The report should recognize these changes and comment on how they affect the report's projections.

2. The report should point out the considerable time and resources that will be required for a project-by-project review of royalty incentives. Reaching agreement on costs, production estimates, future oil prices, and what constitutes an economic project will be a difficult, expensive and time-consuming effort and will likely require an expanded bureaucratic structure. To facilitate this process, costs, accounting methods, price projections and, if possible, methods for estimating EOR production should be standardized so that industry understands the rules it is being asked to play by. DOE does not believe that a project-by-project program is the only one that should be considered -- a competitive bidding process

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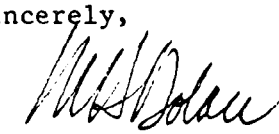
might be more efficient, for example -- but if it does turn out to be the best alternative, policy makers should be made aware of the full extent of the costs and effort involved.

3. In restricting its recommendations to actions that "would result in both increased production and increased federal government revenue" (GAO's emphasis), GAO ignores a broad range of benefits that would accrue to consumers, taxpayers, and the nation from many projects that do not meet the report's strict definition of benefits as arising only from royalty revenues. Reduction of royalties would also produce benefits from increased production of oil that would ultimately reach consumers (oil that otherwise would never be recovered), corporate taxes that would be collected on incremental production, increased economic activity, and decreased dependence on oil imports. An analysis of royalty incentives should include these benefits in order to give decision makers the complete picture.

4. GAO has taken a conservative approach to estimating recoverable EOR. The Lewin and Associates study limited its analysis to previously swept portions of known reservoirs (i.e., areas in which primary and secondary recovery are already taking place). There is also substantial EOR potential from unswept zones of known reservoirs for which additional wells would have to be drilled and from undiscovered reservoirs. The conservative nature of the estimates should be noted in the report. This potential may well be greater than that calculated by GAO for the swept zones.

DOE hopes that these comments will be helpful to GAO in their preparation of the final report.

Sincerely,



Martha Hesse Dolan
Assistant Secretary
Management and Administration

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United States Department of the Interior

OFFICE OF THE SECRETARY
WASHINGTON, D.C. 20240

FEB 8 1985

Mr. J. Dexter Peach
Director, Resources, Community and
Economic Development Division
General Accounting Office
Washington, D.C. 20548

Dear Mr. Peach:

We appreciate the opportunity to review your draft report entitled "Selectively Reducing Offshore Royalty Rates Could Increase Oil Production and Federal Government Revenue In the Gulf of Mexico." The Department of the Interior's comments on the draft report are included in the enclosure.

Sincerely,

Deputy Assistant Secretary - Land and
Minerals Management

Enclosure

APPENDIX I

COMMENTS ON THE GENERAL ACCOUNTING OFFICE DRAFT REPORT ENTITLED "SELECTIVELY REDUCING OFFSHORE ROYALTY RATES COULD INCREASE OIL PRODUCTION AND FEDERAL GOVERNMENT REVENUE IN THE GULF OF MEXICO"

The Department believes that the General Accounting Office (GAO) recommendation may merit further consideration. The GAO recommends that the Minerals Management Service (MMS) "initiate action that would allow for royalty reduction on EOR projects in the OCS in the Gulf of Mexico where it would result in both increased production and increased Federal Government revenue." Further, the GAO recommends that MMS should establish guidelines that:

- "establish specific guidance to facilitate industry preparation of royalty reduction proposals and government's evaluation of these applications;

- permit timely evaluation of royalty reduction proposals (That is, early enough in the productive life of a well or reservoir to permit industry to implement EOR effectively, but late enough for the government to have sufficient data to evaluate the need for royalty reduction, usually during the last few years of conventional production); and

- allow royalty reductions on a project-by-project basis while maintaining the existing royalty for the remainder of the lease area."

The GAO recommendation to review royalty reduction guidelines has merit. However, it must be recognized that EOR is still very much in the pilot stage in Gulf of Mexico-type reservoirs, and that only significant reductions in royalties are likely to induce EOR activity over the next few years. More effective incentives would be provided by major increases in the oil price or sizeable reductions in taxes. Obviously, only royalty rates may be controlled by the Department of the Interior.

The Department agrees that the reduction-in-royalty regulations now in effect may need refinement and clarifying guidelines. This matter is now under study. However, for the reasons presented below, the Department does not agree that GAO recommendations, if applied, would result in the large amounts of incremental oil production suggested.

Recovery

The GAO states that approximately 1.0 billion barrels of oil are technically recoverable with EOR techniques. The report also states that a substantial portion of this oil can be recovered through the implementation of the measures recommended by the GAO. These estimates reflect the most optimistic assumptions with regard to technical recoverability and costs. The geologic complexities of reservoirs in the Gulf of Mexico, the logistics of supplying the necessary fluids and materials to OCS operations, and the availability of injection fluids will restrict the application of most EOR methods in the Gulf for the next several years. Accordingly, the Department believes that the GAO estimates of recoverability represent overstatements of actual EOR potential for the Gulf of Mexico.

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Incentives

The GAO's analysis led to the conclusion that the equivalent of a $4.00 reduction in the royalty rate would, depending on oil price and technology assumptions, produce up to an additional 725 million barrels of oil through the initiation of EOR projects. This seems highly unlikely since a reduction in the windfall profits tax from 70 to 30 percent for EOR projects has produced only one project (with another recently initiated) in the Gulf of Mexico. Two others have been proposed but as yet have not been initiated. Thus, a small reduction in the royalty rate is not likely to encourage sufficient EOR activities to produce anywhere near the recovery predicted by GAO. Moreover, the price of crude oil has dropped to a current price of $27 per barrel and is predicted to drop another $2 in the near future. At $25 per barrel, granting a royalty reduction equal to $4.00 would yield producers a revenue per barrel roughly equivalent to that which they received without a royalty reduction when the price was $29. However, since the latter price was not particularly effective in stimulating EOR activity in the Gulf, it is not expected that the $4.00 incentive will result in the incremental recovery suggested in the GAO report under current low price expectation.

Future oil and gas price uncertainty raises another question concerning the incentives proposed by GAO. The oil that could be recovered by EOR methods may be thought of as a newly discovered marginal field. Obviously, investment and production decisions for marginal fields are sensitive to small price changes. There is a problem in designing incentives that encourage long-term investment decisions over a wide range of prices yet assure a given level of royalty revenue to the Federal Government. It is possible that these two objectives cannot be simultaneously attained.

Platforms

The GAO states that 75 percent of the current platforms could be removed by the year 2000, and unless incentives are put in place to encourage widespread EOR activities in the Gulf in the near future, the 725 million barrels of oil will be lost forever. The Department, for the following reasons, does not agree.

1. The vast majority of the large oil fields are in the Miocene trend. The Miocene trend is a large, deep basin, the depths of which have yet to be explored. We have reason to expect deeper production all along this trend which will require new platforms and wells that can be used for future EOR projects.

2. Many of the current platforms in the large fields are old and could not be adapted easily for large EOR projects. Also, many of the wells are not drilled in the best structural position for EOR projects. Additional wells would be needed although, generally, there is little room on the current platforms for new wells. Thus, it is likely that lessees would choose new platforms for many of the EOR methods. A royalty reduction option would, however, allow a lessee to compare the use of an existing platform with a new platform.

3. Industry's move to deeper waters will likely dictate the design of mobile platforms for production systems as operating depths increase. These mobile platforms could also be used for EOR in the older fields in shallower water. Thus, some lessees may decide to abandon existing platforms and delay EOR decisions until mobile platforms are available. However, these decisions will vary among leases and lessees. A lessee's use of an existing platform would reflect an evaluation of the risk and potential returns of an EOR project.

Linking Royalty Reduction to EOR Projects

There is an implicit assumption in the GAO report that oil left unrecovered at the conclusion of primary and secondary recovery must necessarily be recovered through tertiary techniques. It must be understood that oil is left unrecovered not only because of increasing production costs but also because of the existing royalty rate at the time of shut-down. Reducing or eliminating the royalty rate at this point would create an incentive for additional recovery through conventional means. With a royalty rate reduction or elimination, some of the unrecovered oil could be produced using the same techniques of primary and/or secondary recovery that have been used throughout the production history of the reservoir. It is likely that, in a significant number of cases, the remaining recovery which can be economically undertaken will be achieved through the use of conventional production techniques and not tertiary techniques. However, the GAO report does not take this possibility into account.

The objective for royalty reductions should not be creation of an incentive for recovery through tertiary techniques. Rather, the objective should be additional recovery at the least cost by whatever means is available. The effort involved in making the determination that conventional costs per barrel have exceeded price would be similar to the effort involved in granting a royalty reduction on the basis of costs of a tertiary recovery project.

Administrative Problems in Selecting Royalty Reductions

The administrative problems associated with the GAO recommendations have not been adequately addressed in the report. To a major extent, the administrative problems would hinge on the information requirements imposed upon the MMS. Under the GAO proposal, lessees would apply for royalty reductions on a dollars-per-barrel basis. The application for a royalty reduction submitted by the lessee would take into account the remaining reserves, the present value of expected costs, and the present value of expected revenues given an expected time path for future prices. The MMS would then evaluate the application and presumably negotiate the dollar amount of the reduction in royalties if the amount of the reduction requested were to appear excessive. In order to be able to evaluate applications, the MMS would encounter administrative problems in connection with the production cost, especially the costs associated with new or relatively untested EOR techniques; availability and uncertainty associated with estimates

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of future prices; and reserves remaining in the reservoir. Thus, the evaluations to be conducted by MMS would require time, skilled personnel, and access to data all of which would involve a significant administrative burden on the MMS. The GAO report underestimates the difficulty of performing these functions.

In addition, it must be recognized that most of the regulatory information needed may only be available after lessees have been given the opportunity to test and evaluate pilot EOR projects. This, in turn, creates great regulatory uncertainty on the part of project supporters who will not proceed unless the "ground rules" are clear at the beginning of the EOR project. This point should have been given more attention by GAO, which should have also considered other ways (i.e., elimination of Windfall Profits Tax) to encourage EOR projects.

Despite the concerns raised above, the Department believes that the application of EOR techniques to the OCS is of sufficient importance to warrant further study.

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