OUTER CONTINENTAL SHELF POLICY ISSUES

HEARINGS

BEFORE THE

COMMITTEE ON INTERIOR AND INSULAR AFFAIRS UNITED STATES SENATE

Pursuant to S. Res. 45
A National Fuels and Energy Policy Study

NINETY-SECOND CONGRESS

SECOND SESSION

ON

OVERSIGHT ON OUTER CONTINENTAL SHELF LANDS ACT

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SENATE RESOLUTION 45

NATIONAL FUELS AND ENERGY POLICY STUDY

This publication is a background document for the National Fuels and Energy Policy Study authorized by Senate Resolution 45, introduced by Senators Jennings Randolph and Henry M. Jackson on February 4, 1971, and considered, amended, and agreed to by the Senate on May 3, 1971.

The resolution authorizes the Senate Interior and Insular Affairs Committee, and ex-officio members of the Committees on Commerce and Public Works and the Joint Committee on Atomic Energy, to make a full and complete investigation and study of National Fuels and Energy Policies.

This document is published to assist members of the Committee and other interested parties in their understanding of the issues inherent in the formulation of a long-term National Energy Policy which assures the continued welfare of the Nation, including balanced growth, safeguarding and enhancing the quality of the environment, and national security.

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OUTER CONTINENTAL SHELF POLICY ISSUES

THURSDAY, MARCH 23, 1972

U.S. SENATE,
COMMITTEE ON INTERIOR AND INSULAR AFFAIRS,
Washington, D.C.

The committee met, pursuant to notice, at 10:00 a.m., in Room 3110, New Senate Office Building, Senator Frank E. Moss, presiding.

Present: Senators Moss, Buckley, Bellmon, and Metcalf.

Also present: Jerry Verkler, Staff Director, and Mary Jane Due, staff counsel.

Senator MOSS. The committee will now come to order.

Today we begin our deliberations, pursuant to S. Res. 45, into the administration of the Outer Continental Shelf Lands Act and the Nation's ocean resource policies.

The Outer Continental Shelf has proved to be a major source of energy supply and has satisfied a substantial part of this Nations growing demand for oil, natural gas and other minerals. Yet, at the same time, unfortunate accidents have occurred on the Outer Continental Shelf as a result of drilling and production operations.

At a time when the Nation's energy demands are mounting and concern for the environment weighs on the national conscience, it is timely for us to examine the role that Outer Continental Shelf resources have played in our total energy picture.

Hearings were held before my subcommittee in November in connection with the establishment of marine sanctuaries over the Outer Continental Shelf adjacent to California and these hearings served to focus attention on the need to resolve the many conflicts over the use of the coastal zone. On the one hand, we are beset by an energy crisis. On the other hand, we are faced with an intolerable degradation of environmental values.

Priorities for each of the many applications and exploitable features of these coastal resources need identification. The many sides of this issue provide a classic example of the dilemma of natural resource management facing the Nation today: the need to differentiate and select the best of many potential uses of a resource without foreclosing other benefits inherent in the resource. The choice is not simply one of good and wise options over bad and foolish ones, but rather a sensitive and complicated selection between several resource allocations each of which is extremely valuable or actually essential to the Nation's continued welfare.

These hearings point up the necessity for renewed examination of the Federal policies impinging on the coastal zone.

We have a public trust in these resources not only to satisfy our immediate needs but to meet our obligations to future generations of Americans.

In addition to these next 2 days for hearing Government witnesses, the committee will hear invited industry representatives on April 11 and Congressional representatives and selected environmental organizations on April 18.

We hope that within these 4 days we can make a record which will give the committee the material it needs in trying to adjust to the problems that I have tried to state broadly in this brief opening statement.

I am pleased that several of my colleagues are here to sit with us this morning on this committee and if any of them have any opening remarks—the Senator from Montana.

Senator METCALF. No, thank you, Mr. Chairman.

Senator MOSS. The Senator from Oklahoma.

Senator BELLMON. I have a statement that I have been asked to place in the record by Senator Allott, also I have a brief statement that I would like put in the record.

Senator MOSS. They may be printed in the record at this point.

STATEMENT OF HON. HENRY BELLMON, A U.S. SENATOR FROM THE STATE OF OKLAHOMA

Senator BELLMON. In view of this Nation's present energy crisis, which is becoming more critical day by day, I welcome these Outer Continental Shelf oversight hearings and congratulate our chairman for making them possible.

There is no question that vast amounts of domestic petroleum reserves do, in fact, exist both on and off shore. These can provide the only dependable, secure source of energy for the citizens of this Nation through 1990.

The development of the OCS has been the subject of great controversies and has been retarded as a result of uncertainties brought about by moratoriums on offshore drilling, stoppage of lease sales and the prospect of the establishment of marine sanctuaries.

This great uncertainty has undoubtedly contributed greatly to the transfer of the petroleum industry development efforts and funds abroad at an ever-increasing rate. It is plainly in the national interest that this exploration and producing effort be attracted back into areas which are not subject to the control of foreign governments.

The issues that these proceedings are attempting to clarify are numerous and complex and they cannot be resolved to the total satisfaction of every interest group.

When this vast range of issues has been identified and the facts determined, the necessary and difficult decisions can be made. However, there remains the most important and paramount question which must first be answered: namely, whether or not this Nation deems it essential to maintain a basic, self-sufficiency in energy and how high a priority such development must have.

These and subsequent proceedings will help provide the necessary insight into this key question, so that when the hearings are concluded, the committee will be able to develop an effective course of action that will truly be in the national interest.

STATEMENT OF HON. GORDON ALLOTT, A U.S. SENATOR FROM THE STATE OF COLORADO

Senator ALLOTT. Mr. Chairman, I appreciate this opportunity to make a brief opening statement. I would like simply to focus on the context of this hearing.

Nearly 20 years ago this committee reported out a bill which was enacted into law as the Outer Continental Shelf Lands Act. It was a legislative achievement of which the Congress should be proud. I think it would be useful to include a copy of that act in the hearing record at this point and request that it be so included.

The reason for including it in the record is that it expresses the will of the Congress as of 1953 and, as a matter of law, the present will of the Congress—until amended.

That act declares at section 8(a):

> In order to meet the urgent need for further exploration and development of the oil and gas deposits * * * of the Outer Continental Shelf, the Secretary (of the Interior) is authorized to grant * * * oil and gas leases on * * * the Outer Continental Shelf. * * *

In that section there was—and still is—a declaration of the Congress that there is an urgent need to develop the oil and gas deposits of the Outer Continental Shelf. I anticipate that Secretary Dole in his testimony this morning will confirm that the need to rely on development of OCS oil and gas deposits is as urgent, if not more urgent than it was when the Outer Continental Shelf Lands Act was enacted. The shaky, politically unstable, expropriation-prone Middle East seems to be the only alternative to the OCS to meet this Nation's rising demands for oil and gas.

Under the authority of the Outer Continental Shelf Lands Act 2½ billion barrels of oil, 14½ trillion cubic feet of natural gas and nearly 3 billion gallons of natural gas liquids have been produced with bonuses, rentals and royalty payments accruing to the United States Treasury from 1953 through 1971 in the amount of $6,456,688,788. This oil, gas and natural gas liquids production represents a value of over $11 billion.

That represents the positive side of the ledger. Regrettably, however, three major mishaps have occurred on the OCS off Santa Barbara and in the Gulf of Mexico. Much oil was spilled and people and wildlife were hurt. These incidents have given rise to a reaction which, while well intended, would have the Congress either declare a moratorium on future OCS development or transform the Continental Shelf into a gigantic marine sanctuary from which would be excluded any drilling for, or production of, oil and gas.

The reaction to the Santa Barbara and Louisiana offshore spills has not limited itself to seeking legislative action in the Congress. The reaction has also taken the form of lawsuits in the Federal courts. I refer to the December 1971 Federal district court decision involving the proposed OCS lease sale off Louisiana. Notwithstanding the declaration of Congressional policy to which I made reference regarding the urgency of the need to develop OCS oil and gas, the court held that under the National Environmental Policy Act the Secretary of the Interior was required to consider alternatives to OCS lease sales which went beyond the scope of his authority to implement. The result was a cancellation of the sale.

The litigants have suggested that they will be back in court with another law suit at the next sale.

Thus, as a significant part of our National Fuels and Energy Study the committee is examining in explicit detail the effectiveness of the management system of the executive department in the administration of the Outer Continental Shelf Lands Act.

The major issues we will be considering, as I see them, are:

(1) How environmentally safe and economically necessary is it to continue to rely on the OCS as a major source of oil and gas? Are there viable alternatives to the OCS?

(2) What is the price to be paid, in terms of domestic supplies of oil and gas, for declaring a moratorium on further OCS drilling? What are the social, economic and national security costs to the U.S. if such an option is taken?

(3) Should marine sanctuaries be established on the OCS and if so by the Congress or the executive department and subject to what criteria?

(4) How well has the Interior Department (and other Federal agencies) been administering the Outer Continental Shelf Lands Act, in particular its selection of lease tracts, conduct of lease sales, supervision of operations following lease sales, and protection of the marine environment in general? What recommendations for improvement in the Federal OCS management system should the committee be considering?

The committee is having 4 days of extensive hearings on these and related issues. It is my hope and expectation that the witnesses will be as objective and thoughtful in their presentation on the issues we have asked them to respond to, as we intend to be in our follow-up analysis of their responses.

I look forward to these hearings and hope that as a result of them the air will be cleared regarding what course of action the Nation should be following with respect to its use of the Outer Continental Shelf.

Senator Moss. The Senator from New York.

Senator Buckley. No, Mr. Chairman.

Senator Moss. Thank you. We are pleased that you are here and we are going to hear today from the Assistant Secretary of the Department of Interior, the Secretary for Mineral Resources, the Honorable Hollis M. Dole, who is a very well known man before this committee and we depend on him for a great deal of the information that comes to us that we are able to utilize in trying to work out some of the problems that face the Nation.

We are very glad you are here, Secretary, and look forward to hearing from you today.

STATEMENT OF HOLLIS M. DOLE, ASSISTANT SECRETARY FOR MINERAL RESOURCES, DEPARTMENT OF THE INTERIOR, ACCOMPANIED BY VINCENT McKELVEY, DIRECTOR OF GEOLOGICAL SURVEY, RUSSELL WAYLAND, CHIEF, CONSERVATION DIVISION, AND EUGENE STANDLEY, STAFF ENGINEER, OFFICE OF ASSISTANT SECRETARY

Mr. Dole. Thank you, Mr. Chairman, with your permission I would like to have accompany me at the table, Mr. Eugene Standley, engineer on my staff, Dr. Vincent McKelvey, Director of the U.S. Geological Survey, and Dr. Russell Wayland, who is Chief of the Conservation District of the Geological Survey.

Senator Moss. Very good, we welcome all of you and are very pleased to have you before the committee.

Mr. Dole. I would like to call your attention, Mr. Chairman, that since submitting my prepared statement to you we have made very few and minor technical changes in my statement at the very last minute and I hope you will bear with me in making these changes.

Senator Moss. That is very appropriate, I am glad you were working on it up to the last minute. Now it is completely up to date.

Mr. Dole. I too am glad to see so many of your committee present this morning and I am glad to meet with you today to discuss some of the problems facing the Country today in satisfying a portion of its energy demands from the Outer Continental Shelf.

I have previously stated that the United States has within its boundaries all the energy resources it needs for any degree of self-sufficiency it chooses to maintain, but their development will be more costly than purchasing energy from abroad. Because of this cost we can predict with almost actuarial certainty the acceleration of the trends that are now evident; the forfeiture to oil of markets formerly held by coal and gas concurrent with the decline in domestic petroleum supply, which must, in turn, be made good by rising imports of oil, increasingly from the Eastern Hemisphere. We can slow this rate of foreign dependency with full development of our energy resources from the Outer Continental Shelf.

The Outer Continental Shelf—OCS—has been assuming an increasingly larger role in supplying the Nation's oil and gas requirements. In 1970, the Outer Continental Shelf provided over 10 percent of the oil and gas production of the United States, compared to about 5 percent in 1965. We estimate that by 1980 25 percent of the U.S. oil production and 19 percent of its gas production could be produced from the Outer Continental Shelf. To accomplish this, more Outer Continental Shelf areas would have to be opened for leasing, more wells would have to be drilled and many additional miles of pipelines laid to bring this vital resource to market.

Historical data available on Outer Continental Shelf oil and gas exploration and development help to give us the insight necessary for planning for future OCS development. Only about 1.4 percent of the area of the United States Outer Continental Shelf to the 200 meter water depth has been leased for oil and gas exploration and development. Less than 3 percent is adequately mapped for assessment of its total energy resource potential and for evaluation of the environmental impact of mineral resource development.

The wise use of Outer Continental Shelf fuel resources developed through good mineral conservation practices is a prudent means of enlarging the Nation's energy base. Equally important is the development of technologies which increase efficiency and safety in finding, developing, producing, transporting petroleum so as to continue to make energy available at as reasonable a price as possible. An appropriate national objective is to provide a favorable climate for private invention and innovation, and it is appropriate for Government to initiate and encourage research in technologies which are in the broad national interest. New and safer equipment, better procedures, more efficient operations and increased recovery are some areas where significant advances have been made in Outer Continental Shelf oil and gas development in the past few years.

The legal regime with respect to the continental shelves of the United States involves the Geneva Convention on the Continental Shelf of OCS Lands Act, P.L. 212 for Federal operations and the Submerged Lands Act, P.L. 31, for State waters. The proposed Oceans Policy now before the United Nations for consideration will have significant effect on deeper ocean operations. The litigation involving various States as to ownership boundaries will eventually solve some of our near shore marine land problems.

In Outer Continental Shelf leasing, drilling, and production operations the Department of the Interior's prime responsibility is to see that industry provides adequate safety and environmental protection, and conforms to sound conservation practices.

We described the minerals on the Outer Continental Shelf lands thought to have some actual or potential commercial value in 1968 for the Public Land Law Review Commission. These included crude oil, natural gas, natural gas liquids, sulfur, and salt which are known well enough by the existing marine technology and economics of recovery to be classed as potentially recoverable resources. These estimates were published as an appendix to the report of the Commission. Other estimates of oil and gas resources have been published by the National Petroleum Council—1970—and the Potential Gas Committee—1971.

The public's desire for an increasing supply of fuel for transportation, home heating, and electric power is being tempered by its concern for the environment and the need to protect its quality. Alarmed by accounts of the spill off the southern coast of California, the more recent platform fires in the Gulf of Mexico, and the tanker accidents of the past few years, some have overreacted to the negative aspects of petroleum exploration in the oceans. This reaction has manifested itself in a variety of actions designed to restrain further development in the Santa Barbara Channel off California and on the Atlantic Continental Shelf. Additionally, last December an injunction was issued against the proposed lease sale off Louisiana in response to a suit filed by three environmental groups. This eventually made it necessary for the Secretary to cancel the sale. We are now trying to reestablish our Outer Continental Shelf lease sales program.

Natural gas supplies one-third of our total energy requirement. It is a clean fuel whose demand has greatly exceeded that of other fuels, averaging an annual growth rate of 6 percent during the past 20 years. The problem now is that we have a developing shortage in natural gas. It is already evident in some markets, and no doubt will hit with full force in the next few years. We simply have been consuming more gas than we have been able to replace with new reserves.

In 1970, gas demand was 22 trillion cubic feet and reserves were estimated at 265 trillion cubic feet in the contiguous United States. The reserve-to-production ratio is currently 11.7 to 1, compared with 20 to 1 in 1960. By 1980, gaseous fuel consumption would reach 33 trillion cubic feet—if the gas were available. Between 1971 and 1980, cumulative gas demand would amount to 275 trillion cubic feet, an average of 27.5 trillion cubic feet per year. However, annual additions to proved gas reserves have averaged only 15.2 trillion cubic feet in the past 5 years. The best 5-year annual rate of additions to new reserves ever attained was about 22 trillion cubic feet.

Alternate sources to augment our domestic supply of natural gas such as imports from Canada, liquefied natural gas or LNG, and synthetic gas from coal or other sources are not considered adequate to meet fuel demands in the next 5 to 10 years. Petroleum geologists believe, however, that there are large natural gas resources remaining to be discovered and developed in the Outer Continental Shelf, particularly in the Gulf of Mexico.

Petroleum products supplied 43 percent of total energy consumed in the United States in 1970, averaging 14.7 million barrels daily. Of this total, 23 percent was imported under oil import controls. For the past several years, the Nation's excess petroleum producing capacity has declined and since 1967 the United States has not been self-sufficient in oil.

As in the case of gas, domestic petroleum resources are not being developed at adequate rates to meet anticipated demands. In the last 20 years, geophysical exploration in the United States has decreased 72 percent, exploratory wells drilled have decreased 44 percent, and overall drilling activity has decreased 63 percent. The National Petroleum Council estimates that 436 billion barrels of potential oil resources remain to be discovered in the United States. A substantial portion of these potential resources will most likely come from the Outer Continental Shelf since the most promising undrilled areas are offshore.

Estimates of the source of the annual worldwide oil pollution in the oceans indicate that tankers contribute 29 percent of the total, while offshore production activities contribute only about 2 percent. Reducing the supply of domestic production by curtailing oil production offshore could require additional imports of oil and consequent increase in tanker travel. This in itself could increase the potential for oil pollution of the oceans by increasing the load on a large contribution to world ocean pollution.

Until alternatives are developed which can replace oil and gas as primary contributors to our energy supply, it will be necessary to continue to find and develop hydrocarbon resources in order to maintain our current level of living. This obviously will require expanding Outer Shelf oil and gas operations. However, there is no need to sacrifice environmental quality to accomplish this. We have increased funding fivefold for our Outer Continental Shelf leas emanagement program in the last 3 years, enabling us to increase our technical staff, revise our operating regulations, conduct studies related to the safety of operations, and institute a stringent inspection and enforcement program in order to increase safety and decrease pollution in Outer Continental Shelf operations.

These actions have already produced significant results. There has been a great reduction of incidents of noncompliance with regulations and small leaks and spills offshore have been cut in half. The new safety systems installed have already prevented several platform fires from becoming major disasters.

It is significant that these actions have also motivated a greater consciousness for safety and pollution prevention. Tens of millions of dollars have been spent by industry in response to this endeavor and much resarch is being directed toward further improvement of safety devices and systems.

The work connected with oil and gas development on the Outer Continental Shelf has a relatively good safety record. In fact, it is among the best of the various domestic industries. However, we intend to see that offshore operations are conducted in such a way that damaging accidents are avoided altogether or at least reduced to a lower level.

One last comment before I invite your questions. Accompanying the chairman's invitation of March 8 was an extensive list of questions on the administration of the Outer Continental Shelf Lands Act. I have had the answers to these questions prepared in detailed form and am submitting them for the record. I respectfully request that they be made a part of my testimony. And, Mr. Chairman, I might say that these 300 pages in answer to your questions, I think, will make a very fine record for your committee.

Senator Moss. Thank you. Obviously it has been an extensive job answering those questions, and we do appreciate the work you have done. The responses will be included as part of the record.

(The questions and answers referred to are in the appendix.)

Senator Moss. I appreciate your statement very much. In it you say the amount of funding for OCS mangement has increased fivefold in the last 3 years. This indicates to me that our national policy at this time is to accelerate development of our oil and gas resources recoveries on the Outer Continental Shelf; is that correct?

Mr. Dole. Yes, Mr. Chairman, not only to accelerate the recovery of oil and gas from offshore but it is also a reflection of both the Congress and the administration's view that more care has to be taken in the management of these operations and in the safety of these operations so that the enviromental impact will be reduced to the smallest minimum possible.

Senator Moss. So the funding is in part environmental preservation and management to protect the environment as well as to increase the production; is that correct?

Mr. Dole. Yes, sir; in very large part.

Senator Moss. The Land Law Review Commission calls for State involvement during the course of oil leasing. Do you have any State involvement in such leasing?

Mr. DOLE. Yes, sir, Mr. Chairman. The Geological Survey and the Department of Interior work very closely with the State in the development of the environmental impacts that are prepared prior to the leasing of any area. As a matter of fact, when there was intimation that there was going to be activity off the Atlantic coast, Secretary Morton has not only met with members of Congress to discuss where we stand on this and what we are doing, and I should add it is strictly in the matter of investigation to see what our resources are, but he has also met with Governors of the States in this area. We do have contacts through our various field offices and through our offices here in Washington of the Geological Survey and the Bureau of Land Management in the Department of Interior, we have contact with the State officials and officers and work with the State officials in this respect.

Senator MOSS. Is this working out?

Mr. DOLE. I think it is working out very well. Certainly we have areas that we do not always see eye to eye on but the fact that we have a dialog continuing between the coastal States and our resources managers in the Department of Interior I think is very helpful. They are kept well informed of what we are doing, what we are finding out, and, in most instances, we are able to resolve any problems that might come up.

Senator MOSS. Your testimony indicates an alternative to increasing OCS leasing and production has to be additional imports, is that correct?

Mr. DOLE. Mr. Chairman, we are going to have to rely more on our off-shore imports for our energy supply as regards oil and gas. The extent which we have to rely upon off-shore imports is going to be directly in relation and proportion to the amount of discovery and development of oil found within the boundaries of the United States.

Now, here we run into a very difficult and sensitive national policy and that is, what is the point of reliance that we want to give to off-shore resources. Certainly the off-shore areas have the best chance for ready development and have the best chance for large discoveries of both oil and gas, so it follows that the early development and the active development of the off-shore is going to be a measure of our independence and security.

Senator MOSS. What is your current estimate of reserves, oil and gas reserves, that are contained in the Outer Continental Shelf?

Mr. DOLE. I would like to refer that to Dr. McKelvey, if I may, please.

Senator MOSS. Doctor.

Dr. MCKELVEY. Mr. Chairman, the proved reserves on the Outer Continental Shelf amount to approximately 5 billion barrels. These reserves are explored, are producible under present economic conditions and fit the definition of proved reserves as customarily used. In addition to proved reserves, however, are deposits as yet undiscovered but almost certainly present—identifiable only in a very broad way from the nature of the rocks that occur on the Shelf, but nevertheless almost certainly present in the sedimentary basins that have not yet been explored. Of course, in addition to the undiscovered deposits, there is more petroleum, even in known deposits, that will almost certainly be recovered as the technology for secondary recovery improves.

So the estimate of proved reserves is only a very minimal indication of the amount of oil and gas that may be present.

Now, no one knows, of course, how much actually is present. But as we in the Geological Survey have appraised the situation, we have made the analogy that very likely there is as much oil and gas present and perhaps eventually producible off-shore of the United States as is present on shore.

Senator Moss. Well, when you say 5 billion barrels in what is known as proved reserves and your other estimates are projections for which you don't have proof as to the way you project it, how many would that be in number of barrels?

Dr. McKelvey. Estimates of this vary considerably. There are no well established and agreed upon methods for estimating undiscovered resources and it is very difficult to predict as to how much will actually become recoverable in the future. But, let's say, Geological Survey's estimates of the total oil in the ground indicate the potential of about 1500 billion barrels. How much of that can actually be found, how much of it can be recovered, of course, is entirely conjectural. But that, we think, is the target.

Senator Moss. Are you confined in determining your reserves off-shore to actual drilling? Is there something akin to seismographic exploration?

Dr. McKelvey. Petroleum can only be found by drilling, but indications of its presence come from other kinds of geological studies and geophysical surveys off-shore are extremely important in indicating the areas in which there are thick sediments, areas in which there are favorable structures where petroleum might occur. It is from those kinds of indications that we build our estimates of the potential.

Mr. Dole. May I add to what Dr. McKelvey has said? He noted right at the very beginning that oil and gas are found only by the drill. That the estimates that we make here are those based upon volume of sediment and experience in the past in developing these sediments in other areas. We make these estimates because it is essential for the Nation to know what its resource potential is. But the important thing is that oil and gas are not found unless a drill finds it.

Senator Moss. I realize that and I knew asking for a projection took in a lot of these other indefinite factors, but the geologic inference gives us some very broad guideposts and I would be glad to have a ball park figure of what you estimate might be there. I realize you have to put a drill down before you know it is there.

Mr. Dole. Mr. Chairman, the search for oil and gas is a very risky business and I wish to refer to the sad experience on the OCS off of Oregon-Washington, an area that I followed very closely around 10 years ago. Although about 600,000 acres were leased for a little more than $35,000,000 in bonuses, and after 5 years of drilling, an expenditure of perhaps on the order of $60 to $65 million more, not one bit of oil or gas was found. In other words, after looking at about 600,000 acres of what appeared to be, from seismic records and geological inference, what appeared to be a nice oil province, did not work out at all. So this is the risk that is involved.

Senator MOSS. Have you fixed the date for the offering of the lands offshore, the ones that were canceled by reason of the lawsuit down in Louisiana?

Mr. DOLE. No, sir, Mr. Chairman. We have not and the reason we have been unable to fix a date is because of the requirements of the National Environment Protection Act that upon filing of an Environmental Impact Statement certain periods of time have to remain for public comment, for comment of other agencies in the Government, for other departments and a review time. We are hoping that we can bring on a sale in the Louisiana Gulf sometime later this year. My guess, and this is as close as I can put it, would be sometime in September or October. But Secretary Morton will make the announcement as soon as he can see daylight to do this. But that is not so much the result of work within the Department of Interior, but it is living up to the requirements of the Environmental Protection Act.

Senator MOSS. Is it the present intention to offer esesntially the same acreage that was to be offered before?

Mr. DOLE. This is being discussed and reviewed in the Department at the present time, Mr. Chairman. I am not at liberty right now to say exactly what it will be. I would imagine that it will be in the same area and it very well may be the same amount of acreage.

Senator MOSS. You indicated in your testimony that there has been a considerable change, a tightening up of procedures that reduced the amount of spill and the number of fires and things of that sort. Percentagewise, can you put that into any kind of figure for me?

Mr. DOLE. Mr. Chairman, I am very pleased that you asked that question. I am going to refer it to Dr. McKelvey for complete answering but since January of 1969 to date, the effort on the part of the Geological Survey and the Bureau of Land Management, principally the Geological Survey as it is the manager of the resources, we have revised our OCS orders, our rules and regulations, we have had many studies made and with your permission I would like to ask Dr. McKelvey to go into the extreme work we have done and are doing because I do not believe that it is generally realized that today we are in a completely new ballgame as far as management and control of offshore applications as compared with pre-1969.

Dr. MCKELVEY. Mr. Chairman, first may I say that the overall safety record of off-shore operations has, on the whole, been an excellent one. There have been some 10,000 wells drilled on the Outer Continental Shelf, some additional 6,000 wells in State waters, a total of about 16,000. Of that total amount of drilling and off-shore operations, only three major spills have occurred. This is too much, but still I think it is worth noting that the total spillage and the number of major spills is very small in that total.

The Santa Barbara incident, of course, was bad and did cause much damage from the oil that was spilled. Many birds were killed and oil came on to the beaches. It was a mess to say the least. Since that time much has been done to strengthen regulations to make them much more stringent and inspection programs have been developed to see that these regulations are adhered to. We are in the process of developing improved safety procedures, to improve the inspection pro-

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gram and in other ways to see that accidents as a result of off-shore operations is reduced to the very minimum possible.

Senator MOSS. So the figure you supply me with, three major spills and about 16,000 drilling operations.

Dr. MCKELVEY. Yes. There have been other accidents but actually not large in number, and without serious environmental consequences.

Senator MOSS. One of the major spills, would that be that great fire we had off the coast down there in Louisiana where they allowed it to burn, really, in order to keep the oil from spilling on the water to any major degree? Now, do you count that as a major spill?

Dr. MCKELVEY. The two other spills besides the Santa Barbara spill that resulted in the release of oil in the amount of more than 5,000 barrels were the Chevron and Shell spills, both of which were accompanied by fires.

Senator MOSS. Well, thank you, it is encouraging to have you say the techniques have been tightened up and inspection and procedures have been tightened up greatly to guard against spills. This is one of our great problems which causes an awful lot of concern, of course.

Mr. DOLE. Mr. Chairman, in the Santa Barbara spill of January 1969, less than 1 percent of the spill was contained and recovered. During the Chevron fire in early 1970 approximately 10 percent of the total oil spill was retained and recovered. In the Shell fire in late 1970 approximately 40 percent of the total oil spill was retained and recovered. In the Amoco fire in late 1971, which spilled 450 barrels of oil over a 40-day period, and this was because this was allowed to burn and be consumed, because there was such a small amount of oil spilled, only about 20 percent was recovered. So I think the industry's ability to respond to accidents such as this have shown marked improvement, very marked improvement and the research that is continuing by both the Federal Government and by industry will make that record even better.

Senator MOSS. Thank you. My colleague from Montana is a genuine expert on the Continental Shelf and has held many hearings on the matter, and I am sure he will have some questions.

Senator METCALF. I am far from an expert, Mr. Chairman, I know just about as much about the Continental Shelf as a Senator from a landlocked State such as Montana would be expected to know.

However, in the course of our hearings before the special subcommittee, we did develop a good deal of information, Mr. Secretary, on the matter. Some of our hearings have been in some demand by the academic community as a text book on some of this material because of what is contained. Therefore, I want to congratulate you on supplying the answers to a rather formidable list of questions, and I know that will be volume II of a very interesting and widely used text book on the very subject matter. Certainly I know Senator Bellmon and I, who have conducted many days and hours of hearings on this matter, will welcome that additional material. We will especially welcome it as will our staff and the full committee.

I want to go a little further into this oil spill business. What permanent environmental impact and temporary environmental impact did these oil spills have on the various areas of our country?

Mr. DOLE. Senator Metcalf, I have had a little paper, a short two paragraphs, prepared hoping that you would ask some question like this or anticipating that you would and I would like to quote from that.

In the four major fires since 1970 in the Gulf of Mexico a total of 5,300 barrels of crude were spilled. There was an exposure to pollution for a total of 314 days. Minor amounts of oil hit the shore only 31 times. Oil that did reach shore was either cleaned up immediately or was removed by waves, before it could be cleaned up. In the Gulf of Mexico there have been no significant bird kills, no apparent loss of fish or other wildlife and no visible short-term environmental damage. Although the long range effects are unknown, no adverse effects have been reported to date.

In the Santa Barbara incident of 1969 there was considerable environmental impact from the 10,000 barrels plus spilled. There were 3,686 reported bird deaths, as well as the loss of certain kinds of bottom dwelling fauna. Oil was also washed upon the beaches in the many places in the channel and massive efforts were required to clean up the oil. The long-term effect of the spill has been much more promising.

Dr. Dale Straughan has determined in her studies from the oil spill that the area has recovered rapidly from the effects of the spill.

Senator METCALF. How long will it take before we know some of the long range effects of oil on the water and the damage to the algae to the bottom-feeding fish and things of that sort?

Mr. DOLE. I can't specifically answer that, Senator Metcalf, but I would call to your attention that during World War II there were, I believe—it is estimated that over 95 U.S. flag tankers were sunk off the Gulf coast and off the Atlantic. That has been a period now of almost 35 years.

Senator METCALF. For us veterans of World War II, that is too long.

Senator MOSS. Make it 30.

Mr. DOLE. Around 30 years. As you know, the fishing has never been any better than off the Coast of Florida and the recreational aspects are still very good. I am not sure there has been any real definitive study made of that area and there probably should be. Perhaps Dr. McKelvey could elaborate on this for me, please.

Dr. MCKELVEY. Senator, as far as I know there has not been any definitive or exhaustive studies on those effects in the Gulf.

Senator BELLMON. Mr. Chairman, could I interrupt at this point?

Senator MOSS. Yes.

Senator BELLMON. I have some information received from Dr. Whetland, Chief of the Statistic and Marketing Division of the U.S. Department of Commerce, in which he reports on the harvest of several species of fish from the Louisiana area. I believe this might be enlightening to be a part of the record at this point.

Senator MOSS. It will be inserted at this point as part of the response about the fishing.

(The information follows:)

QUANTITY AND VALUE OF LOUISIANA LANDINGS, 1966–71

[In thousands]

Item	1966 Pounds	1966 Dollars	1967 Pounds	1967 Dollars	1968 Pounds	1968 Dollars
Menhaden	555,852	9,558	510,414	6,134	622,291	7,740
Shrimp	62,276	24,390	75,325	24,575	67,768	25,623
Oysters	4,764	2,156	7,743	3,414	13,122	5,305
Hard blue crabs	7,986	537	7,559	520	9,551	807
Catfish and bullheads	4,205	1,169	3,730	1,040	3,397	978
Total	635,083	37,810	604,771	35,683	716,129	40,453
Marine waters and coastal rivers	656,834	38,979	639,675	37,280	754,502	42,125
Mississippi River area	6,008	902	6,898	1,062	9,467	1,498
Total	662,842	39,881	646,573	38,342	763,969	43,623

Item	1969 Pounds	1969 Dollars	1970 Pounds	1970 Dollars	1971 Pounds	1971 Dollars
Menhaden	856,251	12,764	959,810	18,931	1,237,093	20,050
Shrimp	82,888	33,358	90,948	34,614	92,635	43,000
Oysters	9,178	3,969	8,639	3,631	9,937	4,235
Hard blue crabs	11,602	1,072	10,254	928	10,394	1,060
Catfish and bullheads	4,313	1,215	4,226	1,214	3,804	1,089
Total	964,232	52,378	1,073,877	59,318	1,353,863	69,434
Marine waters and coastal rivers	1,003,160	54,426	1,007,251	61,068	1,396,470	72,430
Mississippi River area	10,341	1,768	6,876	1,308	6,900	1,300
Total	1,013,501	56,194	1,014,127	62,376	1,403,370	73,730

Senator BELLMON. It shows in 1966 the total catch—menhaden, shrimp, oysters, hard blue crabs, catfish, bullheads—was 662,000 pounds and in 1971, after a great deal of offshore activity has taken place, the catch was 1,403,000 pounds. More than doubled.

Senator MOSS. Thank you. You may continue, Dr. McKelvey.

Dr. MCKELVEY. Thank you, Mr. Chairman. When I said an exhaustive study, I was referring to the more subtle effects of oil spills or petroleum pollution effects that might not be observable immediately, even over a considerable period of time. I think the question of what the effects may be, what happens to oil in the sea, what the effects of oil of different kinds in different kinds of environments, with such questions we are dealing certainly with a very complex situation and one that perhaps is not easy to judge from evidence that may appear immediately. We know, for example, that among the tanker spills that have occurred, the damage to the aquatic life has varied considerably from place to place.

Whether this is due to the character of the oil, or the nature of the environment, is unknown and I think most people agree that this is an area where research ought to be done.

Senator MOSS. Isn't it true that there is some natural spillage going on all the time? I recall going off of Coal Oil Point and being able to see the slick that had been there for some time, like 100 years, is that true?

Dr. MCKELVEY. Yes; we estimate something like 50 to 75 barrels a day is being spilled from the natural seep. Historically there have been many oilfields of all dimensions that have become exposed to the surface as a result of erosion and dissipated. There is in the geological record tar and asphaltite deposits, many of which may have originated in that fashion. So one can say that over historical times much oil has been released to the natural environment and to the oceans without a long-term effect that we are able to observe. One possibility that has been offered to explain some of the differences in the effects of tanker spills is that synthetics of various kinds are less biodegradable than natural crude oil and may have, therefore, more serious effects. But, as I say, not enough is really known to define the effects of various kinds of hydrocarbons in various kinds of environments.

Senator METCALF. What kind of research are you doing about this complicated problem? You all remember in World War II we thought DDT was the greatest boom that came along and we sprayed it around and killed the flies and insects and so forth, then after a generation it lost a good deal of its glamour and now it is prohibited. That was a result of further additional research. No one is particularly blamed for that, but are we going forward with research as to the bottom effects of these tanker spills and ordinary geological formations, seepages, and spills as a result of such things and Santa Barbara.

Mr. DOLE. Senator Metcalf, the principal area that the Geological Survey has been concentrating their research, has been in the management of production from offshore, in the safety applications of the producing of the wells. I am not sure whether they are doing any basic research in the biological side of this or not. Perhaps Dr. McKelvey can respond better to that.

Dr. MCKELVEY. We are beginning research in this area, Senator. Other Federal agencies are also becoming concerned with the problem. NOOA, I believe, is undertaking some studies in this area, and the academic institutions are becoming active, and, I believe, some of the petroleum companies are becoming concerned also and have started investigations in this area.

Senator METCALF. Are you satisfied with the kind of research being developed and the progress and rate of its development?

Dr. MCKELVEY. With respect to my knowledge of it, Senator, I would say it is really just getting underway, and in all of the institutions I have been speaking about, this has really only been recognized to be a problem within the last few years. So it needs to be expanded considerably.

Senator METCALF. What are you doing with regard to interagency agreements, Mr. Secretary, working with such organizations as EPA and the Coast Guard in the containment of these spills and prevention and so forth?

Mr. DOLE. We have had, Senator Metcalf, areas of jurisdictional disputes in the past few years. We worked out a contingency plan for oil spills that involves the Coast Guard, the Environmental Protection Agency and the Department of Interior. We have arrangements and agreements with the Coast Guard on cleaning up oil spills. As you know, the Corps of Engineers has the responsibility for the oversight of obstruction to navigation. We work closely with them in this regard. The Coast Guard has certain lighting and buoying regulations. We aid them whenever we can in making inspections.

There is some overlap in the inspection requirements as to safety regulations of the Coast Guard and our inspections of offshore wells, but by and large we are resolving the jurisdictional disputes and are working with the various agencies and I think we have now a much better working relationship than we have had in the past.

Senator METCALF. You are satisfied with the progress you are making on this interagency cooperation?

Mr. DOLE. Yes; I think the progress we have made over the past few years has been very large. There is still some way to go but we are working on this and I am sure we will come to a good agreement with all the various agencies and there will be a concerted Federal effort that will be efficient and not as harassing as it has been in the past.

Senator METCALF. I hope you will continue to keep the committee informed as to the progress of your activities there in this particular area.

Section 12–A of the Outer Continental Shelf Land Act provides that the President of the United States may from time to time withdraw from disposition any of the unleased land to the Outer Continental Shelf. President Eisenhower used this authority to create a marine coral reef preserve off of one of the Florida Keys. Is this authority sufficient for the creation of a future marine reserve or is new or further legislation necessary?

Mr. DOLE. I think that authority, Senator Metcalf, is sufficiently defined and broad enough that it will allow the protection of any highly scenic area that would have a higher use than the production of energy. As you know, in 1969, Secretary Hickel established a reserve off of Santa Barbara Channel called the Santa Barbara Channel Ecological Preserve and that was established under Public Land Order 3478 on March 25. This order withdrew approximately 20,000 acres from all forms of disposition, including mineral leasing and reserved this designated area for use of scientific, recreational and other similar uses as an ecological preserve. In addition, about 30,000 acres of contiguous OCS lands were designated as a buffer zone and will be withheld from mineral leasing. I feel that the law and the rules and regulations developed from that law are sufficiently strong that these other resources of the ocean can have due recognition and that they will receive the recognition that they deserve.

Senator METCALF. I am glad to hear you say that you feel you have adequate legislative authority for the protection and setting aside of these very important marine reserves and I am also glad to hear you say that they will be set aside under that authority if need be.

I have one more question which was handed to me by a member of the staff. He points out that the Bureau of Land Management survey shows that offshore Louisiana petroleum costs only $1.78 a barrel to discover and produce on the average. Even with royalty payments the cost is only $2.34 a barrel. These costs probably have gone up but they are less than the domestic price of oil during the time covered by the survey. These costs are, in fact, less than the price of foreign oil laid down in the United States.

Now, the offshore operations look as if they should be very, very profitable. How do you explain the drastic decline in the offshore explorations, attempts for discovery and general operations of the present leases?

Mr. DOLE. Senator Metcalf, I guess the old story about figures. People who use figures, they can use them any way they want pertains here.

Senator METCALF. Well, I am just trying to get an explanation.

Mr. DOLE. Yes. The fallacy here is that it might cost to produce this amount of oil from a particular reservoir, but what is not figured in here, and something that I spoke to a little bit earlier, is the high risk involved in the search for oil and gas. Not figured into those totals is the tremendous sum spent looking for oil and gas and not finding it. So I would imagine if you would work in all the costs that should be really brought into this, that the amount of money there would be more per barrel than those figures would indicate.

Now, as to why there has not been more activity offshore, and we are becoming more and more reliant upon overseas sources, I think it comes down to the fact that the marketplace is strictly responsive to price and if you don't pay enough you just plain don't get enough.

Inasmuch as gas, and I think it is pretty well acknowledged now that gas has been underpriced, when you compare it with B.t.u. value of 1,000 cubic feet of gas with the B.t.u. value of oil or coal or other energy sources, gas has been underpriced, with the net result that there has not been the economic return for the search for oil and gas in the United States that could be obtained elsewhere. Money does not know any real controls. If you cannot get the return for an investment in one area than you can in another area, the money is going to go to that other area. The size of the fields found overseas would certainly be more attractive than the size of the fields that have been found to date here, with the exception of the large discovery up at Prudhoe Bay.

Senator METCALF. Mr. Secretary, this information was taken from Technical Bulletin No. 5, U.S. Department of Interior, Bureau of Land Management. I am reading from table 1 on page 205 of that bulletin. "The summary of estimated revenues and cost of finding and producing hydrocarbons." The finding cost enumerated here consisted of some of the items that you suggested. Subject to well drilling costs, dry holes, lease facilities, lease acquisition, geophysical and geological lease rentals, land scouting, and other exploratory expenses. So all of the material that you were talking about as to the finding of the dry holes and so forth was included in the figure that I cited, $1.19 for finding costs and other costs amounted to 59 cents, made it $1.78, plus royalties which would be $2.34 on the Gulf of Mexico.

The only point I was making is that this was less than the cost of finding and producing wells in many parts of the United States and even importing oil from the Arabian countries, for instance.

Mr. DOLE. Yes; you are absolutely right, Senator Metcalf. The offshore areas certainly appear to be the areas here in the United States that offer the lowest cost rate and the lowest cost production.

In my introductory statement I noted the amount of oil and gas anticipated to be produced from the off-shore areas in the future is going to increase much more rapidly than it has in the past years. Certainly those figures that you quoted would indicate that the finding of oil and gas offshore is the best bet that the United States has of increasing its reserves. The only inhibiting thing in this to date has been the number of lease sales that have been offered offshore and hopefully we can find the key to the statement that we must file for this and that we can make more land available offshore.

Senator METCALF. This is exactly what I was leading up to. In examination of the cost of finding and producing offshore oil, there still is room for environmental protection and these various conditions that we find we must put around the safety precautions, around these leases, and still make that offshore competitive in the world market, and, especially in the United States; isn't that true?

Mr. DOLE. That is absolutely right, Senator.

Senator METCALF. Mr. Chairman, on November 2, after hearings of the special subcommittee that Senator Jackson, the chairman of our committee, appointed, Senator Bellmon and I joined along with our colleagues Senator Allott and Senator Jackson and Senator Stevens in introducing S. 2801 which is the Deep Sea Bed Hard Mineral Resources Act, I am going to ask, I know Senator Bellmon is going to join me in asking you to set this bill for hearing and while Secretary Dole is here I want to urge him to get the information and report in so that about May, when, if you and Chairman Jackson agree, we can have this bill heard, which is a matter of concern to us and I know to you and to the people who are using it for hard mineral resources.

Senator MOSS. We will be glad to do that.

Mr. DOLE. I think this is an area that certainly needs to be looked into and I hope we can develop some hard mineral legislation that will allow us to not only look to the offshore for oil, gas, and sulfur, but will encompass these other resources of the country and we will certainly be ready.

Senator MOSS. Senator Bellmon comes from a great oil-producing State but also has done a great deal of work in the hearings on offshore production and other minerals besides oil.

Senator BELLMON. Thank you, Mr. Chairman, I might say our State has exactly the same amount of Outer Continental Shelf as Montana.

Mr. DOLE. But you do have a deep seaport now.

Senator BELLMON. Yes. I would like to compliment the Senator from Montana for the excellent job he did in chairing the hearings on the Special Committee on the Outer Continental Shelf and also say the events since that time have shown the wisdom of the position our committee took in the report we issued. I think this may be some time when we had some influence on the activities of the executive branch.

Before we get into the questions, I would like to get into some questions that Senator Allott asked me to bring up.

Senator MOSS. Yes; you may proceed with those.

Senator BELLMON. Mr. Secretary, questions 1, 2, and 3 of the list that the committee sent to you appear to require some consideration in the department. I would like to read these two questions to you and ask you if you would like to comment on them in addition to what you said in your formal reply.

The first question is, in light of existing and projected demands for energy and simultaneous requirement to protect the marine environment, what alternative source of energy other than the OCS petroleum from future leases are readily available and what would be the economic cost and environmental risk of energy from these sources In other words, what can we do if we don't go ahead and develop the OCS?

Mr. Dole. I think the key word there is readily available, Senator. As you know, we have some research programs on the obtaining of gas from coal and liquids from coal. We have a lease program on oil shale and Senator Bible's bill for the development of geothermal resources has passed and we are in the process of letting leases for geothermal resources very soon. But this will not give us any quantity of energy resources before 1980. So, therefore, your term, readily available, becomes that important. We have, really, no major source of energy, oil and gas, which makes up about 75 percent of the energy used here in the United States, other than coal, readily available. Coal is being chased out of the market because of environmental requirements, so therefore the OCS becomes that much more important because it is in this area where the best chances of bringing oil and gas ashore to the economy of the United States the fastest exists. This means, then, that we have to rely upon overseas imports to supply the gap that is widening between our ability to supply energy and the demand on energy. This means then, in this very important segment of our economy, the very basic segment of our economy, where energy is needed for all of our industry, that we must become more reliant upon overseas sources which we have very little if any control upon.

Senator Bellmon. Thank you, Mr. Secretary.

Another question Senator Allott asked me to bring up, it says, what would be the economic security of supply and environmental consequences of alternate strategies for the scheduling of OCS resource development, that is to say, the postponing of development and consumption of these resources until the need is greater through the increased cost or unavailability of imported oil? In other words, if we cut off developing OCS now, what are the economic and environmental consequences?

Mr. Dole. Well, Senator, this would mean, as I mentioned earlier, that we would have to rely upon off-shore sources for our oil and gas and, as you know, worldwide, in the ocean, only about 2 percent of the oil that is found a pollutant in the ocean comes from drilling, whereas a very large percentage, I believe it is 28 percent, comes from tankers. This would mean you would be increasing the number of tankers coming into our ports, with the net result that they are the much larger contributor to oil pollution than is the development of our off-shore resources. So the most secure, the less pollutant source of oil and gas would be from our own field on our own Continental Shelves.

Senator Bellmon. When you mention the large amount of pollution that comes from tankers, does this come because of disasters or is it a fact that tankers flush their tanks? Why do we get pollution from tankers?

Mr. Dole. It comes from many reasons, Senator Bellmon. It comes from off loading and then a bad practice that is being corrected now of pumping bilges. Some comes from the occasional catastrophe in the sinking of a ship or in collisions, but by and large it is the incidental spills connected largely with the off loading and on loading of the ships themselves.

Senator Bellmon. Would you care to state what is being done to correct those problems?

Mr. Dole. Yes, I think the Department of Transportation and the Department of Commerce are largely concerned in this area and I cannot give you a real definitive discussion on this, but I know that the companies have gone to what they call top loadings. That is, putting the bilge and other oils on top of their tanks and then discharging that, not into the ocean but on facilities located on land. The review of the types of materials, the types of connections made for moving oil from a tanker on shore is being done. I know of some organizations that are actually putting booms around the offshore dock unloading facilities in order to contain that. I know they are at this time tightening the rules and regulations and marine laws so that a minimum amount of oil will result from this off-shore unloading or this off-tanker unloading. Nevertheless, as the quantity of oil increases coming from overseas, the number of tankers increase and that increases the number of chances for spills of minimal proportions to take place.

Senator BELLMON. Another question raised by Senator Allott supposing the OPEC countries refuse to sell us oil or sell it at prices exceeding the United States market price, what are the sources available with respect to OCS?

Mr. McKELVEY. If you would like I could elaborate briefly on that. As I mentioned, the estimate of proven reserves on the Outer Continental Shelf is about 5 million barrels.

Senator BELLMON. Could you bring that down to supply in terms of years for the country at present rates of consumption?

Mr. McKELVEY. At present rates of consumption, that would only be about a year and a half's supply, a little bit less, perhaps, but there is a great potential to be developed. Everyone agrees to that, it is a question of just how large it is and, of course, nobody knows precisely how much oil is present, how much can be discovered and how much of that can be recovered economically. But we think that the total in the way of potential resources in the ground is very large. As I mentioned earlier, perhaps as many as 1,500 billion barrels of total oil in the ground. Certainly not all of that could be discovered and not all of it could be produced economically. But a substantial part, perhaps as much as 200 billion barrels is a reasonable target for eventual discovery and production.

Senator BELLMON. That would be perhaps a 40 years supply?

Mr. McKELVEY. At the present rate of consumption, that would be about 15 to 18 years, I believe.

Senator BELLMON. It also has been reported that several U.S. platforms have been hauled to foreign offshore areas due to the decline in U.S. offshore operations.

If this is so, what accounts for the decline in the U.S. offshore operations?

Mr. DOLE. Senator Bellmon, we responded to that question in the compendium that we have here. I would like to elaborate on it by saying this. On the West Coast area, which I am most familiar with, they have only two rigs remaining that can do any exploration offshore.

There are some rigs in the Louisiana Coast where the activity has been, but the reason for it is that we just haven't been putting up the quantity of offshore lands necessary to keep them busy here and they had to find someplace else to send them.

For instance, the Blue Water 2, which was the large platform off of Oregon, and was kept busy in the Santa Barbara Channel for many years, has just now been moved down off the coast of Chile. It is unlikely that it will ever return.

So we not only have lost the capability of having equipment to drill areas, but we also have lost the ancillary manpower and expenditure of moneys within the community. We have lost the trade personnel and we are in bad shape for crews here.

I think that indicates that we must embark upon an accelerated leasing program, as President Nixon has directed be done in his June 4, 1971 Clean Energy Message to Congress.

Senator Bellmon. Do you feel the economics are satisfactory with respect to the availability of drilling locations needed?

Mr. Dole. There is a combination of both, Senator Bellmon. Certainly the economic presence of offshore oil makes that more attractive. However, I think that the events of the last few months, certainly the last couple of years, indicates that economics of offshore oil is no longer as great a spread as it was.

Furthermore, I think with the developments of the last couple of years, that the OPEC countries coming together as they have and it is strictly a seller's market now, it could very well be that these companies are formulating an idea that maybe it is a matter of not furnishing us with all the oil we need, but using oil as a bargaining spot in the world markets today.

I think this would be a good time to now refer to a memorandum I got just this morning from our Office of Oil and Gas on the U.S. imports of crude oil and products in 1971.

It shows that when compared with 1970, 1971 imports increased by almost 13 percent. Crude oil imports increased substantially by almost 28 percent while petroleum products indicated a modest increase of 4 percent.

There are some tables attached here and I would hope after the staff has looked at it, you can include it in your record.

The examination of the tables points out that 78 percent of the total U.S. imports originated in the Western Hemisphere, crude 62 percent and products 91 percent. Canadian products amounted to 43 percent. On an overall basis Canadian imports amounted to 858,000 barrels a day. That was from Canada.

Substantial increases of refined product imports from other Western Hemisphere sources, especially residuals from the Virgin Islands and the new refinery in the Bahamas averaged 530,000 barrels daily.

The Caribbean exporting areas supplied two-thirds of residual fuel oil imports and 22 percent of the total crude products imports.

Total Eastern Hemisphere sources supplied about 22 percent of the total imports. There is no major geographical area that supplied more than 10 percent of the total imports.

Senator Moss. Thank you. We are glad to have those figures. We will include them in the record.

(The information follows:)

U.S. DEPARTMENT OF THE INTERIOR,
OFFICE OF OIL AND GAS,
March 16, 1972.

Memorandum:
To: Director.
From: W. J. Darby.
Subject: U.S. imports of crude oil and products, 1971.

The attached table lists U.S. imports of crude oil, residual fuel oil, all other products and total imports for 1971. Imports are broken down by country of origin and major exporting area.

When compared with 1970, 1971 imports increased by almost 13 percent. Crude oil imports increased substantially by almost 28 percent while petroleum products indicated only a modest increase of about 4 percent.

	1971	1970	Difference	
	Thousand barrels daily	Thousand barrels daily	Thousand barrels daily	Percent total
Crude oil	1,680.6	1,316.6	364.0	27.6
Products	2,195.8	2,117.9	72.9	3.7
Total	3,876.4	3,434.5	441.9	12.9

An examination of the attached table points up several pertinent and interesting factors:

1. Over 78 percent of total U.S. imports originated in the Western Hemisphere—crude 62 percent and products 91 percent.
2. Canadian crude imports amounted to almost 43 percent of total crude imports. On an overall basis Canadian imports registered about 21 percent or 858,000 barrels daily.
3. Substantial increases in refined product imports from other Western Hemisphere sources especially residuals from the Virgin Islands and the new refinery in the Bahamas averaged almost 530,000 barrels daily.
4. The Caribbean exporting area supplied almost two-thirds of residual fuel imports and supplied just about 42 percent of total crude and product imports.
5. Total Eastern Hemisphere sources supplied about 22 percent of total imports. No major geographical area supplied more than 10 percent of total imports.

W. J. DARBY.

UNITED STATES IMPORTS OF CRUDE OIL AND PRODUCTS, 1971

Country	Crude oil		Residual fuel oil		All other products		Total	
	Thousand barrels daily	Percent total	Thousand barrels daily	Percent total	Thousand barrels daily	Percent total	Thousand barrels daily	Percent total
Canada	721.4	42.9	29.2	1.9	107.4	15.9	858.0	22.1
Mexico			4.3	.3	23.5	3.5	27.8	.7
Caribbean:								
Colombia	8.7	.5	16.6	1.1	.5	.1	25.8	.7
N.W.I			302.9	19.9	113.8	16.8	416.7	10.7
Trinidad and Tobago			125.4	8.3	50.4	7.4	175.8	4.5
Venezuela	302.9	18.0	562.2	37.0	133.1	19.7	998.2	25.8
Subtotal	311.6	18.5	1,007.1	66.3	297.8	44.0	1,616.5	41.7
Other Western Hemisphere:								
Argentina			.3				.3	
Bahama Islands			125.2	8.2	24.3	3.6	149.5	3.9
Bolivia	2.2	.2			.2		2.4	.1
Brazil			3.1	.2			3.1	.1
Chile	.7						.7	
Leeward and Windward Islands			1.8	.1	.4		2.2	
Panama			1.4	.1	4.8	.7	6.2	.2
Puerto Rico					95.3	14.1	95.3	2.4
Virgin Islands			210.7	13.9	59.3	8.8	270.0	7.0
Subtotal	2.9	.2	342.5	22.5	184.3	27.2	529.7	13.70
Total Western Hemisphere	1,035.9	61.6	1,383.1	91.0	613.0	90.6	3,032.0	78.2

UNITED STATES IMPORTS OF CRUDE OIL AND PRODUCTS, 1971—Continued

Country	Crude oil: Thousand barrels daily	Crude oil: Percent total	Residual fuel oil: Thousand barrels daily	Residual fuel oil: Percent total	All other products: Thousand barrels daily	All other products: Percent total	Total: Thousand barrels daily	Total: Percent total
Non-Communist Europe:								
Belgium-Luxembourg			5.8	.4	.9	.1	6.7	.2
France			5.5	.4	.1		5.6	.1
Germany, West					.2		.2	
Italy			61.4	4.1	14.0	2.2	75.4	2.0
Netherlands			19.7	1.3	.6	.1	20.3	.5
Norway			1.0				1.0	
Spain			10.5	.7	1.5	.2	12.0	.3
United Kingdom			8.4	.5	.8	.1	9.2	.3
Subtotal			112.3	7.4	18.1	2.7	130.4	3.4
North Africa:								
Algeria	12.8	.8	.9	.1			13.7	.4
Egypt	19.0	1.1					19.0	.5
Libya	53.2	3.2	.4		.4	.1	54.0	1.4
Tunisia	3.3	.2			.2		3.5	
Subtotal	88.3	5.3	1.3	.1	.6	.1	90.2	2.3
West Africa:								
Angola	3.6	.2					3.6	
Gabon			.3				.3	
Ivory Coast			.4				.4	
Nigeria	95.4	5.7	3.8	.3	.2		99.4	2.7
Subtotal	99.0	5.9	4.5	.3	.2		103.7	2.7
Middle East:								
Abu Dhabi	79.5	4.7					79.5	2.0
Bahrain			2.2	.2	8.2	1.2	10.4	.3
Iran	105.7	6.3	3.0	.2	6.1	.9	114.8	3.0
Iraq	10.8	.7					10.8	.3
Kuwait	29.2	1.7	.5		6.9	1.0	36.6	1.0
Saudi Arabia	115.0	6.8	10.5	.7	5.0	.8	130.5	3.4
South Yemen					1.6	.2	1.6	
Subtotal	340.2	20.2	16.2	1.1	27.8	4.1	384.2	10.0
Japan					2.8	.4	2.8	
Far East:								
Australia	7.0	.4					7.0	.2
Indonesia	110.2	6.6					110.2	2.8
Malaysia					8.9	1.3	8.9	.2
Pakistan			.2				.2	
Subtotal	117.2	7.0	.2		8.9	1.3	126.3	3.2
Communist:								
Romania			.8	.1	5.4	.8	6.2	.2
U.S.S.R.			.6				.6	
Subtotal			1.4	.1	5.4	.8	6.8	.2
Total Eastern Hemisphere	644.7	38.4	135.9	9.0	63.8	9.4	844.4	21.8
Grand total	1,680.6	100.0	1,519.0	100.0	676.8	100.0	3,876.4	100.0

Senator BELLMON. What impact will the September 20 Supreme Court decree regarding the Outer Continental Shelf of Louisiana have on helping the Nation meet the energy requirements?

Mr. DOLE. As I mentioned earlier, Senator, your question was on the September 20 Supreme Court supplemental decree?

Senator BELLMON. Yes.

Mr. DOLE. Actually, this will not have a very great impact. We estimate it will only increase production from those wells by five to 10 thousand barrels a day, and on those last statistics that I quoted of 858,000 barrels a day from Canada, you can see that is a very miniscule amount.

Senator BELLMON. Mr. Chairman, I have from Secretary Dole a letter written in response to the question I raised at a recent hearing about the amount of natural gas that is being flared from wells on the Outer Continental Shelf, and I would like to have that made a part of the record at this time.

Senator MOSS. The letter may be inserted in the record.

(The letter follows:)

U.S. DEPARTMENT OF THE INTERIOR,
OFFICE OF THE SECRETARY,
Washington, D.C., March 17, 1972.

Hon. HENRY BELLMON,
U.S. Senate,
Washington, D.C.

DEAR SENATOR BELLMON: During my appearance on February 25 before the Senate Committee on Interior and Insular Affairs, pertaining to production and use of natural gas, you requested information on our policy with respect to the flaring of gas from wells on Federal leases in the Gulf of Mexico. The following outlines our policy and gives some insight to the problems involved in the conservation of natural gas:

1. Our policy is generally expressed in the OCS operating regulations, 30 CFR Part 250, which are administered by the Geological Survey. Section 250.30 requires that a lessee shall take all necessary precautions to prevent damage to or waste of any natural resource. Waste is defined in Section 250.2(h) as:

"Waste means and includes (1) physical waste as that term is generally understood in the oil and gas industry (2) the inefficient, excessive, or improper use of, or the unnecessary dissipation of reservoir energy; (3) the locating, spacing, drilling, equipping,(operating, or producing of any oil or gas well or wells in a manner which causes or tends to cause reduction in the quantity of oil or gas ultimately recoverable from a pool under prudent and proper operations or which causes or tends to cause unnecessary or excessive surface loss or destruction of oil or gas; (4) the inefficient storage of oil; and (5) the production of oil or gas in excess of transportation or marketing facilities or in excess of reasonable market demand."

2. No gas well gas is being flared except for brief initial periods in the testing and cleaning of newly completed wells. The gas being vented or flared in the Gulf of Mexico is gas that accompanies oil produced from oil wells. This gas is in a liquid phase in the oil reservoir but changes to a gaseous phase as the pressure is reduced when the oil rises to the surface. This type of gas is variously referred to as oil well gas, casinghead gas, solution gas, or associated gas. The volume of gas well gas being produced and sold from the OCS is about 6,815,725 MCF (1000 cu. ft.) per day. The volume of oil well gas being produced is about 1,185,600 MCF per day; of this amount, approximately 601,550 MCF per day is being marketed, 312,100 MCF per day is being reinjected for improved oil recovery or used for lease operations, and 272,000 MCF per day is being vented or flared. Thus, about 3.4 per cent of all OCS gas produced is being vented or flared. It is estimated that 20 per cent of the gas now being vented or flared will be recovered upon installation later in 1972 of additional facilities which are required to market the gas. The percentage of casinghead gas being flared in the Gulf of Mexico has been reduced by more than one-third in the last five years.

3. Monthly reports are submitted by each operator showing the disposition of all produced gas, including the volumes of gas being vented or flared. These reports are reviewed by Geological Survey engineers and technicians. Whenever it is indicated, from a review of the reports or by inspection of the platforms, that significant volumes of oil well gas are being vented or flared, our policy is to determine the lessee's plans for conservation of this gas. Our inquiries and evaluation of the specific situation result either in additional compressor capacity being installed, additional pipelines being laid, high gas-oil ratio wells being shut-in, or a determination that the small volumes involved are not economically feasible to recover. In some cases the public's interest is best served by permitting the continued production of the oil until such time as it becomes feasible to market the gas.

4. We have under review and consideration more specific requirements on lessees whereby any flaring of gas other than for short routine well tests or

in emergencies, must be justified in writing to the Geological Survey and formally approved. These requirements are contained in a draft of a new OCS Order, under development since the fall of 1971, which will cover all aspects of production rate control, prevention of waste, and protection of correlative rights This Order is presently being reviewed informally by industry.

5. There will always be a small amount of oil well gas flared or vented in offshore oil well operations unless a large amount of oil production is to be shut-in and kept from the market. Some of the reasons for this gas flaring are: (a) Temporary compressor breakdown or other mechanical difficulties; (b) Delay in deliveries of additional equipment to compress and market the low pressure gas; (c) Delays for FPC certification of gas sales and pipeline construction; (d) Negotiating sales contracts for casinghead gas; (e) Volumes of gas too small to be economically gathered, compressed, and transported to market.

Your concern over flaring of gas in this period of energy needs is understandable. Please be assured that we are doing and will continue to do everything possible to prevent the waste of this energy source from offshore wells.

Sincerely yours,

HOLLIS M. DOLE,
Assistant Secretary of the Interior.

Senator BELLMON. The letter shows 278 million cubic feet per day of natural gas is being flared from the Outer Continental Shelf and it explains in detail why this is being done.

The question I would like to raise with you, Mr. Secretary, is does the State and Federal Government get any royalty return from the flaring of this gas?

Mr. DOLE. Senator Bellmon and Mr. Chairman, I want to congratulate the Senator for bringing this question up at one of our last hearings before your committee.

As I promised the Senator, I personally looked into this matter and I did not realize that it was as large as it was. The letter states that a lot of this material that is being flared comes from gaseous material associated with oil and it is not considered economic to try to pipeline it.

But I can tell you, Senator, that I have asked the Geological Survey to look into charging for this gas and other energy material that is being wasted, with the idea that I am hopeful that it will cause the companies to think twice about flaring this and put it back into the mainstream of commerce.

At the present time, correct me if I am wrong on this, the U.S. Government is not receiving any funds from the flaring of this material; is this correct?

Mr. WAYLAND. That is right.

Senator BELLMON. If a charge was made to a company that felt it was more economic to flare gas than to compress it and market it, this would seem to me to have the effect of causing or increasing the attractiveness of making whatever arrangements are necessary to put this gas into the Nation's energy supply.

Would this be your conclusion?

Mr. DOLE. This is what we hope will happen, Senator. And once again, I thank you for calling this to our attention because we certainly are responding to your inquiry.

Senator BELLMON. It also seems to me that with the Federal Power Commission decision to allow liquified natural gas, which cost this country a price of—what will it be?

Mr. DOLE. At least a dollar. I have seen some prices up to $1.45.

Senator BELLMON. With natural gas being worth that much because the companies aren't bringing it in at a loss, we might put a fairly high value on this gas being flared because it is only a matter of time before it is going to be desperately needed.

I feel frankly rather ill to discover that we are wasting this much of our resources and it would seem that the Department would be justified in taking some rather extreme measures to bring the practice to a halt.

Mr. DOLE. Congress can also aid us in this respect. As I mentioned earlier, on a BTU basis the price of natural gas is much lower than the price of any of the other energy sources.

In other words, it has an economic advantage. Yesterday I had the pleasure of testifying before Senator Hollings in the Commerce Committee on the Hollings bill and the Hansen bill on the pricing of natural gas, and it is my hope that Congress will soon pass the sanctity of contract bill and allow the price of natural gas to seek a free market price rather than a controlled price by the Federal Power Commission.

This, too, this increase in the price of natural gas would not only benefit the oil and gas industry and our energy situation, but it would tend to bring our energy mix in better balance.

Senator BELLMON. It occurs to me that perhaps the Federal Power Commission could give some special dispensation that might be required by the regulation from the Department of Interior to save this gas at a financial loss by allowing it to be marketed at a price equal to what they are allowing LNG to come in here as.

If the company has to build a compressor station to compress this gas and lose its money, it would seem to me it would be in the national interest to allow the FPC to market this gas rather than see it flared, because once it is flared it is gone forever.

Mr. DOLE. As you know, the Federal Power Commission is taking a very hard look at what they can do. But the Federal Power Commission is a regulatory agency that is pretty well bound in by several court rulings.

Their attitude toward the pricing on natural gas is certainly an improvement over that the Federal Power Commission established during the early 1960's and mid-1960's.

I feel they are moving as rapidly toward the solution of pricing of natural gas in order to assure the U.S. customer, the individual, that they will have a supply of these fuels.

Senator BELLMON. The point I was trying to make, if it cost more than the present wellhead price to save this gas, the FPC might be approached on the theory that if it let's the companies sell the gas for what it would cost them to save it, that we would stop wasting the resources.

I would like to put in the record the figures we received from the Interstate Oil Compact Commission showing the amount of gas being flared and I want to set the record straight.

When I brought this up earlier, I said my State was not flaring gas. I found that not only was I wrong, but my State was flaring more gas than any other State in the Union.

The figures for Oklahoma are 370 cubic feet a day and the Nation is 46 billion cubic feet a day. I intend to pursue a course of action to get this stopped.

Senator MOSS. I am very shocked to find we are flaring gas at all. I know economics is the answer, but the fact that we are so desperately short of gas as a source of energy, makes it reprehensible to know some of it is being flared.

Senator BELLMON. I think the responsibility rests with the Federal Power Commission because it sets the price at such a low level it makes it uneconomical to save this resource.

I would like to pursue another line of questioning. You mentioned earlier that procedures are being tightened up to prevent future oil spills. I was impressed, frankly, with what we were able to observe in the fieldtrip the committee made to the Outer Continental Shelf.

I wonder if you would like to be a little more specific about what some of the procedures are that you recently put into effect to control oil spills.

Mr. DOLE. Dr. McKelvey.

Dr. MCKELVEY. Senator Bellmon, they come into two main areas. One is a change in regulations, and the other is a change in inspection procedures, particularly the increase in the amount of inspection activity.

With respect to the changes in the OCS regulations, they have been strengthened to require additional safety features on platforms and pipelines; to require the testing of safety devices prior to, during, and in production use; more careful control of drilling and casing operations; prior approval of plans and equipment for exploration and development drilling; and suspension of any operation threatening life, property or damage to other resources or the environment.

We require the reporting of all leaks and spills and to control the removal of any spills at the leasee's expense.

With respect to the inspection capability, we have more than doubled our staff. We are making use of helicopter support and a radio communication system that allows us to get more for our inspection hour than we were able to do before.

We standardized our inspection procedures. We have provided a basis for inspection strategy. We have increased the number of unannounced inspections, which in turn, has to do with increasing our visibility in the area which is in itself a deterrent, and we have also participated in the development of interagency plans, particularly with the Coast Guard, for contingency plans for oil spill clean up.

I mentioned also that we had other studies in progress. We asked NASA several months ago to undertake a study for us on hazard analysis procedures and that study has been completed and released.

We also have another study under way in-house and still another one is being conducted for us by the National Academy of Engineering.

Senator BELLMON. Let's assume a company has a permit to drill a well. Will your inspector always be on the scene during the time the well is being drilled?

Mr. MCKELVEY. No, Senator Bellmon, it would be an extremely heavy burden, a very great requirement in personnel to have an inspector full time on each rig.

One of the problems that we are investigating is what is the most efficient and effective way of conducting inspections. We have done a lot in the development of and improving of inspections systems, in systematizing it, putting in many elements of the inspeection on a statistical basis so that we are sampling the total operation and keeping the operators on their toes, being aware that at any given time their operation may be inspected for all critical elements.

Mr. DOLE. Senator, I might add to that by saying in the Santa Barbara area we do have an inspector there on those rigs everyday. At least once a day an inspector visits those rigs.

During the critical period in the Santa Barbara Channel area we had an inspector on the rig 24 hours a day, but there are several thousand rigs down in the Gulf Coast and as Dr. McKelvey mentioned, that would be a very large burden on the Federal Government to keep a man on the rig every day there.

Senator BELLMON. Do you happen to know how many drilling rigs are currently operating on the Outer Continental Shelf?

Dr. MCKELVEY. There are about 1,845 platforms, I believe.

Senator BELLMON. I am talking about a drilling rig.

Dr. MCKELVEY. About 90 drilling rigs, some of which would be on platforms.

Senator BELLMON. How many inspectors does the Department have to service these rigs?

Dr. MCKELVEY. About 30, sir.

Senator BELLMON. Thirty?

Dr. MCKELVEY. Yes.

Senator BELLMON. Would this be the only responsibility these 30 inspectors have or do they have to inspect all of the platforms as well?

Dr. MCKELVEY. They would have to inspect the platforms as well.

Senator BELLMON. So you have 30 inspectors available to inspect 90 drilling rigs and 1,800 platforms?

Dr. MCKELVEY. Correct.

Senator BELLMON. How often would an inspector be able to visit a platform or drilling rig?

Dr. MCKELVEY. As Secretary Dole mentioned, in the Santa Barbara area they are visited daily, but in the Gulf of Mexico much less frequently.

Senator BELLMON. What I am leading up to, has the Congress give the Department an adequate budget to do the proper job of super vision and inspection of the Outer Continental Shelf for oil producin activities?

Dr. MCKELVEY. Well, Senator, our budget for this general leas management activity has been increased about fivefold since 1963.

Senator BELLMON. Well, is this from zero?

Dr. MCKELVEY. From a level of about $1 million a year to about $ million currently. Presently we believe we are adequately staffed t insure that the operations are conducted safely. But, as I mentione we are also studying the question of the inspection procedure with thi very specific question in mind.

How much inspection, how frequent, done in what way, just what i needed for adequate surveillance on the Outer Continental Shelf op erations. We don't consider that we have a static situation or that w have at the present time a firm answer by any means.

In other words, we are not saying that our inspection procedure is the most adequate possible by any means. We expect it to be changed with the results of our research, and we expect it to be changed, also, with the future development of technology in the area particularly of development of safety devices and so on.

So it is a changing situation. We think we are on top of it at the present time, but we are not by any means saying we know the procedure that we follow is the most desirable possible and that we don't have to create any changes in the future.

Mr. DOLE. Senator Bellmon, to bring these numbers into the record, in January of this year there were 88 active drilling wells in the Gulf of Mexico and on the offshore there are 650 producing leases on 2.8 million acres.

So, we have two things. One, those that are drilling and those that are producing.

Senator BELLMON. How many inspectors oversee this?

Mr. DOLE. Thirty inspectors.

Senator BELLMON. I have never tried to cover 2.4 million acres but it sounds like a large area.

Can the Department demonstrate any results from the increased inspection activities?

Dr. MCKELVEY. Yes, sir. Part of our inspection procedure consists of a very detailed list of items that each inspector checks. We call these potential incidents of noncompliance. These include some things that might seem to be trivial. If something went wrong with a particular item, possibly a major accident would not develop, but nevertheless they represent the things that presently we consider to add up to a safe operation.

We have found a marked decrease in the number of violations that have been reported in our inspection over the period that this procedure has been in operation.

In other ways it is evident that the inspection procedure is having a salutory effect in tightening up operations on the part of the companies.

They have helped to develop a safety consciousness, if you like, through the entire industry.

With respect to specific examples, we think the sum total of our activities has already served to avoid some serious disasters.

If you would permit, I might read one or two specific examples of reports.

Mr. DOLE. While he is looking at that, Senator Bellmon, I have a note that has just been handed to me that says:

"Specs conducted on the production platforms have found a great many reductions in missing or inoperable safety equipment between December of 1970 and January of 1972.

"In December of 1970, 2 months after the revision of OCS orders prescribing safety equipment procedures, 5.8 percent of the equipment, records and procedures were found to be not in compliance.

"In the January of 1972 special inspection, this number was reduced to 0.38 percent. In other words, a reduction from 5.8 percent to 0.38 percent."

Senator BELLMON. Have there been fewer spills or accidents as a result of your inspection activities? Have you had a spill this last 12 months?

Mr. DOLE. The number of small oil leaks and spills we estimate have been cut in half and there has not been a major fire or spill on the OCS in the past 6 months. I believe it was October of last year, so it is 6 months.

Senator BELLMON. Do you feel that the present regulations pertaining to oil and gas production on the OCS are sufficiently strict to adequately protect the marine environment and the safety of the personnel involved?

Dr. MCKELVEY. Senator, to say absolutely protect, I don't think anyone could say, dealing with any kind of operation in which human beings are involved, that it would be possible to reduce the likelihood of an accident to zero probability. One can't even cross the street with that kind of certainty. You can look up and down the street, no cars are coming, but still one can shoot you from a window, or something of that sort, something totally unanticipated.

But, Senator, I do feel that regulations as now developed, the inspection procedures that have been developed and the improvement in safety devices and so on, all have served to reduce greatly the probability of serious accidents on the OCS.

I may say also we feel there is still room for improvement. As I said earlier, we are dealing with an accident record that in toto is already pretty good, and we feel that we have reduced the chances of mishaps in the ways that I have mentioned considerably, but we are still working on it. We believe that further improvement is possible.

I think that Secretary Dole a while ago referred to the improvements that have been made in the containment of spills, for example. Very little of the oil in the Santa Barbara spill was recovered, about 10 percent was recovered in the first Gulf accident, about 40 percent in the one after that.

The conditions under which those spills took place are not exactly the same. Maybe it is not fair to make that comparison or to say that that amount of improvement is due solely to the improvement in the procedures. But they show a learning curve, I think, no matter how you interpret them.

We think this learning curve is applicable or applies throughout other operations as well. We think we are doing better, but we think we can still do better.

Senator BELLMON. I will ask this one additional question.

Which agency has final authority so far as environmental questions are concerned on the OCS? Do you make your own rules?

Dr. MCKELVEY. With respect to the enforcement or the definition of operations that are to take place in connection with operations on offshore leasing, the Geological Survey has the full responsibility.

Senator BELLMON. You don't have any procedure for clearing with the Environmental Protection Agency?

Dr. MCKELVEY. We are working closely with the Environmental Protection Agency, but their jurisdiction does not extend to the OCS, sir.

Mr. DOLE. They set sewerage treatment standards. We see that the operations meet those standards.

Senator BELLMON. So there is, then, a clear line of authority as to who has the responsibility on OCS?

Mr. DOLE. We think there is, Senator Bellmon, but I am not so sure this is exactly so.

Senator BELLMON. That is all, Mr. Chairman.
Senator MOSS. Thank you.
The Senator from New York.
Senator BUCKLEY. Thank you, Mr. Chairman.

At the outset of this hearing you asked me if I had a statement to introduce. Because of traffic difficulties, I did not at that moment, but if I may, I would appreciate being able to insert this statement and have it printed.

Senator MOSS. That will be printed in the record.

STATEMENT OF HON. JAMES L. BUCKLEY, A U.S. SENATOR FROM THE STATE OF NEW YORK

Senator BUCKLEY. I would like to take a moment to express my sense of good fortune to have become a member of this committee and for the opportunity which this hearing provides me for the examination of an issue which is of particular concern to the people of the State of New York, particularly those living on Long Island. The possibility that the Atlantic Outer Continental Shelf contains commercially valuable oil or gas reserves has stirred deep apprehension, and often alarm, among those citizens who live and work near coastal areas in my State; I am sure they share these fears with their neighbors to the north and south on the Atlantic seaboard.

At a time when the public's awareness of potential environmental dangers is acute, memories of the Santa Barbara blowout in January 1969, the Gulf Coast fire in early 1970, the West Falmouth tanker spill in September 1969 do not fade quickly. Long Islanders are constantly reminded of the dangers of oil spillage with each report of a tanker going aground near Port Jefferson and with each mysterious appearance of a slick that is claimed by no one.

The dense concentrations of population along the east coast are an important factor in placing coastal areas at a premium, and with good reason. Long Islanders jealously guard their values: those of shellfishing, sport and commercial fishing, recreation, and the value of coastal wetlands to seabirds and those minute marine organisms which provide food for larger species and which play a vital role in the marine ecosystem.

I appreciate the fact that these hearings are being conducted not to determine whether it is wise or necessary to drill for oil in the Atlantic, but rather to oversee the broad policy issues associated with the administration of the Outer Continental Shelf nationwide, particularly as OCS reserves contribute to our national fuel and energy supplies.

Nevertheless, I believe that the situation now presented by possible OCS leasing in the Atlantic Ocean serves to focus the attention of the Federal Government on the environmental issues probably more than ever before.

I am particularly interested in examining how the Department of the Interior intends to safeguard environmental values, both in its guidelines and inspection of offshore facilities and in its ability to require and assist in the immediate removal of any oil which is spilled. Most important, I hope that at some point during these hearings, we might receive information on the state of our knowledge of the short and long-term effects of oil spillage on the marine environment. This is an issue fraught with controversy and one which is of particular significance in determining whether it is in fact wise public policy to increase any activity which adds to the threat of irreversible damage by oil.

I thank my colleagues for their indulgence in allowing me to express my special concerns and those of my constituents.

Mr. Secretary, in listening to the questions that have been asked you, I find that many of the questions that I did have have been anticipated. But I would like to concentrate on one area of concern which is geographically localized, namely, the northeast coast of the United States.

We have, first of all, one of the largest populations in the United States. Over the years we have managed to destroy more than our share of beaches, marine areas, coastal wetlands and so on, so what we have left is rather precious.

There is a tremendous concern at the present time at the prospect of drilling off the Atlantic Coast. So my questions are more or less directed to this area, and I would appreciate if you could answer in this light, considering this particular series of problems.

Now, I was interested in a statistic which you gave us to the sources of our overall global oil pollution, ocean pollution.

You mentioned 2 percent of it is derived from drilling and something like 29 percent from tankers. Now taking into consideration the concern for the protection of beaches and wetland areas, do you have any comparable figures that would give us a breakdown of pollution, say, within 10 miles of the shoreline or within the Continental Shelf area?

Mr. Dole. Not within that area, but I would like to add another bit of statistics that I think is highly applicable to your area, Senator Buckley. That is, let's see, 28 percent from tankers and about 30 percent from automobile crankcase oil, 19 percent from other marine vessels, industrial waste, 21 percent.

Now, let's look at this automobile crankcase oil and this—although this report is only current to 1968, it is the only thing I can find this morning. It says about 6 million metric tons of lubricating oil was sold during 1968. The total amount drained for refill was about 3 million metric tons. These include automotive use as well as industrial machinery. The 3 million tons were disposed of in the following manner: Rerefined in which the oil is reused again, 0.441 metric tons. Disposed of as fuel oil, that is to be generally burned in diesel trains, 0.97. Used as road oil, 0.441. Dumped on land or in sewers, 0.61. Not accounted for 0.52.

In other words, better than 1.2 was dumped on the land and not accounted for.

Now, the Coast Guard has estimated that 1.4 million metric tons from highway vehicles and 0.75 million tons from industrial machines finds its way into the sea. This totals 2.1 million metric tons. They arrive at these figures by means of a roundhouse estimate that 75 percent of all drainage finds its way to the sea.

I do not have any figures on the localization of oil around the beaches, but we had a study made by an interim student 2 years ago in which he found out that the greatest oil pollution is found near the industrial centers.

In other words, New York Harbor has a greater amount of oil pollution than do the areas where oil and gas are produced.

Now speaking specifically to the subject that you have introduced, that is the concern that you and your people are expressing on the work that is being done at the present time in trying to find out what the resources might be in the Atlantic Coast, especially the mineral resources off the Atlantic Coast, and this is all we are doing, I want to make this perfectly clear here.

There has been no decision made to even make an environmental impact statement, let alone go through any leasing route.

I want to make this perfectly clear. All we are doing is trying to find out what the resources are. But one of your biggest problems, Senator Buckley, as you well know, as you get it from constituents, is the high price of fuel oil and of gas and oil in the New England area.

You are actually, literally at an end of the pipeline. The pipeline coming from the Gulf Coast up into that area. It is in the New England and New York area that all these projects for the making of methane from imported naphtha, the manufacture of gas from liquefied natural gas, or the manufacturer of gas petroleum, it is within the east coast area where most of these are concentrated.

Now, as Senator Bellmon pointed out, natural gas at the New York gate sells around 45 cents per million B.t.u. Fuel oil sells for considerably more than that.

Number 2 oil, residual, sells for considerably more than that, two to three times as much.

On the other hand, gas from LNG or SNG will be in the order of $1.50 to $2. Now, if there could be found and developed substantial oil and gas deposits off the Atlantic Coast, you would find that you would have less pollution because you would have less tanker traffic bringing it in there. You would have a greater security of supply and certainly the cost is not going to be comparable to the cost of importation of LNG or SNG.

I think a lot of rethinking has to be done by the people along the Atlantic Coast and the priorities put in their proper perspective before any decision is made whether to or whether not to look at the mineral resources of the Atlantic Coast in trying to develop it.

Senator Buckley. I would agree, Mr. Secretary.

Of course, one of the problems is to get the information on the basis of which we make these relative judgments. I think, first of all, I personally feel you ought to free up all sources of energy for the maximum competitive—expose them to the maximum competitive mechanisms of the marketplace.

I think that we want to preserve some of our environmental assets and we have to be prepared to pay the cost. But we have to know what the costs are and the dangers.

Now, in terms of some of the figures that you have given where we have pollution, but in a very diffused way, I think, concerning people specifically on Long Island, for example, what is concerning them is he possible effect of a local catastrophe which might appear in the world and global statistics of .0001 of the total spillage but might nevertheless do serious, lasting damage to a particular wetland to the oysters and clams of that area. This is the kind of thing that I hope we can focus on and get hard information about.

Given the problem that we now have and the new techniques for safety which was described by you and Dr. McKelvey, is there a distance from shore at which one could state that spillage would not effect onshore facilities and land?

Mr. DOLE. I think, Senator Buckley, that distance very definitely is a factor. The farther from shore the less effect it will have on them and their probably is a distance where the effects would be very minimal.

From our knowledge to date of the geology off the Atlantic seacoast, it appears that those structures that may have interest would be from 50 to 80 miles out. They would not be adjacent to the shore or visible from the shorelines as they are out in Santa Barbara Channel. But Alaska has had a very minimum of pollution.

On the Cook Inlet where there was one drilling here several years ago, I believe it was in the mid-60's, where there was a well that blew out and actually burned for a year before it was brought under control, and as you know in the Cook Inlet the tides are very high and the winds are high, and to the best of my knowledge there was no discernible effect on the beach.

On the other hand, we know of oil accumulations that have come ashore from an unannounced source, but undoubtedly it was from the pumping of bilges that did destroy birdlife and animal life onshore.

The inference I am trying to make is that in high seas and at some distance away, any problems that you might expect from drilling—the effect would probably be very low. But a tanker has to come to shore and the tanker poses a much greater problem than does the drilling.

Senator BUCKLEY. In terms of developing a national strategy to, number one, supply us with the energy which our population wants and by the same token minimize the risk to the environment, do you feel there is adequate coordination?

You, for example, as the Department of the Interior, have jurisdiction over Continental Shelf drilling. By the same token you point out the greater hazard of tankers. Is there any mechanism which would, for example, determine rules and regulations as to how close in tankers should come or determine what ports of entry might be best suited for this operation or might pose the least possible danger?

Mr. DOLE. I am not quite sure I understand your question, Senator Buckley, but let me take a stab at it.

Number one, the determination of an energy policy is going to be very difficult because of the responsibility of many agencies within the Government, such as the Atomic Energy Commission, such as the Department of Commerce or Marine Division on tankers. It has been the Office of Oil and Gas and the Geological Survey and the Department of the Interior, the Federal Power Commission.

It is difficult to get the coordination that will be required for the establishment of a national energy policy. This is one of the reasons why I feel that the Department of Natural Resources as proposed by President Nixon in his Reorganization Message to the Congress is why I am hopeful that the Congress will take this up at a very early time because I think the Department of Natural Resources is absolutely necessary for the development of a good, close energy policy.

Now, as I understood another one of your questions or another part of your question; is there a mechanism for the establishment of the size of ship that can come inshore and the like and the amount of traffic?

I think the factor here that must be considered is that we are going—that the shipping industry is going to get larger and larger tankers and, to the best of my knowledge, there are only two ports in the United States that can take the so-called supertanker and those are both on the west coast. I believe it is Long Beach Harbor and in Puget Sound.

This then indicates that if you are going to make the savings in the movement of oil that are effected by utilization of the supertanker, we have to look to offshore loading facilities.

My guess is that studies such as these are underway here in Government because now the only plans I know of are to establish large scale supertanker unloading facilities in the Bahamas and Nova Scotia.

Senator BUCKLEY. You mentioned earlier, Mr. Secretary, that the Department has negotiations with the States in terms of developing mutually agreeable rules. Let us assume a case such as New York or any other coastal State feels it desirable in terms of its own priorities to make an absolutely fail-safe protection of one specific area or another, let's say a particular evironment that is essential to the survival of a particular species.

Would you believe it is desirable that the States should be given a veto power over the development of Outer Continental Shelf where exploratory activities or production activities could in the case of an accident, jeopardize that particular area?

Mr. DOLE. Senator Buckley, I had the pleasure of testifying before Chairman Moss' committee here not too long ago on a bill that would give the States a veto power on this.

In this testimony I brought out that the—no I felt the Secretary of Interior should have the final authority on this.

However, this does not preclude a close cooperative agreement with the States. As a matter of fact, I think you would be pleased to know that the head of the New York Environmental Agency and I were in conversation just the day before yesterday.

He was concerned about mined land reclamation in the New England States. I have sent him a bunch of material that he and his fellow environmentalists in the New England area will find useful, I am sure. I think you will be pleased to know that next month the Under Secretary and myself and other members of the Department of Interior will be meeting with a delegation of Atlantic Coast and New England people who will be down here and we will discuss again many of the problems we have discussed today.

We are trying to show them all the information we have available, but in answer to your question, no, I think that the Secretary has to have final authority on this because I think it is important to realize that although one area may have the problems where they have large sources of a particular material, copper, for instance, or oil in Wyoming, for instance, but that isn't only for the benefit of the people in that local area. It is for the benefit of the economy and the people of the whole United States and these are Federal concerns.

Senator BUCKLEY. Thank you, Mr. Secretary.

A little earlier you read from a paragraph which you had in anticipation of questions about the evironmental impact on spillages. You quoted from a Dr. Dale Straughan who examined the damages at Santa Barbara. Have you been aware of study recently in progress by which scientists, specifically Dr. Max Blumer—well, if I may, let me quote from a summary of some of their findings thus far.

This is based on the study of a tanker spill of fuel oil off of Woods Hole, in September of 1969.

This particular study concludes:

> All crude oils are poisons for all marine organisms; many crude oil distillates are more severly poisonous because they contain higher proportions of the immediately toxic compounds.
>
> Long-term toxicity may harm marine life that is not immediately killed by spills, and oil can be incorporated into the meat of marine animals, making it unfit for human consumption. Crude oil and oil products may cause cancer in marine organisms and in man; even at very low concentrations oil may interfere with processes which are vital for the propagation of marine species.
>
> The most immediately toxic fractions of oil are water soluble; therefore, recovery of oil slicks is often futile, except for the aesthetic improvement.
>
> Treatment with detergents, even the "nontoxic" ones, is dangerous because it exposes marine organisms to higher concentrations of soluble and toxic hydrocarbons and because it disperses oil into droplets that can be ingested and retained by many organisms.

Are you aware of this line of investigation?

Mr. DOLE. I am, and I think this refers to the statement Dr. McKelvey made earlier about synthetics, or if you wish, refined oils that we do not know as much about those as is desirable.

I think it is also referring back to discussions we had earlier here today in which we pointed out that oil seepages have been occurring here in this world of ours since the beginning of time and there has been an awful lot of crude oil brought to the ocean surfaces and without any, at that time, visible damage, but, of course, that could be due to the lack of research.

Now, I understand, Senator Buckley, that one of Dr. Blumer' cohorts at Woods Hole has also been studying the material which Dr. Blumer refers to, that particular oil spill, the tanker spill. I have no gotten this firsthand, but I understand that the findings of Dr. Blumer's fellow scientists are practically opposite conclusions to wha Dr. Blumer did.

Perhaps Dr. McKelvey is more acquainted with this study than and would like to add something to this.

Dr. McKELVEY. I am sorry, I heard the same thing, but I can' elaborate on it. We haven't gotten any specifics on it. But if I may refe to the work of Dr. Blumer, I think perhaps that he has over general ized, in assuming that the observation in a particular area that h studied, particularly the effects of a particular spill, to say that this i true in all cases, I think is perhaps going too far.

It is in contradiction with the results, for example, of the work o the scientists at the University of Southern California on Santa Bar bara. It would seem not to be supported by other observations else where. It goes back to the questions I mentioned earlier.

The effects of differences in oils and different kinds of environments involve a good many variables. It is quite possible that a certain oil in a specific environment will have a deleterious effect, whereas another oil in another environment may not.

Senator Moss. Haven't we identified a bacteria that actually breaks down the molecule and in fact this is one of the areas of research to be applied in areas where we do have an oil slick.

Dr. McKelvey. Yes, sir. This is true, Mr. Chairman.

Certain bacteria do break down and degrade petroleum. As a matter of fact, this is one of the things that may have to do with the accumulation of petroleum in the first place.

It has been recognized for some time that petroleum or the compounds from which it is derived are destroyed in oxidizing environments on the sea bottom. Petroleum is organic in origin. It originates through organic activity, produced by marine organisms of various kinds.

If organic fats and oils are not destroyed by oxidation they can end up as petroleum. As it becomes buried by the accumulation of sediments—it has been recognized for some time that these kinds of materials are destroyed by oxidizing environments and in considerable part through the activities of various kinds of bacteria and perhaps other organisms.

Senator Moss. Well, I have understood that this is the reason these analyses and exposures that have occurred previously have all gradually been dissipated because the oil molecules have been broken down into the component parts and disappeared into the general environment.

Dr. McKelvey. Right. But, and Dr. Blumer referred to this in the statement Senator Buckley quoted, it is possible that the biodegradeability of the various hydrocarbon compounds may vary considerably. Some may be more resistant than others to the bacterial attack. This may be true even with natural oils.

There is a great variation of crude oil. It is not a chemical compound. It consists of many chemical compounds. One crude oil is likely to be very different in composition than another. So it is quite possible that variability exists among natural crude oil to say nothing of the synthetics.

Mr. Dole. May I add to that also by saying that in 1969 there were 34,002 tanker arrivals at the Atlantic Coast Ports of which 11,736 were into New York Harbor and 7,094 were into Boston Harbor.

So in 1969 we had 34,000. As your dependency on offshore oil increases, you see the type of traffic we will be looking to at that time.

Senator Buckley. Mr. Chairman, I wonder if I could make a part of the record at this time the paper by Dr. Blumer.

Senator Moss. Yes, it may be placed in the record.

Senator Buckley. I would also like to observe, and apparently Dr. Blumer is not the only scientist whose conclusions are under attack, I note the studies made by Dr. Straughan are attached by Dr. Nushel of the University of California who also investigated the spill under contract with the Oil Pollution Administration.

In this report Nushel made the statement, "There was no extensive ecological damage." I am a layman, of course, and I have no expertise but it does appear to me there is a great deal of uncertainty as to what the facts are.

I note Dr. McKelvey stated earlier he thought this was an area of research which must be pursued. May I assume any environmental impact statement in connection with the offshore leases off the Atlantic will make a detailed investigation of all these areas?

Mr. DOLE. Well, Senator, you can certainly be assured of that. Secretary Morton, who is a Marylander, as you know, has absolutely insisted we have close contact with the States in any work we do out here. And when your bossman instructs it, I can tell you, you do it.

Senator BUCKLEY. Given the fact that the NEPA legislation now mandates that those departments broaden their sights to take into it environmental consequences, does the Department of Interior intend to initiate the kind of study that Dr. McKelvey feels is desirable?

Mr. DOLE. You mean basic research, Senator Buckley, on oil?

Senator BUCKLEY. Yes.

Mr. DOLE. I am not so certain that this is the precise area where we should be doing research. I would prefer to have Dr. McKelvey answer this and perhaps I can get together at some future time to discuss it.

Dr. MCKELVEY. As I mentioned we have already in the Geological Survey done some work on this. I might say that one of the things that stimulated us was a sort of curious event and that was that we found that much of the oil from one of the spills in the San Francisco Bay had sunk. As you know, oil is lighter than water and this phenomenon made us think that actually in many other areas where spills may have sometimes occurred, they dissipated quickly and they also sunk. So it underscored to us that we do not really know all we need to know about what happens when oil is released in sea water.

But yes, the Geological Survey is beginning some work in this area. The question is also of interest to the Bureau of Sport Fisheries and Wildlife within the Interior, and as I mentioned, it is of interest to other Government agencies as well, and a number of them are undertaking the studies in this field.

Mr. DOLE. I think Dr. McKelvey would tell you that it was from an inquiry from me that they started their research on what happened from this oil.

So I can assure you we are concerned.

(Paper by Max Blumer follows:)

PAPER PUBLISHED BY MAX BLUMER, SENIOR SCIENTIST, WOODS HOLE OCEANOGRAPHIC INSTITUTION, WOODS HOLE, MASS.

OIL CONTAMINATION AND THE LIVING RESOURCES OF THE SEA

(By Max Blumer)

ABSTRACT

Pollution introduces an estimated 5–10 million tons of crude oil and oil products into the ocean per year. The threat to the living resources of the sea is most severe in the coastal environment. There, oil pollution adds to the growing stresses from sewage, insecticides, chemicals, overfishing, and the filling of wetlands.

All crude oils are poisons for all marine organisms; many crude oil distillates are more severely poisonous because they contain higher proportions of the immediately toxic compounds. Long-term toxicity may harm marine life that is not immediately killed by spills, and oil can be incorporated into the meat of marine animals, making it unfit for human consumption. Crude oil and oil products may cause cancer in marine organisms and in man; even at very low concentrations oil may interfere with processes which are vital for the propagation of marine species.

The most immediately toxic fractions of oil are water soluble; therefore, recovery of oil slicks is often futile, except for the aesthetic improvement. Treatment with detergents, even the "nontoxic" ones, is dangerous because it exposes marine organisms to higher concentrations of soluble and toxic hydrocarbons and because it disperses oil into droplets that can be ingested and retained by many organisms.

Natural bacterial action eventually decomposes spilled oil; however, the most toxic fractions disappear much more slowly than the more harmless ones. Within the lipids of marine animals and in sediments petroleum hydrocarbons are stable for long time periods.

MARINE RESOURCES—MULTIPLE USES

Throughout history man has used the ocean and especially the coastal waters as a source of food and of minerals, for shipping and for disposal of his wastes. Today, more than ever, the ocean has a very large tangible and intangible value and an even greater potential. The present annual world income from marine fishing in now roughly $8 billion. The world ocean freight bill is nearly twice that. In contrast, the mineral recovery has a relatively small value; the world oil and gas production from the seabed is worth approximately half that of the fish catch, and all other mineral production adds only $250 million.[1] The value of the ocean for recreation and for waste disposal is not easily put into similar figures; through its interaction with the terrestrial ecosystems a healthy ocean may well have critical importance for the survival of the human species.

The economic and aesthetic potential of the coastal regions is far greater than what we realize now; it has been estimated that with presently available technology Puget Sound (in western North America) alone could produce annually 6 million pounds of oyster meat, equal in value to the entire present U.S. fish catch.[2] Most of the potential marine productivity is concentrated in coastal waters. Ryther[3] states that the open sea—90 percent of the ocean—is essentially a biological desert, that produces a negligible fraction of the present fish catch and has little potential for yielding more in the future. The coastal waters produce almost the entire shellfish crop and nearly half of the total fish crop; the remainder comes from regions of upwelling waters that occupy one-tenth of 1 percent of the ocean surface and that are located near the margins of some continents. Similarly, recreational values, oil and mineral resources and marine waste disposal areas are concentrated almost entirely in the coastal regions of the ocean.

MARINE RESOURCES—MULTIPLE STRESSES

Our growing population and our expanding technology lead to an increasing dependence on marine values. Different uses of the marine resources are often in conflict and are being made and planned with little regard for the marine environment as a large interrelated ecosystem. Many unrelated causes contribute to the deterioration of the environment; oil pollution, the subject of this review, is only one of them. Additional stresses come from the loss of marshland, from overfishing, from pollution with persistent chemicals and with domestic and industrial wastes. The marine environment is tolerant of changes—up to a point. Many individual actions and even single large stresses can be tolerated; whether this is still true for the sum of the stresses imposed on the environment now, should be a matter of great common concern. We have polluted many of our rivers and lakes, including some large bodies of water like Lake Erie. The wastes that now enter the ocean are similar to those that have damaged the Great Lakes; in fact they are probably more toxic and more persistent. Given the same damaging input, the ocean differs from the lakes principally only in its size and time constant; changes may take a much longer time to become evident but as a direct consequence, restoration of a polluted ocean will also require an entirely different time scale. A polluted small lake can be reclaimed within a few years. Lake Erie may or may not be restored within fifty years but a polluted ocean will remain irreversibly damaged for many generations.

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[1] Holt, S. J., "The Food Resources of the Ocean," Scientific American, Vol. 221, pp. 178–194, 1969.
[2] Westley, R., "Conference on Pollution of the Navigable Waters of Puget Sound, the Strait of San Juan de Fuca and their Tributaries and Estuaries, Seattle," Vol. 1, pp.174 f–m, 1967.
[3] Ryther, J. H., "Photosynthesis and Fish Production in the Sea," Science, Vol. 166, pp. 72–76, 1969.

Ketchum[4] has pointed out "that nature has a tremendous capacity to recover from the abuses of pollution, so long as the rate of addition does not exceed the rate of recovery of the environment. When this limit is exceeded, however, the deterioration of the environment is rapid and sometimes irreversible."

It is not within the scope of this paper to consider the entire field of marine pollution; the further discussion is restricted to the problem of marine oil pollution because of the increasing extent of oil spillage and because of its severe, but largely unrecognized, biological effects.

OIL POLLUTION-EXTENT

Oil pollution is the almost inevitable consequence of our dependence on an oil-based technology. The use of a natural resource without losses is nearly impossible and environmental pollution occurs through intentional disposal or through inadvertent losses in production, transportation, refining and use. Large catastrophes like that of the "Torrey Canyon", the blowouts at Santa Barbara and in the Gulf of Mexico get the attention of the public because of the obvious aesthetic damage and the harm to birds. Small and continuing spills and their far greater impact on less visible resources are less apparent to the public. It is estimated that 10,000 pollution incidents occur annually in U.S. waters alone and that oil pollution accounts for 7,500 of these. We have estimated that the present practices in tanker ballasting introduce about 3 million tons of petroleum into the ocean. The pumping of bilges by vessels other than tankers contributes another 500,000 tons. In addition, in-port losses from collisions and during loading and unloading contribute an estimated 1 million tons.[5]

Oil enters the ocean from many other sources whose magnitude is much less readily assessed; among these are accidents on the high seas (Torrey Canyon) or near shore, outside of harbors (West Falmouth, Mass.), losses during exploration (oil based drilling mud) and production (Santa Barbara, Gulf of Mexico), in storage (submarine storage tanks) and in pipeline breaks, also, spent marine lubricants and incompletely burned fuels. A major contribution may come from untreated domestic and industrial wastes; it is estimated that nearly 2 million tons of used lubricating oil is unaccounted for each year in the United States alone, a significant portion of this reaches our coastal waters.[6] [7]

Thus, the total annual oil influx to the ocean lies probably between 5 and 10 million tons. There is an urgent need for a more accurate assessment of the pollution of individual oceanic regions and of the relative contribution of different oils.

OIL—COMPOSITION AND PERSISTENCE

Petroleum is one of the most complex natural materials and contains many thousand different compounds. Different crude oils differ markedly in their physical properties, such as gravity, viscosity and boiling point distribution. It is beyond the scope of this paper to describe the crude oil composition more than superficially (see reviews in: Eglinton and Murphy).[8] However, for our discussion, considerable simplification is possible since every crude oil contains the same homologous series of closely related compounds. Different crudes differ mainly in the relative contribution of the individual number of these series. However, within these homologous series, chemical properties and toxicity vary little. Thus, low and high boiling saturated and aromatic hydrocarbons occur in every crude oil and though their numbers may go into thousands, individual members of these series have very similar chemical and biological properties. It follows that in their chemical, biological and toxicological properties crude oils are very similar, in spite of marked differences in individual composition and overall physical properties.

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[4] Ketchum, B. H., "Testimony before the Subcommittee on Air and Water Pollution," Senate Committee on Public Works, March 5, 1970. Unpublished Manuscript.

[5] Blumer, M. "Scientific Aspects of the Oil Spill Problem," Presented at the NATO/CCMS Conference on Ocean Oil Spills, Brussels, Nov. 2–6, 1970.

[6] Anon., "Final Report of the Task Force on Used Oil Disposal," American Petroleum Institute, New York, N.Y., 1970.

[7] Murphy, T. A., "Environmental Effects of Oil Pollution," Paper presented to the Session on Oil Pollution Control, American Society of Civil Engineers, Boston, Mass., July 13, 1970.

[8] Eglinton, G. and Murphy, M. T. J., Ed., "Organic Geochemistry," Springer, Berlin, 1969.

Petroleum and petroleum hydrocarbons in the marine environment are remarkably stable. Hydrocarbons that are dissolved in the water column are eventually destroyed by bacterial attack, though it should be pointed out that the most toxic compounds are also the most refractory ones.

We have demonstrated that hydrocarbons that are ingested by marine organisms can pass through the wall of the digestive tract and can be retained for long time periods[9 10 11] Thus, oysters that had been polluted by a fuel oil spill were removed to a clean aquarium. After six months the analyses showed that the amount and chemical composition of the fuel oil hydrocarbons in the fat of the animals remained nearly unchanged.[12] Hydrocarbons can be transferred from prey to predator; they spread through the marine food web in a manner similar to that of other persistent chemicals, e.g. DDT.[10 13]

Within marine sediments, hydrocarbons are also well protected from bacterial degradation, especially if the sediments are anaerobic or become anaerobic as a result of pollution. Thus in a spill of fuel oil in 1969 at West Falmouth, Massachusetts, U.S.A., oil was incorporated into the sediments of coastal waters, rivers, harbors and marshes. The oil is still present in the sediments, now, one year after the accident, and transport of oil laden sediment has contaminated more distance areas that had remained unpolluted immediately after the spill.[12]

OIL—IMMEDIATELY TOXICITY

All crude oils and all oil fractions except highly purified and pure materials are poisonous to all marine organisms. This is not a new finding. The wreck of the "Tampico" in Baja California, Mexico "created a situation where a completely natural area was almost totally destroyed suddenly on a large scale . . . Among the dead species were lobsters, abalone, sea urchins, starfish, mussels, clams and hosts of smaller forms"[14] Similarly, the spill of fuel oil in West Falmouth, Massachusetts, U.S.A., has virtually extinguished life in a productive coastal and intertidal area, with a complete kill extending over all phyla represented in that habitat.[15] Toxicity is immediate and leads to death within minutes or hours.[16]

Responsible for this immediate toxicity are principally three complex fractions. The *low boiling saturated hydrocarbons* have, until quite recently been considered harmless to the marine environment. It has now been found that this fraction, which is rather readily soluble in sea water produces at low concentration anaesthesia and narcosis and at great concentration cell damage and death in a wide variety of lower animals; they may be especially damaging to the young forms of marine life[17]. The *low boiling aromatic hydrocarbons* are its most immediately toxic fraction. Benzene, toluene and xylene are acute poisons for man as well as for other organisims; naphthalene and phenanthrene are even more toxic to fishes than benzene, toluene and xylene. These hydrocarbons and substituted one, two-and three ring hydrocarbons of similar toxicity are abundant in all oils and most, especially the lower boiling, oil products. Low boiling aromatics are even more water soluble than the saturates and can kill marine organisms either by direct contact or through contact with dilute solutions. *Olefinic hydrocarbons,* intermediate in structure and properties and probably in toxicity between saturated and aromatic hydrocarbons are absent in crude oil but occur in many refining products, e.g. gasoline and cracked products, and they are in part responsible for their immediate toxicity.

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[9] Blumer, M., "Hydrocarbons in Digestive Trace and Liver of a Basking Shark," Science, Vol. 156, pp. 390–391, 1967.

[10] Blumer, M., Mullin, M. M. and Guillard, R. R. L., "A Polyunsaturated Hydrocarbon (3, 6, 9, 12, 15, 18 heneicosahexaene) in the Marine Food Web," Marine Biology, *6* 226–36, 1970.

[11] Blumer, M., Souza, G. and Sass, J., "Hydrocarbon Pollution of Edible Shellfish by an Oil Spill," Marine Biology, *5*, 195–202, 1970.

[12] Blumer, M., Sass, J., Souza, G., Sanders, H. L., Grassie, J. F. and Hampson, G. R., "The West Falmouth Oil Spill," Woods Hole Oceanographic Institution, Ref. No. 70–44, Unpublished Manuscript, 1970.

[13] Blumer, M., Sass, J., Souza, G., Sanders, E. and Sass, J., "Phytol-Derived C_{19} Di- and Triolefinic Hydrocarbons in Marine Zooplankton and Fishes," Biochemistry, Vol. 8, p. 4067, 1969.

[14] North, W. J., "Tampico, a Study of Destruction and Restoration," Sea Frontiers, Vol. 13, pp. 212–217, 1967.

[15] Hampson, G. R. and Sanders, H. L., "Local Oil Spill," Oceanus, Vol. 15, pp. 8–10, 1969.

[16] Wilber, Ch. G., "The Biological Aspects of Water Pollution," Ch. C. Thomas, Publisher, Springfield, Ill., 1969.

[17] Goldacre, R. J., "The Effects of Detergents and Oils on the Cell Membrane," pp. 131–37. Suppl. to Vol. 2 of Field Studies, Field Studies Council, London, 1968.

Numerous other components of crude oils are toxic, among those named by Speers and Whitehead [18] cresols, xylenols, naphthols, quinoline and substituted quinolines and pyridines and hydroxybenzoquinolines are of special concern here because of their great toxicity and their solubility in water.

It is unfortunate that statements which disclaim this established toxicity are still being circulated. Simpson [19] claimed that "there is no evidence that oil spilt round the British Isles has ever killed any of these (mussels, cockles, winkles, oysters, shrimps, lobster, crabs) shellfish." It was obvious when this statement was made that such animals were indeed killed by the accident of the Torrey Canyon as well as by earlier accidents; work since then has confirmed the earlier investigation. In addition, by its emphasizing only the effect on adult life forms such a statement implies wrongly that juvenile forms were also unaffected.

OIL AND CANCER

The higher boiling crude oil fractions are rich in multiring aromatic compounds. It was at one time thought that only a few of these compounds, mainly 3, 4-benzopyrene, were capable of inducing cancer. As R. A. Dean [20] of British Petroleum Company stated "as far as I know, no 3,4-benzpyrene has been detected in any crude oil . . . it therefore seems that the risk to the health of a member of the public by spillage of oil at sea is probably far less than that which he normally encounters by eating the foods he enjoys." However, before that time carcinogenic fractions containing 1,2-benzanthracene and alkylbenzanthracenes had already been isolated [21] from crude oil and it was known that "biological tests have shown that the extracts obtained from high-boiling fractions of the Kuwait oil . . . (method) . . . are carcinogenic." Further "Benzanthracene derivatives, however, are evidently not the only type of carcinogen in the oil. . . ."

In 1968, the year when Dean claimed the absence of the powerful carcinogen 3,4-benzopyrene in crude oil, this hydrocarbon was isolated in crude oil from Libya, Venezuela and the Persian Gulf.[22] The amounts measured were between 450 and 1800 milligrams per ton of the crude oil.

Thus, we know that chemicals responsible for cancer in animals and man occur in petroleum. The causation of cancer in man by crude oil and oil products has been observed some years ago, when a high incidence of skin cancer in some refinery personnel was observed. The cause was traced to prolonged skin contact by these persons with petroleum and with refinery products.

According to Wilber [10] "there is evidence that even a highly refined, diesel engine lubricating oil obtained from a naphthenic base crude oil, and lacking in substances ordinarily known to be carcinogenic, can induce tumors of the digestive tract of animals." Also, "Cutting oil is known to have carcinogenic potency."

These references and a general knowledge of the composition of crude oils suggest that all crude oils and all oil products containing hydrocarbons boiling between 300 and 500° C should be viewed as potential cancer inducers.

This has severe implications for fisheries and human health. In our study of the West Falmouth oil spill [11, 12] we showed that oil from that spill was taken up by shellfish and built into their body fat without fractionation of the hydrocarbons. In that specific accident an oil boiling between 170 and 370° C was involved; this boiling range overlaps with that within which carcinogens have to be expected. Human consumption of such contaminated shellfish and other fisheries resources should therefore be viewed with great suspicion.

Carcinogenic hydrocarbons can enter the chain leading to human food at an even lower level of the food chain; thus, it was shown by Doerr [23] that intact plant roots can take up carcinogens like 3,4-benzopyrene from their growth medium.

The level of oil pollution encountered in many oceanic regions suggests that fisheries resources may often be contaminated with toxic petroleum derived hydrocarbons at levels that may constitute a public health hazard. Laboratories

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[18] Speers, G. C. and Whithead, E. V., "Crude Petroleum." In "Organic Geochemistry," Eglinton, G. and Murphy, M. T. J., Ed., Springer, Berlin, pp. 638–675, 1969.

[19] Simpson, A. C., "Oil, Emulsifiers and Commercial Shell Fish," pp. 91–98, Suppl. to Vol. 2 of Field Studies. Field Studies Council, London, 1968.

[20] Den, R. A., "The Chemistry of Crude Oils in Relation to their Spillage on the Sea," pp. 1–6, Suppl. to Vol. 2 of Field Studies, Field Studies Council, London, 1968.

[21] Carruthers, W., Stewart, H. N. M. and Watkins, D. A. M., "1,2-Benzanthracene Derivatives in a Kuwait Mineral Oil." Nature, Vol. 213, pp. 691–692, 1967.

[22] Graef, W. and Winter, C., "3,4 Benzpyren in Erdoel," Arch. Hyg. *152/4*, 289–293, 1968.

[23] Doerr, R., "Alkaloid and Benzopyrene Uptake by Intact Plant Roots," Naturwissenschaften, Vol. 52, p. 166, 1965.

to assay fisheries products for such contamination do not exist. Public health authorities should be urged to establish such laboratories for continuous surveys of the pollution level encountered in commercial sea food.

Other questions suggest themselves: Floating masses of crude oil now cover all oceans and are being washed up on shores. We have shown that such lumps, even after considerable weathering still contain nearly the full range of hydrocarbons of the original crude oil, extending in boiling point as low as 100° C. Thus, such lumps still contain some of the immediately toxic lower boiling hydrocarbons. In addition, the oil lumps contain all of the potentially carcinogenic material in the 300–500° boiling fraction. The presence of oil lumps ("tar") or finely dispersed oil on recreational beaches may well constitute a severe public health hazard, through continued skin contact.

OIL—DESTRUCTION OF FISHERIES RESOURCES

It has been said that "a review of the literature indicates that in deep water, whether in the open ocean or a mile or so offshore, no significant damage to marine life is encountered from even large oil spills because pelagic fish avoid the spill and few other marine species are present".[25] We wonder whether anyone could take such a statement seriously, who knows the established toxicity of crude oil, the richness of coastal life and the complexity of marine life cycles. The dead fish washed ashore after the West Falmouth oil spill[15] clearly were unable to avoid the spill, nor will the fish fry in estuaries and marshes or the planktonic food organisms in the open ocean be able to avoid a large spill or the plume of toxic dissolved hydrocarbons descending from it. Unfortunately, investigation of the effects of major accidents (e.g. Torrey Canyon, Santa Barbara) have very largely concentrated on the study of damage to adult fish or of any immediate reduction in fish catches. This is not sufficient; we must also consider the damage to the often more delicate juvenile forms and to the food organisms on which commercial fishes feed. Damage to these will not show up immediately nor will it be evident necessarily at the location of the accident. A large spill may lead to a gradual reduction of productivity over a large but diffusely defined area. The combined effect of many such spills and of other stresses, e.g. from overfishing and from the filling of marshlands may lead to a reduction in fishing income which is difficult to trace to any single cause.

The so called "tainting" of fish and shellfish by oil spills has been recognized for many years, however, it was not realized until now that oil passes through the intestinal barrier and is incorporated into and stabilized in the lipid pool of the organisms[11 12]

It has been widely assumed that fish and shellfish "tainted" by oil will again be fit for human consumption after a period from 2 weeks[19] to several months.[25] Our experience referred to above makes this highly improbable. If the oil were contained solely in the gut of the animals it might be readily displaced, however oil is resorbed and incorporated into the lipids where it may not be readily mobilized as long as the animal lives.

The disappearance of an "oily small" is no clue whether fish or shellfish has cleansed itself of the oil pollution. Only a small fraction of the petroleum has a pronounced odor and loss of these compounds may occur while the more harmful high boiling, taste and odorless carcinogens are retained. It has been reported that boiling or frying will remove the odor; however, it will not affect the presence of polycyclic aromatic hydrocarbons.

OIL-LOW LEVEL EFFECTS

We are concerned that oil pollution, even at very low levels, may be responsible for long term damage to the marine ecology. Many biological processes which are important for the survival of marine organisms and which occupy key positions in their life processes are mediated by extremely low concentration of chemical messengers in the sea water. We have demonstrated that marine predators are attracted to their prey by organic compounds at concentrations below the part per billion level.[26] Such chemical atteraction—and in a similar

[25] Little, A. D., Inc., "Combating Pollution Created by Oil Spills," Report to the Dept. of Transportation, U.S. Coast Guard, Vol. 1: Methods, p. 71386 (R), June 30, 1969.

[24] Contingency Plan for Spills of Oil and Other Hazardous Materials in New England; Federal Water Pollution Control Administration, Draft, 1970.

[26] Whittle, K. J. and Blumer, M., "A Predator-Prey Relationship. Sea Stars-Bivalves. The Chemical Basis of the Response of *Asterias vulgaris* to *Crassostrea virginica*," Woods Hole Oceanographic Institution, Ref. No. 70–20, Unpublished Manuscript, 1970.

way repulsion—plays a role in the finding of food, the escape from predators, in homing of many commercially important species of fishes, in the selection of habitats and in sex attraction. There is good reason to believe that pollution interferes with these processes in two ways: by blocking the taste receptors and by mimicking for natural stimuli; the latter leads to false responses. Those crude oil fractions likely to interfere with such processes are the high boiling saturated and aromatic hydrocarbons and the full range of the olefinic hydrocarbons.

It has long been known that lobsters are attracted to crude oil distillate fractions, especially kerosene,[27 28] this has now been confirmed in the laboratory and with purified hydrocarbon fractions derived from kerosene.[29] Thus it is likely that an oil spill will attract lobsters away from their normal food and guide them into the direction of the spill, where they are more likely to be severely contaminated or killed. Again, this is in direct contradiction to the opinion quoted above[25] that marine animals will actively avoid oil spills. It may be relevant that after the West Falmouth oil spill numerous dead lobsters were washed ashore.

Interference with normal taste reception at very low and seemingly innocuous pollution levels may have disastrous effects on the survival of many marine species through their links in marine food web.

COUNTERMEASURES

Compared to the number and size of accidents and disasters the present countermeasures are inadequate. However, a rapidly advancing technology is hopeful of developing techniques that will be effective in dealing even with very large spills under severe sea conditions. Yet, while we may hope that the gross aesthetic damage from oil spills may be avoided sometime in the future, there is no reason to believe that existing or planned countermeasures will eliminate the biological impact of oil pollution.

The most immediately toxic fractions of oil and oil products are soluble in sea water, therefore, biological damage will occur at the very moment of the acident. Water currents will immediately spread the toxic plume of dissolved oil components and, if the accidents occurs in inshore waters, the whole water column will be poisoned even if the bulk of the oil floats on the surface. The speed with which the oil dissolves is increased by agitation, and in storm conditions the oil will partly emulsify and will present a much larger surface area to the water; consequently, the toxic fraction will dissolve more rapidly and reach higher concentrations.

From the point of view of avoiding the immediate biological effects of oil spills, countermeasures can be completely effective only if *all of the oil is recovered immediately* after the spill. The technology to achieve this goal does not exist. Some comments on existing countermeasures and their biological effects appear appropriate:

Detergents and dispersants

The toxic, solvent-based detergents which did so much damage in the clean-up after the Torrey Canyon accident are presently only in limited use. However so-called "non-toxic dispersants" have been developed. The term "non-toxic" is misleading, these chemicals may be nontoxic to a limited number of often quite resistant test organisms but they are rarely tested in their effects upon a very wide spectrum of marine organisms including their juvenile forms, preferably in their normal habitat. Further, in actual use the dispersant-oil mixtures are severely toxic, because the oil is toxic and bacterial degradation of "non-toxic" detergents may lead to toxic breakdown products.

A dispersant lowers the surface tension of the oil to a point where it will disperse in the form of small droplets. It is recommended that the breakup of the oil slick be aided by agitation, natural or mechanical. Thus, the purpose of the detergent is essentially a cosmetic one, and it appears attractive to those who wish to alleviate only the aesthetic damage. However the recommendation to apply dispersants is often made in disregard of their ecological effects. Instead of removing the oil, dispersants push the oil actively into the marine environment; because of the finer degree of dispersion, the immediately toxic fraction

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[27] Prudden, T. M., "About Lobsters," The Bond Wheelwright Co., Freeport, Maine, 1967.
[28] Anon. (Editorial), "Sea Secrets," Vol. 13, No. 11, p. 7, 1969.
[29] Boylan, D. B., unpublished results, 1970.

dissolves rapidly and reaches a higher concentration in the sea water than it would if natural dispersal were allowed. The long term poisons (e.g. the carcinogens) are made available to and are ingested by marine filter feeders, and, they can eventually return to man incorporated into the food he recovers from the ocean.

For these reasons I feel that the use of dispersants is unacceptable, inshore or offshore, except under special circumstances, e.g. extreme fire hazard from spillage of gasoline, as outlined in the contingency plan of the Federal Water Quality Administration.[24]

Physical sinking

Sinking has been recommended: "the long-term effects on marine life will not be as disastrous as previously envisaged. Sinking of oil may result in the mobile bottom dwellers moving to new locations for several years; however, conditions may return to normal as the oil decays." [25] Again, these conclusions disregard our present knowledge of the effect of oil spills.

Sunken oil will kill the bottom faunas rapidly, before most mobile bottom dwellers have time to move away. The sessile forms of commercial importance (oysters, scallops, etc.) will be killed and other mobile organisms (lobsters) may be attracted into the direction of the spill where the exposure will contaminate or kill them. The persistent fraction of the oil which is not readily attacked by bacteria contains the long term poisons, e.g. the carcinogens, and it will remain on the sea bottom for very long time periods. Exposure to these compounds may damage bottom organisms or render them unfit for human nutrition even after the area has been repopulated.

Combustion

Burning the oil through the addition of wicks or oxidants appears more attractive from the point of view of avoiding biological damage than dispersion and sinking. However, it will be effective only if burning can start immediately after a spill. For complete combustion, the entire spill must be covered by the combustion promoters, since burning will not extend to the untreated areas; in practice, in stormy conditions, this may be impossible to achieve.

Mechanical containment and removal

Containment and removal appear ideal from the point of avoiding biological damage. However, they can be fully effective only if applied immediately after the accident. Under severe weather conditions floating booms and barriers are ineffective. Booms were applied during the West Falmouth oil spill; however, the biological damage in the sealed-off harbors was severe and was caused probably by the oil which bypassed the booms in solution in sea water and in the form of wind-dispersed droplets.

Biological degradation

Hydrocarbons in the sea are naturally degraded by marine microorganisms. It is hoped to make this the basis of an oil removal technology through bacterial seeding and fertilization of oil slicks. However, great obstacles and many unknowns stand in the way of the application of this principally attractive idea.

No single microbial species will degrade any whole crude oil; bacteria are highly selective and complete degradation requires many different bacterial species.[30] Bacterial oxidation of hydrocarbons produces many intermediates which may be more toxic than the hydrocarbons; therefore organisms are also required that will further attack the hydrocarbon decomposition products.[30]

Hydrocarbons and other compounds in crude oil may be bacteriostatic or bacteriocidal: [30] this may reduce the rate of degradation, where it is most urgently needed. The fraction of crude oil that is most readily attacked by bacteria is the least toxic one, the normal paraffins; the toxic aromatic hydrocarbons, especially the carcinogenic polynuclear aromatics, are not rapidly attacked.[12 13 30]

The oxygen requirement in bacterial oil degradation is severe; the complete oxidation of 1 gallon of crude oil requires all the dissolved oxygen in 320,000 gallons of air saturated sea water.[30] Therefore, oxidation may be slow in areas where the oxygen content has been lowered by previous pollution and the bacterial degradation may cause additional ecological damage through oxygen depletion.

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[30] ZoBell, C. E., "Microbial Modification of Crude Oil in the Sea," Joint API–FWPCA Conference on Prevention and Control of Oil Spills, Press Release, Dec. 17, 1969.

Cost effectiveness

The high value of fisheries resources, which exceeds that of the oil recovery from the sea, and the importance of marine proteins for human nutrition demand that cost effectiveness analysis of oil spill counter-measures consider the cost of direct and indirect ecological damage. It is disappointing that existing studies completely neglect to consider these real values. A similarly one-sided approach would be, for instance, a demand by fisheries concerns that all marine oil production and shipping be terminated, since it clearly interferes with fisheries interests.

We have to start to realize that we are paying for the damage to the environment, especially if the damage is as tangible as that of oil pollution to fisheries resources and to recreation. Experience has shown that cleaning up a polluted aquatic environment is much more expensive than it would have been to keep the environment clean from the beginning.[31] In terms of minimizing the environmental damage spill prevention will produce far greater returns than clean-up—and we believe that this relationship will hold in a *realistic* analysis of the overall cost effectiveness of prevention or cleanup costs.

SELF CONTROL AND LAW ENFORCEMENT

The oil industry has an outstanding personnel and plant safety record. Oil refineries probably operate more safely than any other plants of equal production capacity. The industry has achieved this record through internal control because of the realization of the cost effectiveness of personnel safety.

We believe that in the past the oil industry has not been fully aware of the substantiated toxicity of oil in the marine environment. We hope that the increasing recognition of the threat of oil pollution to marine resources will lead industry to aim for a ecological safety record similar to the plant safety record.

It would be unrealistic to expect that intentional and negligent oil pollution can be stopped through education or appeals to man's responsibility. In this respect law enforcement will have to speak more strongly. Methods for the identification of oil spills by day and night through spectroscopic surveys from airplanes are becoming available.[32] Active tagging of oil in marine transit[33] should provide for simple and conclusive identification of spills. Even without active tagging, which depends on the willing cooperation of the ship owners and operators, each oil and oil product has its unique fingerprint. Fast and simple analytical techniques are available (e.g. capillary gas chromatography combined with mass spectrometry) that can qualitatively and quantitatively determine hundreds of different compounds in a spilled oil within a very short time. These techniques should be a great aid to more effective law enforcement.

In their effectiveness for law enforcement these techniques could be greatly supported if the oil industry would make available samples or analyses of those crude oils and products which are being transported across the sea.

CONCLUSIONS

The *toxicity* of crude oil and oil products to marine life and the danger of oil pollution to the marine ecology has been established in several independent ways:

(1) Studies of crude oil composition and isolation of compounds known to be toxic, e.g. low boiling aromatic hydrocarbons and the carcinogenic, high boiling polycyclic aromatics.

(2) Laboratory studies of the effect of oil and oil fractions on marine organisms.

(3) Field studies of the effect of oil spills on marine organisms in their normal habitat.

Pollution with crude oil and oil fractions *damages the marine ecology* through different effects:

(1) Direct kill of organisms through costing and asphyxiation.[34]

(2) Direct kill through contact poisoning of organisms.

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[31] Ketchum, B. H., "Biological Effects on Pollution of Estuaries and Coastal Waters," Boston Univ. Press, In Press, 1970.

[32] Swaby, L. G., "Remote Sensing of Oil Slicks," Joint API–FWPCA Conference on Prevention and Control of Oil Spills, Press Release, Dec. 17, 1969.

[33] Horowitz, J., "Oil Spills: Comparison of Several Methods of Identification," Joint API–FWPCA Conference on Prevention and Control of Oil Spills, Press Release, Dec. 17, 1969.

[34] Arthur, D. R., "The Biological Problems of Littoral Pollution by Oil and Emulsifiers—a Summing up," pp. 159-164, Suppl. to Vol. 2 of Field Studies, Field Studies Council, London, 1968.

(3) Direct kill through exposure to the water soluble toxic components of oil at some distance in space and time from the accident.

(4) Destruction of the generally more sensitive juvenile forms of organisms.

(5) Destruction of the food sources of higher species.

(6) Incorporation of sublethal amounts of oil and oil products into organisms resulting in reduced resistance to infection and other stresses (the principal causes of death in birds surviving the immediate exposure to oil [35]).

(7) Destruction of food values through the incorporation of oil and oil products, into fisheries resources.

(8) Incorporation of carcinogens into the marine food chain and human food sources.

(9) Low level effects that may interrupt any of the numerous events necessary for the propagation of marine species and for the survival of those species which stand higher in the marine food web.

Some oil products may be more poisonous than whole crude oils—thus, kerosene and #2 fuel oil are particularly rich in the low boiling water soluble poisons and higher boiling distillates are rich in carcinogenic hydrocarbons. However, the toxicity of oil is spread over such a wide boiling range, and the composition of different crudes in terms of their chemical type distribution is so similar, that all crude oils and distillates must be considered severe environmental poisons.

Crude oil and most products are persistent poisons; they enter the marine food chain, they are stabilized in the lipids of marine organisms and they are transferred from prey to predator. The persistence is especially severe for the most poisonous compounds of oil; most of these do not normally occur in organisms and natural pathways for their biodegradation are missing.

The presence of toxic and potentially carcinogenic hydrocarbons in fisheries products may constitute a public health hazard. Laboratories to measure routinely the contamination level and to assess the public health hazard do not now exist; such laboratories should be organized to carry out continuous surveys of the safety of fisheries resources to public health.

Because of their low density, relative to sea water, crude oil and distillates should float; however, both the experiences of the "Torrey Canyon" and the West Falmouth oil spill have shown oil on the sea floor. Oil in inshore and offshore sediments is not readily biodegraded; it can move with the sediments and can contaminate unpolluted areas long after an accident.

None of the presently used containment and recovery techniques prevents the ecological damage and the damage to fisheries products from oil spills. Toxicity is evident immediately and the poisonous fraction will be carried in water solution away from the accident, even if the surface spill is contained and recovered rapidly. The sinking method and the use of *detergents and dispersants*, while cosmetically effective, are especially harmful since they *introduce all the oil into the environment*. There are no dispersants that are not toxic in the presence of oil. The use of sinking agents and of dispersants should be most strongly discouraged.

Natural mechanisms for the degradation of oil in the sea exist; unfortunately, these are least effective for the most severely toxic components of oil. As a result, the most toxic fractions are also the most persistent ones. The breakdown products of oil and dispersants may also be toxic. Further, oil that has been incorporated into the lipids of marine organisms and into the sediments at the sea bottom and in estuaries and marshes is largely unavailable to the natural degradation; poisoning of the bottom habitats and of the marine food web will therefore be more severe and more persistent than the posioning of the water column itself.

The tolerance of the marine ecology to oil spills is unknown. The great persistence of oil and the existence of low level effects suggest a lower tolerance than we would expect by considering only the immediate toxicity of oil at high concentration levels.

The effects of oil pollution, especially in the coastal environment cannot be considered without also considering the other stresses on these most productive regions of the ocean.

The combined impact of oil and oil products, chemicals, domestic sewage and municipal wastes, of the filling of wetlands, of dredging and of overfishing might

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[35] Beer, J. V., Post-Mortem Findings in Oiled Auks during Attempted Rehabilitation," pp. 123–129, Suppl. to Vol. 2 of Field Studies, Field Studies Council, London, 1968.

lead to a deterioration of the coastal regions similar to that which we have brought about in the Great Lakes. Because of the much longer time scale of the oceans such a catastrophic deterioration would not likely be reversed within many generations; it would have a deep and lasting impact on the future of mankind.

ACKNOWLEDGMENTS

We are grateful for continued support of our work on origin and fate of hydrocarbons in the sea by ONR, NSF and FWPCA (current grants and contracts, NOO 14-66-CO-241, GA 1625, EBN 18050).

The concern and suggestions of many colleagues has contributed. Special gratitude goes to Drs. R. H. Backus, V. T. Bowen, J. M. Hunt, B. H. Ketchum, J. Ryther, H. L. Sanders and O. C. Zafiriou.

This is Contribution No. 2474 of the Woods Hole Oceanographic Institution.

Senator BUCKLEY. Thank you very much.

Mr. Chairman, I have no further questions.

Senator MOSS. Thank you very much.

We appreciate your testimony. We have kept you a long time.

I think the import of the questions of the Senator from New York and the answers indicate there is probably a lot of research yet to be done. Perhaps we can give attention as to how that can be coordinated someway between industry and government to make sure we are attacking all possible areas of research and know what oil does, and where it goes, and whether indeed it does persist in marine life or elsewhere if it is ingested while it is on the surface or elsewhere.

So I think this hearing will help us to point up to that and see that we can get that done.

This has been most profitable and interesting, and I appreciate the very detailed answers you have prepared for our rather long list of questions.

I want to thank all of you gentlemen for appearing.

Senator BELLMON. Mr. Chairman, I would like to ask permission that an article entitled "Price Gap Between U.S. and Foreign Oil Shrinking" be included in the record.

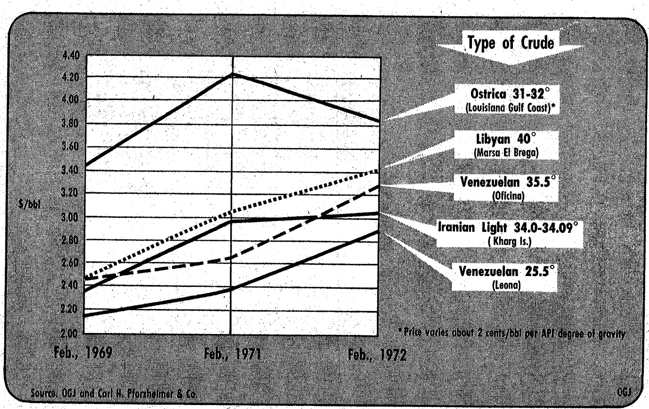
Senator MOSS. That will be included in the record without objection.

(The article follows:)

[From *The Oil and Gas Journal,* March 20, 1972]

NEWS

How landed costs of crude compare on U.S. East Coast



Price gap between U.S. and foreign oil shrinking

LESTER F. VAN DYKE
Management Editor

"CHEAP" foreign crude oil is becoming more expensive all the time. And the chances that the trend established during the past 3 years will stop or even slow down are remote.

Price upheavals in the main producing countries of the Mideast and North Africa have steadily narrowed the gap between the landed cost of imported crudes on both the U.S. East and West coasts and the price of domestic crude.

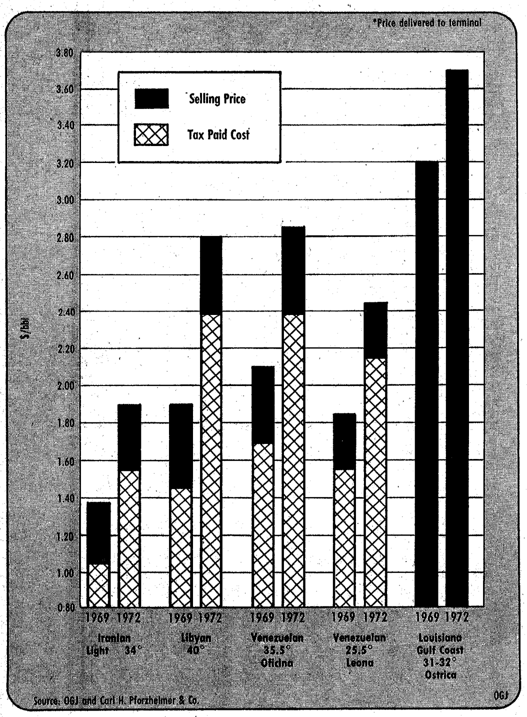
A Journal study of four representative foreign crudes shows that the average landed cost of these oils in New York compared to the landed cost of a South Louisiana crude moved in large volume to the New York area has climbed 42¢/bbl since early 1969.

These figures are supported by the value of import tickets. Tickets brought about $1.45/bbl in 1969. The value today is around $1.

A similar shrinkage of the gap between foreign and domestic prices is taking place on the West Coast.

Despite the foreign price increases, there is still a substantial price spread—with a couple of exceptions—in favor of offshore oil. But industry economists and crude-supply executives point out dangers in taking the figures at face value.

How actual selling prices have increased*



Surplus domestic crude supplies are drying up fast. Without domestic reserves to fall back on, the U.S. is much more vulnerable to price escalations abroad.

Also anything which would boost the now relatively low tanker rates could erase the price gap. Supply disruptions in the producing countries, of course, could serve as such a trigger—just as they have in recent years.

Finally, there is little chance that the price of domestic crude oil will increase this year.

What's happened. Throughout most of the 1960's, there was little change in world crude-oil prices. Early in 1969, the U.S. got its first real crude-price increase in almost a decade. In September 1970, posted prices for Mediterranean crudes began to move, followed in a couple of months by other Mideast crudes.

With the February 1971 Tehran agreement, world crude-oil prices took an even larger leap upward. Tax-paid costs of crudes jumped, along with postings and selling prices. At the same time, tanker rates soared to record levels. And import-ticket exchange values vanished.

To see how these moves have affected the price differential between foreign and U.S. oil, the Journal picked four representative crudes and traced their price movements since 1969.

Iranian light (34° gravity) was selected from the Persian Gulf. Before price escalations began it had a relatively stable posting of $1.79/bbl and a tax-paid cost delivered to the terminal of about $1.01/bbl. A general rule of thumb called for between 35 and 40¢/bbl profit margin to the company. And the crude was selling at about $1.38/bbl fob. Based on the AFRA rate for a medium-range tanker to the U.S. East Coast, oil could be brought to New York then for about 88¢/bbl plus 10.5¢/bbl duty and landed for roughly $2.36/bbl.

Domestic Ostrica-type 32°-gravity crude, moving under fairly high rates—even using time charters as the Journal did for this study—was coming into the East Coast from Louisiana at about $3.45/bbl. This figure includes about a 25¢/bbl sulfur discount.

Libyan 40° crude oil was about 10¢/bbl more costly than the Iranian in 1969, figuring a 45¢/bbl freight rate.

The lower-gravity, higher-sulfur Venezuelan Leona crude enjoyed about a $1.30/bbl advantage over the domestic crude and at least 20¢/bbl over other offshore oils. Freight rates on the Caribbean/USNH run were about 25¢/bbl in 1969.

By February 1971, prices were up on most oils following the Tehran agreement. But the erratic freight market played tricks with the landed cost figures. Rates on almost all runs were up 25 to 50¢/bbl on the AFRA basis. The spot market had soared to record levels, erasing import-ticket values on marginal crude movements.

Prices today. AFRA rates are settling back to near normal but still are higher than in 1969. Even so, the effect price hikes on foreign crudes has had on their relative competitive position in the U.S. market is apparent. Libyan crude, moving under a 5¢/bbl higher freight rate than in 1969, now is only 40¢/bbl cheaper than Ostrica crude, compared with a $1/bbl spread in 1969. It does enjoy a certain premium due to its low sulfur content.

Iranian light crude was only 10¢/bbl cheaper in 1969 than the Libyan oil. But today it can be landed on the U.S. East Coast for 35¢/bbl less. Only 15¢ of that can be attributed to increased freight costs.

The 35.5° Oficina Venezuelan crude was on a par with the Libyan oil in 1969 but now is about 12¢/bbl cheaper. Roughly 7¢ of that, however, must be subtracted due to higher transportation costs. Again, the Iranian light oil holds a much larger price advantage over Venezuelan crude landed on the East Coast than it did 3 years ago.

Heavier Venezuelan crude also has lost ground. The $1.30 difference between it and Ostrica 32°-gravity in 1969 has melted to 95¢. There's 7¢ added freight that has to be considered, though. In 1969 the 25.5°-gravity Venezuelan crude was about 30¢/bbl cheaper than the Libyan and higher gravity Venezuelan oil. Today the range is 50¢/bbl.

West Coast. The price gap between foreign and domestic crude on the West Coast also has narrowed sharply in recent years and likely will continue to do so.

Because of the drop in tanker rates the past year, the laid-down price of offshore crude on the West Coast is actually smaller today than a year ago. But compared with prices 2 years ago, the difference is apparent.

The West Coast is heavily dependent on imported and tankered crude. Late last year, California production was around 950,000 b/d. Added to this was Alaska's 220,000 b/d, which went to West Coast refineries. Canadian imports added another 203,000 b/d.

Overseas imports, which provide the supply flexibility, accounted for 272,000 b/d. Of this amount, 135,000 b/d came from the Mideast, 91,200 b/d from Indonesia, 37,700 b/d from South America, and 7,600 b/d from Australia.

Comparing prices of foreign and domestic crude on the West Coast, as in the East, is complicated by changing tanker rates and continuing price negotiations with exporting countries.

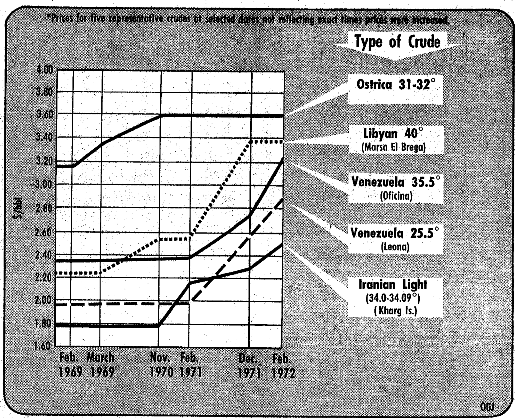
Crude of 35°-gravity from Huntington Beach field in the Los Angeles area sells for $3.67/bbl. Adding 5¢/bbl transportation charge for movement to refineries puts the cost at $3.72.

Today's price of Indonesian crude from Sumatra—the most costly of the overseas crudes—is approaching this figure. The low-sulfur oil sells for $2.60. Transportation adds 72¢/bbl. And the import duty of 10.5¢ brings the figure to $3.43. When current negotiations on repricing Indonesian crude—based on revaluation of the American dollar—are completed, an added increase of about 22¢ will nearly wipe out the gap. It would bring the cost of Sumatran crude to $3.65 compared to $3.72 for Huntington Beach crude at Los Angeles.

Cheaper and less-valuable Saudi Arabian crude is not as competitive, but it will be moving closer as annual increases take effect.

With the latest increase Saudi crude is coming in at about $2.94/bbl in Los Angeles. This will increase by another 20¢ under contract terms by 1975.

How posted crude prices have risen*



Continuing price rise. The cost increases of the Tehran pact that apply to the West Coast, of course apply in the East. Tax-paid cost increases totaling roughly 32¢/bbl are plugged into the Tehran and Geneva accords by 1975.

Libya and Algeria are expected to apply the Geneva agreement terms—or better—to their crude prices. And the Journal assumed such an increase in calculating the price of Libyan crude for its charts.

If the Geneva accord is applied in Libya, it would raise the government's take by 16 to 18¢/bbl, compared to 11-12¢/bbl in the Persian Gulf.

In Libya, the 8.49% increase would apply not only to postings, but also to the 9¢/bbl retroactivity "buy-out." This is an extra payment, on top of the tax, that was included in last year's 5-year Tripoli agreement. As the proposal stood it would not apply retroactively. But the way Algeria acts in applying the Geneva terms to its own oil could have a bearing on this.

So far, major international crude-oil suppliers appear able generally to pass along to their customers the price increases they have had to bear. Price hikes to customers have come on an across-the-board basis following each round of price increases by the producing countries.

While the tax-paid cost is scheduled to increase some 32¢/bbl by 1975, indications are that the selling price will climb by roughly 21-23¢/bbl. However, that's assuming rather static conditions in supply/demand patterns and some stabilizing of price negotiations in the Mideast and North Africa. And with such issues as participation still to be resolved, such stable conditions seem unlikely.

Profit margins on crudes have held up so far. But one economist notes that the rule of thumb for figuring the selling price after calculating the tax-paid cost in the Mideast is now to add 30-35¢/bbl. It used to be 35-40¢. By the mid-to-late 1970's it could be closer to 20-25¢, he says.

World crude-oil prices are moving rapidly toward some sort of "parity"—all things such as freight and quality differences considered—most industry sources seem to agree. And that might not be as bad as it might seem at first glance. Overall effect probably would be to dampen the continuing struggle among the producing countries and the producers, sources add.

The U.S. is certain to become more and more dependent on offshore crude. And whether it's secure or not, it won't be cheap by the end of this decade, industry economists say.

Mr. DOLE. May I leave one more thought with you, Mr. Chairman.

I feel this hearing that you have called today on the OCS and what it means to the United States is very important, and I want to thank you for having us put this together so it will be in the public record.

I would like to leave the thought with you at the present time, besides the OCS, and besides furnishing about 12 percent of our oil production and 10 percent of our gas production as of last year, that it has brought into the U.S. Treasury—in other words, this is material that did not have to be collected through the tax route. It has been brought into the U.S. Treasury over $7 billion.

So we not only get an economic advantage from the oil and gas that is brought in to meet our energy needs, but a very substantial sum of money into the Treasury.

Senator MOSS. Thank you very much.

We will be in recess until tomorrow when we will hear from Russell Train and David Wallace.

(Whereupon, at 12:40 p.m., the hearing was recessed, to reconvene Friday, March 24, 1972, at 10 a.m.)

APPENDIX

(Under authority previously granted, the following statements and communications were ordered printed:)

QUESTIONS AND POLICY ISSUES RELATED TO OVERSIGHT HEARINGS ON THE ADMINISTRATION OF THE OUTER CONTINENTAL SHELF LANDS ACT TO BE HELD BY THE SENATE COMMITTEE ON INTERIOR AND INSULAR AFFAIRS, PURSUANT TO S. RES. 45, MARCH 23, 1972.

The following questions are directed towards developing historical and background information on the legal and management regime for the Outer Continental Shelf (OCS) as well as significant policy issues concerning the OCS. Issues which are not covered in this paper are those relating to OCS Lease Bidding Policy alternatives and possibilities for revenue sharing with the States. These issues will be examined in later hearings.

U. S. DEPARTMENT OF THE INTERIOR

A. THE PRESENT LEGAL REGIME FOR THE OUTER CONTINENTAL SHELF

Question A. 1.

What Federal statutes directly contribute to or constitute the existing legal regime for the management of the resources of the OCS (including relevant Executive Orders or other executive branch policy statements and relevant court decisions)?

Answer:

The rights of the United States in the Outer Continental Shelf are set in the Geneva Convention on the Continental Shelf (1958). The basic authority for the management of resources of the Outer Continental Shelf is the Outer Continental Shelf Lands Act (43 U. S. C. §§ 1331-1343). In conjunction with this statute, the Submerged Lands Act (43 U. S. C. §§ 1301-1315) must be read to determine the extent of the Federal area of the Continental Shelf. The National Environmental Policy Act of 1969 (42 U. S. C. §§ 4321-4347) also affects the Department's management of OCS lands, and section 102(1) requires the Department to administer and interpret the OCS Act "to the fullest extent possible" in accordance with the policies and provisions of NEPA.

The discharge of oil into the waters of the contiguous zone, which includes portions of the OCS, is governed by the Water Quality Improvement Act of 1970 (33 U. S. C. § 1161-1164).

31 U. S. C. § 483a requires the receipt of fair market value for the grant of rights under the OCS Act.

The President's Clean Energy Message of June 4, 1971, is the most recent Executive branch statement affecting the management of the OCS. Prior to that is the President's U. S. Oceans' Policy Statement of May 23, 1970.

Question A. 2.

What, in summary form, is the major goal or purpose of each of these statutes, orders or policy statements (e. g. resource development, oceanographic research, fish and wildlife protection, pollution control, etc.)?

Answer:

The basic purpose of the OCS Act is to assure that the natural resource of the seabed and the subsoil of the Outer Continental Shelf will be subject to Federal jurisdiction, control, and power of disposition. Pursua to this general purpose, the OCS Act provides for the disposition of the mineral resources of the OCS. Particular emphasis is laid on the disposition of oil, gas, and sulphur, but provision is made for the disposition of other minerals.

The purpose of NEPA is to provide a national policy which will encourage productive and enjoyable harmony between man and his environment. Pursuant to NEPA the Department has prepared environmental impact statements in connection with major Federal actions on the OCS significantly affecting the quality of the human environment.

The purpose of the Water Quality Improvement Act is to prevent the discharge of oil upon or into the navigable waters of the United States, onto adjoining shorelines, or upon or into the waters of the contiguous zone.

The purpose of 31 U.S.C. § 483a is to obtain for the United States a fair return for rights granted.

The President's Clean Energy Message directed the Department to accelerate the offering of tracts for OCS lease and to prepare a five-year schedule for lease sales.

Question A. 3.

Which entities within which Federal agencies have been assigned OCS responsibilities and what formal and informal coordinating relationships (inter-agency committees, memoranda of understanding, etc.) exist among these agencies regarding OCS administration? (Provide organization chart showing agencies and their links.)

Answer:

The Secretary of the Interior is authorized by section 5 of the OCS Act (43 U.S.C. § 1334) to administer the provisions of that statute relating to leasing of the OCS. Within the Department of the Interior the Bureau of Land Management administers the OCS leasing provisions (43 CFR Part 3300) and the Geological Survey administers the OCS operating regulations (30 CFR Part 250). The Geological Survey is also responsible for geological and geophysical exploration under section 11 of the OCS Act (43 U.S.C. § 1340). The Secretary of the Army has certain responsibilities, exercised through the Corps of Engineers, for preventing certain obstructions to navigation under section 4(f) (43 U.S.C. § 1333(f)). The Coast Guard has other responsibilities with respect to navigation under section 4(e). Section 5(e) authorizes the Secretary of the Interior to grant rights of way for minerals on the OCS, but provides that determinations as to proportionate amounts to be transported by such pipelines shall be made, with respect to natural gas, by the Federal Power Commission and, with respect to oil, by the Interstate Commerce Commission.

Under section 11(c)(2) of the Federal Water Pollution Control Act, 33 U.S.C. § 1161, the National Oil and Hazardous Materials Pollution Contingency Plan has been established to provide coordinated and integrated responses by departments and agencies of the Federal Government to pollution spills affecting the contiguous zone and the continental shelf bottom.

Question A. 4.

What changes in the existing legal regime or Federal organizational structure for management of the OCS have been proposed or recommended by Federal advisory committees or by the Administration and what, in summary form, is the purpose of these recommended changes?

Answer:

The Department has made no recommendations for amendment of the OCS Act, nor has there been any major organizational change recommended. The Public Land Law Review Commission Recommendations No. 72 through 77, inclusively, apply to the OCS. Three were of particular importance in respect to this question. Recommendation No. 72 called for consolidation of OCS functions within the Government to the greatest possible degree. The Commission also recommended coordination of activities with the States. Recommendation No. 75 called for amendment of the OCS Act to give the Secretary authority for more flexibility in the methods of holding competitive sales.

Question A. 5.

What additional changes in the existing legal regime or Federal organizational structure merit Congressional consideration and review?

Answer:

The Department has no changes in the OCS Act. The Administration has proposed establishment of a Department of Natural Resources as a Federal organizational structure.

B. HISTORICAL DATA

Question:

What is the available statistical information related to OCS oil, gas, sulfur, and salt leasing, drilling production, income and related information for the period 1953-1971?

Answer:

Enclosed are 55 tables of statistics related to OCS oil, gas, sulfur, and salt leasing, drilling production, income and related information for the period 1953-1971.

1. Geological and Geophysical Exploration

   a) Permits Granted by Number, Years, and Areas Covered -- table 1

2. Leasing

   a) Lease Sales by Years, States and Products -- tables 2-4

   b) Producing and Non-producing Leases by Years and States -- tables 5-9

3. Development

   a) Well Status

      i) By Years -- table 10
      ii) By Years, and States -- tables 11-15

   b) Well Activity

      i) By Years -- table 16
      ii) By Years, and States -- tables 17-20

   c) Unit Plans, Number of, by Years -- table 21

4. Production and Revenue

a) Statistics by Years

i) Oil and Condensate, and Gas Production -- tables 24-27
ii) Revenue and Production Values -- table 22
iii) All Leasable Minerals - Value and Royalty -- table 23

b) Production, Value, and Royalty by Products

i) Oil and Condensate -- table 24
ii) Gas -- table 27
iii) Natural Gasoline and L. P. G. -- table 28
iv) Salt -- table 29
v) Sulfur -- table 30

c) Production, Value and Royalty, by Years, States, and Products

i) California
Oil and Condensate -- tables 31, 33
Gas -- tables 31, 33
Gasoline and L. P. G. -- tables 31, 34

ii) Louisiana
Oil and Condensate -- tables 31, 35, 36
Gas -- tables 31, 36
Gasoline and L. P. G. -- tables 31, 37
Salt -- tables 32, 38
Sulfur -- tables 31, 37

iii) Texas
Oil and Condensate -- tables 31, 39, 40
Gas -- tables 31, 40
Gasoline and L. P. G. -- tables 31, 41

d) Summary of Bonuses, Minimum Royalties, Rentals, Shut-In Gas Payments, Royalties, and Total by Years, States and Products

California -- table 42
Florida -- table 43
Louisiana -- tables 44-47
Oregon -- table 48
Texas -- tables 49, 50
Washington -- table 51
Total by States -- table 52

5. Total Offshore and United States Production of Oil and Condensate, and Gas

   a) Total Offshore "State" and "Federal OCS" Production by Years, and States

      Oil and Condensate -- table 53
      Gas -- table 54

   b) Total United States and Outer Continental Shelf Production of Crude Oil and Condensate, and Gas -- table 55

6. What has been the average excess, shut-in or reserve producing capacity for oil and gas on the OCS in each year? What portion of this capacity has resulted from

   a) Market demand prorationing?
   b) MER prorationing?
   c) Lack of pipeline connections?
   d) Economic factors?

Answer:

The estimated excess productive capacity of OCS oil wells has decreased as follows:

1/1/69	357,000 BOPD
1/1/70	348,000 BOPD
1/1/71	103,000 BOPD
1/1/72	0

The drop in excess capcity was due to a squeeze between increasing allowable schedules caused by increased demand and the relatively static (in the absence of further leasing) potential capacity of the area. Demand was increasing faster than hydrocarbons were being discovered. There is essentially no excess capacity in gas pipelines which is the major limiting factor curtailing gas production.

Whatever excess capacity cushion we enjoyed in the past was due to market demand prorationing which is closely allied with economic factors. Lack of pipeline connections is more important to gas production than to oil production. Economic factors and lack of pipeline connections are closely related. Reserves must be large enough to amortize the cost of a pipeline. The amount of uncommitted gas in the Gulf OCS is insignificant.

7. How much natural gas has been vented or flared on OCS lease in each year? How much (if any) royalty is collected on this ga

Answer:

No gas well gas is being flared except for brief initial periods in the testing and cleaning of newly completed wells. The volume of gas well gas being produced and sold from the OCS is about 6,815,725 MCF (1000 cu. ft.) per day. The volume of oil well gas being produced is about 1,185,600 MCF per day; of this amount, approximately 601,550 M per day is being marketed, 312,100 MCF per day is being reinjected for improved oil recovery or used for lease operations, and 272,000 MCF per day is being vented or flared. Thus, about 3.4 percent of all OCS gas produced is being vented or flared. It is estimated that 20 percent of the gas now being vented or flared will be recovered upon installation in 1972 of additional facilities which are required to market the gas. The percentage of oil well gas being flared in the Gulf of Mexico has been reduced by more than one-third in the last five years.

The annual amount of gas flared during the years in which these statistics are available is as follows:

1968	95,873,748 MCF
1969	81,649,932 MCF
1970	75,846,960 MCF
1971	79,255,518 MCF

No royalty is collected on the flared gas. The lessee is required to pa royalty on the production saved, removed, or sold from the leased area. Gas used for purposes of production from and operations upon the leased area or unavoidable lost is not considered to be subject to royalty under the terms of the lease.

8. What volume of petroleum resources have been lost in oil spills or consumed by accidental fire in connection with OCS developmental activities? How much, if any, royalty is collected on these resources?

Answer:

About 300,000 barrels of oil and 4,000,000 MCF (1000 cu. ft.) have been spilled in major OCS accidents since 1953. During this period about 2.45 billion barrels of oil and condensate and 14.4 billion MCF of gas have been produced and sold. Minor nuisance type spills were contributing an additional estimated 4,000 barrels per year. This figure is steadily dropping as better safety equipment is installed and more stringent anti-pollution measures are enforced. An additional 2,000,000 barrels of oil and 3,000,000 MCF of gas are estimated to have been consumed in accidental fires.

Royalty has been collected on about 200,000 barrels of the oil spilled due to part of it being recovered, covered by insurance payments, and by direct billing for oil lost due to negligent operations.

9. What proportion of OCS lease acreage and petroleum production has been accounted for by oil "majors", "minors", "independents", and non-oil companies (or by another appropriate classification of enterprises)?

Answer:

A. Groups of majors

35% of acreage — 34% of production

B. Individual majors

46% of acreage — 63% of production

C. Groups of independents

17% of acreage — 2% of production

D. Individual independent

2% of acreage — 1% of production

For comparison with our figures, a list prepared by Merrill, Lynch, Pierce, Fenner and Smith of the 21 top companies in terms of cash income shows that since the start of the OCS leasing program, 88.6% of the leased acreage has been acquired by "Majors", 10.8% by "Independents" and .6% by "Others." Investment companies were classified in the "other" category. The historical participation of certain companies in the offshore was also taken into account.

10. How many offshore drilling rigs have been

a) Present on or adjacent to the OCS, or

b) Working on the OCS in each past year?

Answer:

Active Drilling Wells - Gulf of Mexico, OCS

January 1972	June 1971	June 1970	June 1969	June 1968
88	83	100	86	108

In addition to the Gulf of Mexico there have been 2 to 5 rigs active on the OCS in the Santa Barbara Channel over the last few years.

OUTER CONTINENTAL SHELF

NUMBER OF PERMITS GRANTED FOR
GEOLOGICAL AND/OR GEOPHYSICAL EXPLORATION

YEAR	ALASKA	ATLANTIC	GULF COAST					PACIFIC	YEARLY TOTAL
			Alabama	Florida	Louisiana	Mississippi	Texas		
1963	9	1	2	1	143	1	18	6	181
1964	5	6	2	7	110	1	85	14	230
1965	12	2	3	7	155	1	140	21	341
1966	11	10	11	30	360	6	136	27	591
1967	17	5	7	26	301	3	138	54	551
1968	27	9	13	26	188	12	95	28	398
1969	30	7	10	10	160	9	61	18	305
1970	40	4	4	13	134	5	48	5	253
1971	27	4	7	19	150	5	38	4	254
GRAND TOTAL 1963-1971	178	48	59	139	1,701	43	759	177	3,104

TABLE 1

OUTER CONTINENTAL SHELF LEASE SALES
By Years, States, Products

Date of Sale	Adjacent State	Product	No. Leases	Acreage	Bonus	First Year Rental
10-13-54	Louisiana	Oil & Gas	90	394,721	$ 116,378,476	$ 1,184,175
10-13-54	Louisiana	Sulfur	5	25,000	1,233,500	50,000
11-9-54	Texas	Oil & Gas	19	67,149	23,357,029	201,450
Total 1954			114	486,870	140,969,005	1,435,625
7-12-55	Louisiana	Oil & Gas	94	252,807	100,091,263	758,442
7-12-55	Texas	Oil & Gas	27	149,760	8,437,462	449,280
Total 1955			121	402,567	108,528,725	1,207,722
5-26-59	Florida	Oil & Gas	23	132,480	1,711,872	397,440
8-11-59	Louisiana	Oil & Gas	19	38,820	88,035,121	388,200
Total 1959			42	171,300	89,746,993	785,640
2-24-60	Louisiana	Oil & Gas	99	464,046	246,909,784	1,392,159
2-24-60	Texas	Oil & Gas	48	240,480	35,732,031	721,440
5-19-60	Louisiana	Salt	1	2,500	75,250	7,500
Total 1960			148	707,026	282,717,065	2,121,099
12-15-61	California	Phosphate	6	30,240	122,000	15,120
5-12-65	Refunded		(6)	(30,240)	(122,000)	(15,120)
3-13/16-62	Louisiana	Oil & Gas	401	1,879,527	445,036,032	5,638,671
3-16-62	Texas	Oil & Gas	10	28,800	557,720	86,400
10-9-62	Louisiana	Oil & Gas	9	16,178	43,887,359	161,780
Total 1962			420	1,924,505	489,481,111	5,886,851
5-14-63	California	Oil & Gas	57	312,945	12,807,587	938,838

TABLE 2

OUTER CONTINENTAL SHELF LEASE SALES
By Years, States, Products

Date of Sale	Adjacent State	Product	No. Leases	Acreage	Bonus	First Year Rental
4-28-64	Louisiana	Oil & Gas	23	32,673	$ 60,340,626	$ 326,780
10-1-64	Oregon	Oil & Gas	74	425,433	27,768,772	1,276,302
10-1-64	Washington	Oil & Gas	27	155,420	7,764,928	466,260
Total 1964			124	613,526	95,874,326	2,069,342
12-14-65	Texas	Sulfur	50	72,000	33,740,309	216,000
3-29-66	Louisiana	Oil & Gas	17	35,056	88,845,963	350,570
10-18-66	Louisiana	Oil & Gas	24	104,717	99,164,930	523,600
12-15-66	California	Oil & Gas	1	1,995	21,189,000	9,980
Total 1966			42	141,768	209,199,893	884,150
6-13-67	Louisiana	Oil & Gas	158	744,456	510,079,178	2,233,458
9-5-67	Louisiana	Salt	1	2,495	30,564	7,485
Total 1967			159	746,951	510,109,742	2,240,943
2-6-68	California	Oil & Gas	71	363,181	602,719,262	1,089,543
5-21-68	Texas	Oil & Gas	110	541,304	593,899,046	1,623,915
11-19-68	Louisiana	Oil & Gas	16	29,682	149,868,789	296,820
Total 1968			197	934,167	1,346,487,097	3,010,278
1-14-69	Louisiana	Oil & Gas	20	48,505	44,037,339	485,050
5-13-69	Louisiana	Sulfur	4	5,625	715,150	16,875
12-16-69	Louisiana	Oil & Gas	16	60,153	66,908,196	601,550
Total 1969			40	114,283	111,660,685	1,103,475
7-21-70	Louisiana	Oil & Gas	19	44,642	97,769,013	446,420
12-15-70	Louisiana	Oil & Gas	116	543,898	845,832,785	1,631,694
Total 1970			135	588,540	943,601,798	2,078,114
11-4-71	Louisiana	Oil & Gas	11	37,222	96,304,522	372,230

TABLE 3

SUMMARY OF OUTER CONTINENTAL SHELF LEASE SALES
October 13, 1954 through November 4, 1971
By State - By Product

Lease Sales from 10-13-54 to 11-4-71 By State	By Product	No. Leases	Acreage	Bonus	First Year Rental
California		129	678,121	$ 636,715,849	$ 2,038,361
Florida		23	132,480	1,711,872	397,440
Louisiana		1,143	4,762,723	3,101,543,840	16,873,459
Oregon		74	425,433	27,768,772	1,276,302
Texas		264	1,099,493	695,723,597	3,298,485
Washington		27	155,420	7,764,928	466,260
GRAND TOTAL		1,660	7,253,670	$4,471,228,858	$24,350,307
	Oil & Gas	1,599	7,146,050	$4,435,434,085	$24,052,447
	Salt	2	4,995	105,814	14,985
	Sulfur	59	102,625	35,688,959	282,875
	GRAND TOTAL	1,660	7,253,670	$4,471,228,858	$24,350,307

TABLE 4

OCS LEASE SALE

DATE	TYPE SALE	STATE	OFFERED TRACTS	OFFERED ACRES	LEASED TRACTS	LEASED ACRES	TOTAL BONUS	TOTAL FIRST YEAR RENTAL	AVERAGE BID PER AC.	HIGHEST BID PER AC.
10/13/54	O&G	La.	199	748,000	90	394,721	$116,378,476.00	$1,184,175	$ 294.84	$ 1,220.00
10/13/54	Sul.	La.	108	523,000	5	25,000	1,233,500.00	50,000	49.34	130.20
11/09/54	O&G	Texas	38	111,788	19	67,148	23,357,029.78	201,450	347.84	2,209.00
07/12/55	O&G	Texas	39	216,000	27	149,760	8,437,461.60	449,280	56.34	177.00
07/12/55	O&G	La.	171	458,095	94	252,806	100,091,263.81	758,442	395.92	2,076.80
02/26/59	O&G	Fla.	80	458,000	23	132,480	1,711,872.00	397,440	12.92	16.17
08/11/59	O&G	La.	38	81,813	19	38,820	88,035,120.37	388,200	2,267.78	10,442.08
02/26/60	O&G	Texas	97	437,760	48	240,480	35,732,031.20	721,440	148.59	1,026.25
		La.	288	1,173,223	99	464,047	246,909,783.59	1,392,159	532.07	2,501.51
05/19/60	Salt	La.	10	22,085	1	2,500	75,250.00	7,500	30.10	30.10
03/13/62	O&G	La.	401	1,808,276	206	951,811	177,260,304.75	2,855,433	186.23	3,201.10
03/16/62	O&G	Texas	30	90,720	10	28,800	577,719.50	86,400	19.37	26.25
		La.	380	1,780,265	195	927,746	267,775,677.06	2,783,238	288.63	3,081.00
10/09/62	O&G	La.	19	33,855	9	16,178	43,887,358.72	161,780	2,712.79	8,480.00
05/14/63	O&G	Calif.	129	669,777	57	312,976	12,807,586.68	938,838	40.93	454.80
04/28/64	O&G	La.	28	34,028	23	32,675	60,340,626.00	326,780	1,846.69	10,490.40
10/01/64	O&G	Ore.	149	836,134	74	425,433	27,768,772.24	1,276,302	65.27	376.00
		Wash.	47	253,940	27	155,420	7,764,928.40	466,260	49.96	310.05
12/14/65	Sul.	Texas	658	947,520	50	72,000	33,740,308.80	216,000	468.61	2,013.00
03/29/66	O&G	La.	18	35,993	17	35,056	88,845,963.42	350,570	2,534,43	6,112.20
10/18/66	O&G	La.	52	227,898	24	104,717	99,164,930.42	523,600	946.98	3,128.00
12/15/66	O&G	Calif.	1	1,995	1	1,995	21,189,000.00	9,980	10,618.49	10,618.49
06/13/67	O&G	La.	206	971,489	158	744,456	510,079,177.76	2,233,458	685.17	6,500.00
09/05/67	Salt	La.	8	16,995	1	2,495	30,563.75	7,485	12.25	12.25
02/06/68	O&G	Calif.	110	540,609	71	363,181	602,719,261.60	1,089,543	1,659.56	11,373.70
05/21/68	O&G	Texas	169	728,551	110	541,304	593,899,046.38	1,623,915	1,097.16	7,602.00
11/19/68	O&G	La.	26	46,824	16	29,679	149,868,789.27	296,820	5,049.58	27,400.73
01/14/69	O&G	La.	38	96,389	20	48,505	44,037,339.65	485,050	907.90	2,161.00
05/13/69	Sul.	La.	120	163,105	4	5,625	715,150.00	16,875	127.14	214.93
12/16/69	O&G	La.	27	93,764	16	60,153	66,908,195.60	601,550	1,112.29	6,600.00
07/21/70	O&G	La.	34	73,360	19	44,642	97,769,013.00	446,420	2,190.06	8,[illegible]1.00
12/15/70	O&G	La.	127	593,485	116	543,898	845,832,785.00	1,631,694	1,555.13	12,875.00
11/04/71	O&G	La.	18	55,872	11	37,222	96,304,522.50	372,230	2,587.29	18,004.76
TOTALS			3,863	14,330,607	1,660	7,253,729	4,471,248,808.85	24,350,307		

TABLE 4a

OUTER CONTINENTAL SHELF

PRODUCING AND NON-PRODUCING LEASES (OIL, GAS, SALT AND SULFUR)
UNDER SUPERVISION AS OF DECEMBER 31, (1954-1970)

YEAR	PRODUCING		NON-PRODUCING		TOTAL	
ADJACENT STATE	NUMBER	ACREAGE	NUMBER	ACREAGE	NUMBER	ACREAGE
1954						
Louisiana	58	240,028	295	1,066,739	353	1,306,767
Louisiana-Sulfur	-	-	5	25,000	5	25,000
Texas	-	-	120	196,926	120	196,926
	58	240,028	420	1,288,665	478	1,528,693
1955						
Louisiana	102	432,316	356	1,567,147	458	1,999,463
Louisiana-Sulfur	-	-	5	25,000	5	25,000
Texas	4	5,760	144	346,509	148	352,269
	106	438,076	505	1,938,656	611	2,376,732
1956						
Louisiana	167	668,416	265	842,143	432	1,510,559
Louisiana-Sulfur	-	-	5	25,000	5	25,000
Texas	4	5,760	121	314,019	125	319,779
	171	674,176	391	1,181,162	562	1,855,338
1957						
Louisiana	210	771,246	176	587,552	386	1,358,798
Louisiana-Sulfur	-	-	5	25,000	5	25,000
Texas	3	4,320	27	97,389	30	101,709
	213	775,566	208	709,941	421	1,485,507
1958						
Louisiana	226	959,495	136	453,593	362	1,413,088
Louisiana-Sulfur	-	-	5	21,995	5	21,995
Texas	4	10,080	21	75,789	25	85,869
	230	969,575	162	551,377	392	1,520,952

TABLE 5

OUTER CONTINENTAL SHELF

PRODUCING AND NON-PRODUCING LEASES (OIL, GAS, SALT AND SULFUR) UNDER SUPERVISION AS OF DECEMBER 31, (1954-1970)

YEAR	PRODUCING		NON-PRODUCING		TOTAL	
ADJACENT STATE	NUMBER	ACREAGE	NUMBER	ACREAGE	NUMBER	ACREAGE
1959						
Florida	-	-	23	132,480	23	132,480
Louisiana	259	1,079,620	85	209,983	344	1,289,603
Louisiana-Sulfur	-	-	5	22,000	5	22,000
Texas	13	23,040	4	19,983	17	43,023
	272	1,102,660	117	384,446	389	1,487,106
1960						
Florida	-	-	23	132,480	23	132,480
Louisiana	285	1,141,959	94	428,361	379	1,570,320
Louisiana-Salt	1	2,500	-	-	1	2,500
Louisiana-Sulfur	-	-	5	22,000	5	22,000
Texas	13	23,040	48	240,480	61	263,520
	299	1,167,499	170	823,321	469	1,990,820
1961						
Florida	-	-	23	132,480	23	132,480
Louisiana	294	1,189,146	85	366,967	379	1,556,113
Louisiana-Salt	1	2,500	-	-	1	2,500
Louisiana-Sulfur	5	6,953	-	-	5	6,953
Texas	15	30,240	40	205,920	55	236,160
	315	1,228,839	148	705,367	463	1,934,206
1962						
California-Phosphate	-	-	6	30,240	6	30,240
Florida	-	-	11	63,360	11	63,360
Louisiana	311	1,261,262	475	2,177,985	786	3,439,247
Louisiana-Salt	1	2,500	-	-	1	2,500
Louisiana-Sulfur	5	6,953	-	-	5	6,953
Texas	15	30,240	34	152,640	49	182,880
	332	1,300,955	526	2,424,225	858	3,725,180

TABLE 6

OUTER CONTINENTAL SHELF

PRODUCING AND NON-PRODUCING LEASES (OIL, GAS, SALT AND SULFUR)
UNDER SUPERVISION AS OF DECEMBER 31, (1954-1970)

YEAR / ADJACENT STATE	PRODUCING		NON-PRODUCING		TOTAL	
	NUMBER	ACREAGE	NUMBER	ACREAGE	NUMBER	ACREAGE
1963						
California	-	-	57	312,945	57	312,945
Louisiana	342	1,381,874	441	2,030,043	783	3,411,917
Louisiana-Salt	1	2,500	-	-	1	2,500
Louisiana-Sulfur	5	6,953	-	-	5	6,953
Texas	15	40,500	26	115,200	41	155,700
	363	1,431,827	524	2,458,188	887	3,890,015
1964						
California	-	-	54	295,665	54	295,665
Louisiana	357	1,463,149	422	1,870,554	779	3,333,703
Louisiana-Salt	1	2,500	-	-	1	2,500
Louisiana-Sulfur	5	6,953	-	-	5	6,953
Oregon	-	-	74	425,433	74	425,433
Texas	12	31,860	29	123,840	41	155,700
Washington	-	-	27	155,420	27	155,420
	375	1,504,462	606	2,870,912	981	4,375,374
1965						
California	-	-	50	272,625	50	272,625
Louisiana	406	1,632,544	335	1,487,335	741	3,119,879
Louisiana-Salt	1	2,500	-	-	1	2,500
Louisiana-Sulfur	5	6,953	-	-	5	6,953
Oregon	-	-	74	425,433	74	425,433
Texas	13	37,620	26	109,440	39	147,060
Washington	-	-	27	155,420	27	155,420
	425	1,679,617	512	2,450,253	937	4,129,870

TABLE 7

OUTER CONTINENTAL SHELF

PRODUCING AND NON-PRODUCING LEASES (OIL, GAS, SALT AND SULFUR)
UNDER SUPERVISION AS OF DECEMBER 31, (1954-1970)

YEAR / ADJACENT STATE	PRODUCING NUMBER	PRODUCING ACREAGE	NON-PRODUCING NUMBER	NON-PRODUCING ACREAGE	TOTAL NUMBER	TOTAL ACREAGE
1966						
California	-	-	35	186,225	35	186,225
Louisiana	469	1,917,276	303	1,307,869	772	3,225,145
Louisiana-Salt	1	2,500	-	-	1	2,500
Louisiana-Sulfur	5	6,953	-	-	5	6,953
Oregon	-	-	60	344,793	60	344,793
Texas	13	37,800	26	109,260	39	147,060
Texas-Sulfur	-	-	41	59,040	41	59,040
Washington	-	-	21	120,960	21	120,960
	488	1,964,529	486	2,128,147	974	4,092,676
1967						
California	-	-	3	13,515	3	13,515
Louisiana	506	2,038,821	293	1,303,928	799	3,342,749
Louisiana-Salt	1	2,500	1	2,495	2	4,995
Louisiana-Sulfur	5	6,953	-	-	5	6,953
Oregon	-	-	8	45,825	8	45,825
Texas	13	37,800	16	87,660	29	125,460
Texas-Sulfur	-	-	34	48,960	34	48,960
Washington	-	-	3	17,280	3	17,280
	525	2,086,074	358	1,519,663	883	3,605,737
1968						
California	3	13,156	69	352,021	72	365,177
Louisiana	518	2,119,651	276	1,182,081	794	3,301,732
Louisiana-Salt	2	4,995	-	-	2	4,995
Louisiana-Sulfur	5	6,953	-	-	5	6,953
Oregon	-	-	2	11,520	2	11,520
Texas	10	11,430	125	622,304	135	633,734
Texas-Sulfur	-	-	10	14,400	10	14,400
Washington	-	-	3	17,278	3	17,278
	538	2,156,185	485	2,199,604	1,023	4,355,789

TABLE 8

OUTER CONTINENTAL SHELF

PRODUCING AND NON-PRODUCING LEASES (OIL, GAS, SALT AND SULFUR)
UNDER SUPERVISION AS OF DECEMBER 31, (1954-1971)

YEAR	PRODUCING		NON-PRODUCING		TOTAL	
ADJACENT STATE	NUMBER	ACREAGE	NUMBER	ACREAGE	NUMBER	ACREAGE
1969						
California	7	30,300	65	334,876	72	365,176
Louisiana	531	2,182,860	265	1,106,437	796	3,289,297
Louisiana-Salt	2	4,995	-	-	2	4,995
Louisiana-Sulfur	5	6,953	4	5,625	9	12,578
Texas	23	83,430	113	549,134	136	632,564
Texas-Sulfur	-	-	6	8,640	6	8,640
	568	2,308,538	453	2,004,712	1,021	4,313,250
1970						
California	10	42,256	60	312,983	70	355,239
Louisiana	557	2,329,365	254	999,393	811	3,328,758
Louisiana-Salt	2	4,995	-	-	2	4,995
Louisiana-Sulfur	5	6,953	4	5,625	9	12,578
Texas	34	146,340	90	431,324	124	577,664
Texas-Sulfur	-	-	1	1,440	1	1,440
	608	2,529,909	409	1,750,765	1,017	4,280,674
1971						
California	12	53,776	58	301,463	70	355,239
Louisiana	596	2,497,933	303	1,248,742	899	3,746,675
Louisiana-Salt	2	4,995	-	-	2	4,995
Louisiana-Sulfur	5	6,953	4	5,625	9	12,578
Texas	34	146,340	69	336,464	103	482,804
	649	2,709,997	434	1,892,294	1,083	4,602,291

TABLE 9

W E L L   S T A T U S
OUTER CONTINENTAL SHELF
1950-1971

Year	New Wells Drilling: Act.	New Wells Drilling: Susp'd	Wells Completed	Producible Zones: Active Oil	Producible Zones: Active Gas	Producible Zones: Shut-In Oil	Producible Zones: Shut-In Gas	Producible Zones: Total Act. & Shut-In	Producible Zones: Serv. Inp.-Disp.	All Other Wells not P&A	Wells P & A	Total Wells
1950 a/	24	-	410	371	-	13	26	410	-	-	79	513
1951	-	-	-	-	-	-	-	-	-	-	-	-
1952	-	-	-	-	-	-	-	-	-	-	-	-
1953	-	-	-	-	-	-	-	-	-	-	-	-
1954	27	-	130	50	20	15	45	130	-	-	104	261
1955	41	-	239	117	29	31	62	239	-	-	175	455
1956	76	-	357	195	32	41	89	357	-	-	261	694
1957	61	17	588	330	31	83	144	588	-	-	402	1,068
1958	35	21	795	487	74	80	154	795	-	-	485	1,336
1959	40	31	1,461	864	173	245	179	1,461	-	-	569	2,101
1960	58	53	1,923	1,138	210	326	249	1,923	-	-	686	2,720
1961	54	99	2,467	1,463	240	429	335	2,467	-	-	814	3,434
1962	56	107	3,091	1,863	333	513	382	3,091	-	-	1,002	4,256
1963	62	130	3,631	2,237	397	584	413	3,631	-	-	1,226	5,049
1964	73	193	4,313	2,708	417	622	486	4,233	80	102	1,372	6,053
1965	89	261	4,733	3,068	516	687	462	4,733	-	-	1,685	6,768
1966	82	-	3,305	3,588	660	747	504	5,499	35	444	1,871	5,702
1967	95	-	3,762	4,080	870	759	507	6,216	60	496	2,233	6,586
1968	133	-	4,258	4,483	1,040	908	578	7,009	91	592	2,592	7,575
1969	103	129	4,752	4,985	1,280	880	578	7,723	117	590	2,919	8,493
1970	106	115	5,359	5,565	1,574	882	645	8,666	164	534	3,278	9,392
1971	89	152	5,718	5,704	1,872	953	602	9,131	217	551	3,724	10,234

a/ Tide and submerged, California.

NOTE: Wells completed equal hole completions beginning with Calendar Year 1966.

TABLE 10

WELL STATUS

OUTER CONTINENTAL SHELF

Year, State	New Wells Drilling Act.	New Wells Drilling Susp'd	Wells Completed	Producible Zones: Active Oil	Producible Zones: Active Gas	Producible Zones: Shut-In Oil	Producible Zones: Shut-In Gas	Producible Zones: Total Act.& Shut-In	Serv. Inp.-Disp.	All Other Wells not P&A	Wells P & A	Total Wells
1954												
Louisiana	26	-	130	50	20	15	45	130	-	-	103	259
Texas	1	-	-	-	-	-	-	-	-	-	1	2
	27	-	130	50	20	15	45	130	-	-	104	261
1955												
Louisiana	38	-	235	117	29	30	59	235	-	-	170	443
Texas	3	-	4	-	-	1	3	4	-	-	5	12
	41	-	239	117	29	31	62	239	-	-	175	455
1956												
Louisiana	75	-	353	194	32	41	86	353	-	-	242	670
Texas	1	-	4	1	-	-	3	4	-	-	19	24
	76	-	357	195	32	41	89	357	-	-	261	694
1957												
Louisiana	61	17	585	330	31	83	141	585	-	-	381	1,044
Texas	-	-	3	-	-	-	3	3	-	-	21	24
	61	17	588	330	31	83	144	588	-	-	402	1,068
1958												
Louisiana	34	21	791	487	74	80	150	791	-	-	464	1,310
Texas	1	-	4	-	-	-	4	4	-	-	21	26
	35	21	795	487	74	80	154	795	-	-	485	1,336
1959												
Louisiana	40	31	1,455	864	173	244	174	1,455	-	-	545	2,071
Texas	-	-	6	-	-	1	5	6	-	-	24	30
	40	31	1,461	864	173	245	179	1,461	-	-	569	2,101

TABLE 11

WELL STATUS

OUTER CONTINENTAL SHELF

Year, State	New Wells Drilling Act.	New Wells Drilling Susp'd	Wells Completed	Producible Zones: Active Oil	Active Gas	Shut-In Oil	Shut-In Gas	Total Act. & Shut-In	Serv. Inp.-Disp.	All Other Wells not P&A	Wells P & A	Total Wells
1960												
Florida	1	-	-	-	-	-	-	-	-	-	1	2
Louisiana	55	53	1,916	1,138	210	324	244	1,916	-	-	657	2,681
Texas	2	-	7	-	-	2	5	7	-	-	28	37
	58	53	1,923	1,138	210	326	249	1,923	-	-	686	2,720
1961												
Florida	-	-	-	-	-	-	-	-	-	-	3	3
Louisiana	54	99	2,456	1,463	240	427	326	2,456	-	-	771	3,380
Texas	-	-	11	-	-	2	9	11	-	-	40	51
	54	99	2,467	1,463	240	429	335	2,467	-	-	814	3,434
1962												
Florida	-	-	-	-	-	-	-	-	-	-	3	3
Louisiana	56	107	3,079	1,863	333	511	372	3,079	-	-	955	4,197
Texas	-	-	12	-	-	2	10	12	-	-	44	56
	56	107	3,091	1,863	333	513	382	3,091	-	-	1,002	4,256
1963												
California	1	-	-	-	-	-	-	-	-	-	1	2
Florida	-	-	-	-	-	-	-	-	-	-	3	3
Louisiana	60	130	3,617	2,235	397	583	402	3,617	-	-	1,175	4,982
Texas	1	-	14	2	-	1	11	14	-	-	47	62
	62	130	3,631	2,237	397	584	413	3,631	-	-	1,226	5,049

TABLE 12

W E L L S T A T U S

OUTER CONTINENTAL SHELF

Year, State	New Wells Drilling Act.	New Wells Drilling Susp'd	Wells Com-pleted	Producible Zones: Active Oil	Producible Zones: Active Gas	Producible Zones: Shut-In Oil	Producible Zones: Shut-In Gas	Producible Zones: Total Act.& Shut-In	Producible Zones: Serv. Inp.-Disp.	All Other Wells not P&A	Wells P & A	Total Wells
1964												
California	2	-	-	-	-	-	-	-	-	-	8	10
Florida	-	-	-	-	-	-	-	-	-	-	3	3
Louisiana	70	193	4,281	2,708	417	615	461	4,201	80	102	1,302	5,948
Texas	1	-	32	-	-	7	25	32	-	-	59	92
	73	193	4,313	2,708	417	622	486	4,233	80	102	1,372	6,053
1965												
California	-	-	-	-	-	-	-	-	-	-	15	15
Florida	-	-	-	-	-	-	-	-	-	-	3	3
Louisiana	87	241	4,694	3,067	516	681	430	4,694	-	-	1,597	6,619
Oregon	1	1	-	-	-	-	-	-	-	-	3	5
Texas	1	19	39	1	-	6	32	39	-	-	67	126
	89	261	4,733	3,068	516	687	462	4,733	-	-	1,685	6,768
1966												
California	1	-	-	-	-	-	-	-	-	-	16	17
Florida	-	-	-	-	-	-	-	-	-	-	3	3
Louisiana	80	-	3,254	3,580	630	744	474	5,428	35	427	1,773	5,534
Oregon	-	-	-	-	-	-	-	-	-	-	7	7
Texas	1	-	51	8	30	3	30	71	-	17	70	139
Washington	-	-	-	-	-	-	-	-	-	-	2	2
	82	-	3,305	3,588	660	747	504	5,499	35	444	1,871	5,702

TABLE 13

W E L L   S T A T U S

OUTER CONTINENTAL SHELF

Year, State	New Wells Drilling Act.	New Wells Drilling Susp'd	Wells Com-pleted	Producible Zones Active Oil	Producible Zones Active Gas	Producible Zones Shut-In Oil	Producible Zones Shut-In Gas	Total Act.& Shut-In	Serv. Inp.-Disp.	All Other Wells not P&A	Wells P & A	Total Wells
1967												
California	-	-	-	-	-	-	-	-	-	-	26	26
Florida	-	-	-	-	-	-	-	-	-	-	3	3
Louisiana	93	-	3,681	4,053	789	756	499	6,097	60	493	2,111	6,378
Oregon	-	-	-	-	-	-	-	-	-	-	8	8
Texas	2	-	81	27	81	3	8	119	-	3	81	167
Washington	-	-	-	-	-	-	-	-	-	-	4	4
	95	-	3,762	4,080	870	759	507	6,216	60	496	2,233	6,586
1968												
California	9	-	26	24	-	2	-	26	-	4	51	90
Florida	-	-	-	-	-	-	-	-	-	-	3	3
Louisiana	117	-	4,147	4,428	956	903	569	6,856	91	576	2,425	7,265
Oregon	-	-	-	-	-	-	-	-	-	-	8	8
Texas	7	-	85	31	84	3	9	127	-	12	101	205
Washington	-	-	-	-	-	-	-	-	-	-	4	4
	133	-	4,258	4,483	1,040	908	578	7,009	91	592	2,592	7,575
1969												
California	6	7	94	77	-	17	-	94	-	4	71	182
Florida	-	-	-	-	-	-	-	-	-	-	3	3
Louisiana	92	120	4,567	4,875	1,189	860	569	7,493	117	570	2,689	8,029
Oregon	-	-	-	-	-	-	-	-	-	-	8	8
Texas	5	2	91	33	91	3	9	136	-	16	153	267
Washington	-	-	-	-	-	-	-	-	-	-	-	-
	103	129	4,752	4,985	1,280	880	578	7,723	117	590	2,919	8,493

TABLE 14

WELL STATUS
OUTER CONTINENTAL SHELF

Year, State	New Wells Drilling		Wells Com- pleted	Producible Zones						All Other Wells not P&A	Wells P & A	Total Wells
				Active		Shut-In		Total Act.& Shut-In	Serv. Inp.- Disp.			
	Act.	Susp'd		Oil	Gas	Oil	Gas					
1970												
California	5	9	162	149	-	14	-	163	-	5	77	258
Florida	-	-	-	-	-	-	-	-	-	-	3	3
Louisiana	100	102	5,099	5,384	1,483	861	629	8,357	164	510	3,006	8,817
Oregon	-	-	-	-	-	-	-	-	-	-	8	8
Texas	1	4	98	32	91	7	16	146	-	19	180	302
Washington	-	-	-	-	-	-	-	-	-	-	4	4
	106	115	5,359	5,565	1,574	882	645	8,666	164	534	3,278	9,392
1971												
California	1	13	188	182	-	11	-	193	1	5	88	295
Florida	-	-	-	-	-	-	-	-	-	-	3	3
Louisiana	81	131	5,429	5,495	1,771	935	588	8,789	216	526	3,429	9,596
Oregon	-	-	-	-	-	-	-	-	-	-	8	8
Texas	7	8	101	27	101	7	14	149	-	20	192	328
Washington	-	-	-	-	-	-	-	-	-	-	4	4
	89	152	5,718	5,704	1,872	953	602	9,131	217	551	3,724	10,234

TABLE 15

WELL ACTIVITY
OUTER CONTINENTAL SHELF
1954 - 1971

Year	New Wells Started	Well Comple-tions	Producible Zone Completions			Dry Holes, Failures, Abandoned
			Oil	Gas	Service Inp.-Disp.	
1954	5	5	3	2	-	2
1955	148	90	59	31	-	45
1956	230	123	98	25	-	87
1957	322	177	133	44	-	109
1958	304	225	174	51	-	126
1959	278	210	162	48	-	72
1960	403	425	333	92	-	106
1961	461	462	337	125	-	114
1962	453	539	409	130	-	135
1963	537	516	421	95	-	210
1964	688	612	507	102	3	241
1965	809	427	538	94	-	290
1966	823	415	528	143	2	464
1967	868	350	455	102	9	359
1968	995	436	550	166	7	349
1969	923	435	520	125	5	446
1970	900	605	681	266	13	357
1971	841	407	393	240	7	552

Note: Well activity is on a Fiscal Year basis for 1954-1963 and a Calendar Year basis beginning with 1964. Well completions equal hole completions beginning with Calendar Year 1965.

TABLE 16

W E L L   A C T I V I T Y

OUTER CONTINENTAL SHELF

Year, State	New Wells Started	Well Comple-tions	Producible Zone Completions: Oil	Producible Zone Completions: Gas	Producible Zone Completions: Service Inp.-Disp.	Dry Holes, Failures, Abandoned
1954						
Louisiana	5	5	3	2	-	2
1955						
Lousiana	145	89	58	31	-	44
Texas	3	1	1	-	-	1
	148	90	59	31	-	45
1956						
Louisiana	220	120	98	22	-	80
Texas	10	3	-	3	-	7
	230	123	98	25	-	87
1957						
Louisiana	313	176	133	43	-	99
Texas	9	1	-	1	-	10
	322	177	133	44	-	109
1958						
Louisiana	303	225	174	51	-	125
Texas	1	-	-	-	-	1
	304	225	174	51	-	126
1959						
Louisiana	276	208	162	46	-	71
Texas	2	2	-	2	-	1
	278	210	162	48	-	72

TABLE 17

WELL ACTIVITY

OUTER CONTINENTAL SHELF

Year, State	New Wells Started	Well Completions	Producible Zone Completions: Oil	Producible Zone Completions: Gas	Producible Zone Completions: Service Inp.-Disp.	Dry Holes, Failures, Abandoned
1960						
Florida	1	-	-	-	-	1
Louisiana	398	423	331	92	-	103
Texas	4	2	2	-	-	2
	403	425	333	92	-	106
1961						
Florida	1	-	-	-	-	1
Louisiana	444	461	337	124	-	102
Texas	16	1	-	1	-	11
	461	462	337	125	-	114
1962						
Florida	1	-	-	-	-	1
Louisiana	444	535	409	126	-	126
Texas	8	4	-	4	-	8
	453	539	409	130	-	135
1963						
Louisiana	536	516	421	95	-	208
Texas	1	-	-	-	-	2
	537	516	421	95	-	210
1964						
California	8	-	-	-	-	6
Louisiana	653	594	504	87	3	221
Texas	27	18	3	15	-	14
	688	612	507	102	3	241

TABLE 18

WELL ACTIVITY

OUTER CONTINENTAL SHELF

Year, State	New Wells Started	Well Comple- tions	Producible Zone Completions: Oil	Producible Zone Completions: Gas	Producible Zone Completions: Service Inp.-Disp.	Dry Holes Failures, Abandoned
1965						
California	5	-	-	-	-	7
Louisiana	765	420	537	87	-	273
Oregon	5	-	-	-	-	3
Texas	34	7	1	7	-	7
	809	427	538	94	-	290
1966						
California	2	-	-	-	-	1
Louisiana	800	400	524	118	2	444
Oregon	2	-	-	-	-	4
Texas	17	15	4	25	-	13
Washington	2	-	-	-	-	2
	823	415	528	143	2	464
1967						
California	9	-	-	-	-	10
Louisiana	828	339	444	96	9	335
Oregon	1	-	-	-	-	1
Texas	28	11	11	6	-	11
Washington	2	-	-	-	-	2
	868	350	455	102	9	359
1968						
California	64	26	26	-	-	25
Louisiana	893	406	520	162	7	304
Texas	38	4	4	4	-	20
	995	436	550	166	7	349

TABLE 19

WELL ACTIVITY

OUTER CONTINENTAL SHELF

Year, State	New Wells Started	Well Comple-tions	Producible Zone Completions			Dry Holes, Failures, Abandoned
			Oil	Gas	Service Inp.-Disp.	
1969						
California	97	72	72	-	-	25
Louisiana	764	358	448	118	5	362
Texas	62	5	-	7	-	59
	923	435	520	125	5	446
1970						
California	77	70	70	-	-	9
Louisiana	788	528	607	260	13	324
Texas	35	7	4	6	-	24
	900	605	681	266	13	357
1971						
California	35	28	36	-	1	15
Louisiana	780	375	357	236	6	522
Texas	26	4	-	4	-	15
	841	407	393	240	7	552

TABLE 20

OUTER CONTINENTAL SHELF
UNIT PLANS
CALENDAR YEARS 1956--1971

YEAR	UNIT PLANS					
	APPROVED a/		TERMINATED a/		OUTSTANDING	
	Number	Acreage	Number	Acreage	Number	Acreage
1956	11	314,172	-	-	11	314,172
1957	2	35,477	1	38,250	12	311,399
1958	1	22,500	-	-	13	333,899
1959	4	104,400	1	22,499	16	415,800
1960	-	5,001	1	52,501	15	368,300
1961	1	15,000	1	35,047	15	348,253
1962	-	-	-	-	15	348,253
1963	1	22,270	-	-	16	370,523
1964	5	94,144	-	1,260	21	463,407
1965	7	198,753	-	-	28	662,160
1966	16	317,176	1	273	43	979,063
1967	7	171,702	3	127,820	47	1,022,945
1968	3	29,803	1	51,600	49	1,001,148
1969	29	49,279	-	24,062	78	1,026,365
1970	18	96,083	3	101,864	93	1,020,584
1971	7	4,166	2	72,606	98	952,144
Through 1971	112	1,479,926	14	527,782	98	952,144

a/ Includes expansions and contractions of unit plan agreements.

TABLE 21

OUTER CONTINENTAL SHELF
REVENUE AND PRODUCTION VALUE
PERCENTAGE CUMULATIVE REVENUE OF CUMULATIVE PRODUCTION VALUE
CALENDAR YEARS 1953 - 1971

YEAR	BONUSES	MINIMUM ROYALTIES	RENTALS	SHUT-IN GAS PAYMENTS	ROYALTIES	TOTAL REVENUE	TOTAL CUMULATIVE REVENUE	TOTAL PRODUCTION VALUE	TOTAL CUMULATIVE PROD. VALUE	PER-CENT a/
ALL STATES										%
1953	$ -	$ -	$ 1,359,630	$ 30,650	$ 967,892	$ 2,358,172	$ 2,358,172	$ 5,036,861	$ 5,036,861	47
1954	140,969,005	-	3,855,333	86,950	2,748,977	147,660,265	150,018,437	14,370,098	19,406,959	774
1955	108,528,725	-	3,406,351	122,000	5,140,006	117,197,082	267,215,519	27,060,679	46,467,638	575
1956	-	-	4,006,193	79,950	7,629,383	11,715,526	278,931,045	39,497,871	85,965,509	324
1957	-	68,581	3,270,122	110,268	11,391,245	14,840,216	293,771,261	61,072,588	147,038,097	200
1958	-	184,396	2,420,584	121,218	17,423,878	20,150,076	313,921,337	96,471,136	243,509,233	129
1959	89,746,993	171,036	2,285,725	84,984	26,539,977	118,828,715	432,750,052	150,472,527	393,981,760	110
1960	282,717,065	316,975	3,603,140	49,350	37,095,301	323,781,831	756,531,883	200,969,615	594,951,375	127
1961	-	314,121	3,073,861	37,100	47,920,332	51,345,414	807,877,297	273,636,456	868,587,831	93
1962	489,481,111	517,722	8,412,207	62,200	66,096,334	564,569,574	1,372,446,871	376,675,900	1,245,263,731	102
1963	12,807,587	668,339	8,435,184	52,950	76,999,225	98,963,285	1,471,410,156	450,866,484	1,696,130,215	87
1964	95,874,326	820,343	9,798,573	45,800	88,400,230	194,939,272	1,666,349,428	506,783,510	2,202,913,725	76
1965	33,740,309	1,072,699	8,731,378	38,450	102,862,540	146,445,376	1,812,794,804	594,222,732	2,797,136,457	65
1966	209,199,893	1,367,250	6,869,277	41,700	136,987,537	354,465,657	2,167,260,461	801,724,611	3,598,861,068	60
1967	510,109,742	1,891,515	6,208,936	41,400	157,607,609	675,859,202	2,843,119,663	947,214,691	4,546,075,759	63
1968	1,346,487,097	2,145,178	8,230,787	52,300	201,136,931	1,558,052,293	4,401,171,956	1,179,912,209	5,725,987,968	77
1969	111,660,685	1,923,632	8,312,507	41,550	240,090,666	362,029,240	4,763,201,196	1,443,870,472	7,169,858,440	65
1970	943,601,798	1,745,864	8,585,355	47,700	283,494,568	1,237,475,285	6,000,676,481	1,707,593,450	8,877,451,890	68
1971	96,304,522	1,891,000	7,741,997	32,300	350,042,488	456,012,307	6,456,688,788	2,135,677,078	11,013,128,968	59
TOTAL ALL STATES	$4,471,228,858	$15,098,651	$108,607,240	$1,178,920	$1,860,575,119	$6,456,688,788	$6,456,688,788	$11,013,128,968	$11,013,128,968	59%

a/ Percentage accumulated revenue of accumulated production value.

NOTE: Revenue = charges and/or collections -- bonuses and first year rentals adjusted from book transfer dates (years) to GS from BLM, to actual sales dates. Distribution of escrow funds totaling $39,316,545 to the State of Louisiana and Lessees, pursuant to Supreme Court decree dated December 13, 1965, was not deducted from calendar year 1966 revenue charges, nor was the production value of $157 million deducted.

TABLE 22

OIL AND GAS OPERATIONS
ALL PRODUCTS - OUTER CONTINENTAL SHELF

YEAR	PRODUCTION VALUE($)	ROYALTY VALUE($)
1953	5,036,861	967,892
1954	14,370,098	2,748,977
1955	27,060,679	5,140,006
1956	39,497,871	7,629,383
1957	61,072,588	11,391,245
1958	96,471,136	17,423,878
1959	150,472,527	26,539,977
1960	200,969,615	37,095,301
1961	273,636,456	47,920,332
1962	376,675,900	66,096,334
1963	450,866,484	76,999,225
1964	506,783,510	88,400,230
1965	594,222,732	102,862,540
1966	801,724,611	136,987,537
1967	947,214,691	157,607,609
1968	1,179,912,209	201,136,931
1969	1,443,870,472	240,090,666
1970	1,707,593,450	283,494,568
1971	2,135,677,078	350,042,488
THROUGH 1971	11,013,128,968	1,860,575,119

TABLE 23

OIL & CONDENSATE - OUTER CONTINENTAL SHELF

Year	Production Barrels	Production Value	Royalty Value
1953	1,150,697	$ 3,490,530	$ 719,541
1954	3,342,230	9,976,130	2,043,198
1955	6,705,484	19,942,648	4,023,364
1956	11,014,532	32,502,811	6,525,685
1957	16,070,187	53,564,155	10,225,867
1958	24,769,037	80,737,194	15,110,378
1959	35,697,521	113,069,363	21,221,459
1960	49,665,989	146,434,371	29,171,651
1961	64,330,078	201,672,863	37,250,253
1962	89,736,582	278,927,806	51,506,810
1963	104,579,240	332,965,755	59,237,084
1964	122,500,126	375,619,494	68,647,794
1965	144,968,615	443,805,831	80,408,174
1966	188,714,070	579,668,024	103,707,597
1967	221,861,614	682,179,835	121,398,258
1968	268,995,890	835,280,068	148,037,661
1969	312,859,987	1,019,130,848	178,291,525
1970	360,646,168	1,193,591,525	207,076,462
1971	418,548,946	1,481,680,916	253,229,024
Through 1971	2,446,156,993	7,884,240,167	1,397,831,785

TABLE 24

OIL - OUTER CONTINENTAL SHELF

YEAR	PRODUCTION BARRELS	PRODUCTION VALUE($)	ROYALTY VALUE($)
1953	940,634	2,770,866	584,088
1954	2,723,173	8,028,326	1,681,702
1955	5,871,853	17,318,314	3,539,946
1956	10,136,355	29,764,624	6,019,747
1957	15,373,071	51,166,849	9,793,597
1958	23,709,108	77,266,710	14,482,598
1959	34,177,529	108,197,518	20,331,723
1960	47,359,144	139,113,972	27,843,125
1961	61,265,770	192,144,960	35,462,210
1962	84,931,909	264,052,899	48,707,457
1963	98,331,298	313,797,445	55,618,246
1964	114,977,253	352,677,995	64,360,892
1965	136,236,062	417,141,510	75,419,562
1966	175,187,399	537,917,792	96,028,102
1967	205,860,535	633,989,826	112,770,550
1968	252,016,345	780,113,838	138,248,305
1969	295,429,477	958,388,119	167,701,123
1970	337,122,885	1,112,183,855	193,102,272
1971	390,180,091	1,378,656,056	235,780,785
THROUGH 1971	2,291,829,882	7,374,691,474	1,337,476,030

TABLE 25

CONDENSATE - OUTER CONTINENTAL SHELF

YEAR	PRODUCTION BARRELS	PRODUCTION VALUE($)	ROYALTY VALUE($)
1953	210,063	719,664	135,453
1954	619,057	1,947,804	361,496
1955	833,631	2,624,334	483,418
1956	878,177	2,738,187	505,938
1957	697,116	2,397,306	432,270
1958	1,059,929	3,479,484	627,780
1959	1,519,992	4,871,845	889,736
1960	2,306,845	7,320,399	1,328,526
1961	3,064,308	9,527,903	1,788,043
1962	4,804,673	14,874,907	2,799,353
1963	6,247,942	19,168,310	3,618,838
1964	7,522,873	22,941,499	4,286,902
1965	8,732,553	26,664,321	4,988,612
1966	13,526,680	41,750,232	7,679,495
1967	16,001,079	48,190,009	8,627,708
1968	16,979,545	55,166,230	9,789,356
1969	17,430,510	60,742,729	10,590,402
1970	23,523,283	81,407,670	13,974,190
1971	28,368,855	103,024,860	17,448,239
THROUGH 1971	154,327,111	539,548,693	90,355,755

TABLE 26

GAS - OUTER CONTINENTAL SHELF

YEAR	PRODUCTION MCF	PRODUCTION VALUE($)	ROYALTY VALUE($)
1953	19,881,055	1,546,331	248,351
1954	56,325,083	4,393,968	705,779
1955	81,279,042	7,118,031	1,116,642
1956	82,892,538	6,995,069	1,103,698
1957	82,573,604	7,508,433	1,165,378
1958	127,692,848	15,733,942	2,313,500
1959	207,156,296	37,403,164	5,318,518
1960	273,034,451	52,761,614	7,636,074
1961	318,280,095	64,615,520	9,483,489
1962	451,952,659	92,209,196	13,748,400
1963	564,352,606	106,783,758	16,136,781
1964	621,731,438	118,377,080	17,887,512
1965	645,589,469	126,977,562	19,248,110
1966	1,007,447,235	189,381,492	29,142,325
1967	1,187,215,750	227,694,353	32,034,125
1968	1,524,178,078	291,257,157	48,453,728
1969	1,954,486,975	365,770,489	57,390,306
1970	2,418,676,591	438,136,408	69,445,227
1971	2,777,043,418	549,648,012	87,405,869
THROUGH 1971	14,401,789,231	2,704,311,570	419,933,812

TABLE 27

GASOLINE AND LPG - OUTER CONTINENTAL SHELF

YEAR	PRODUCTION GALLONS	PRODUCTION VALUE($)	ROYALTY VALUE($)
1969	222,430,316	9,777,811	714,111
1970	1,075,386,730	51,180,237	3,728,914
1971	1,550,667,787	80,563,166	5,944,366
THROUGH 1971	2,848,484,833	141,521,214	10,387,391

TABLE 28

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SALT - OUTER CONTINENTAL SHELF

YEAR	PRODUCTION TONS	PRODUCTION VALUE($)	ROYALTY VALUE($)
1960	59,794	10,764	1,792
1961	528,581	95,142	15,857
1962	176,924	31,848	5,308
1963	262,951	47,334	7,889
1964	212,978	38,334	6,389
1965	290,804	52,334	8,724
1966	297,475	53,544	8,924
1967	274,422	49,396	7,422
1968	540,651	97,317	17,030
1969	343,060	61,751	10,292
1970	269,691	48,544	8,091
1971	370,406	66,673	11,112
THROUGH 1971	3,627,737	652,981	108,830

TABLE 29

SULFUR - OUTER CONTINENTAL SHELF

YEAR	PRODUCTION TONS	PRODUCTION VALUE($)	ROYALTY VALUE($)
1960	98,025	1,762,866	285,784
1961	401,521	7,252,931	1,170,733
1962	285,975	5,507,050	835,816
1963	552,573	11,069,637	1,617,471
1964	634,875	12,748,602	1,858,535
1965	1,090,950	23,387,005	3,197,532
1966	1,400,848	32,621,551	4,128,691
1967	1,409,276	37,291,107	4,167,804
1968	1,553,621	53,277,667	4,628,512
1969	1,232,939	49,129,573	3,684,432
1970	1,099,584	24,636,736	3,235,874
1971	1,178,400	23,718,311	3,452,117
THROUGH 1971	10,938,587	282,403,036	32,263,301

TABLE 30

OUTER CONTINENTAL SHELF
CALENDAR YEAR 1971

STATE	PRODUCTION	PRODUCTION VALUE($)	ROYALTY VALUE($)
	(BARRELS)	OIL	
CALIFORNIA	31,103,548	98,407,829	16,401,306
LOUISIANA	358,366,080	1,277,637,359	218,947,766
TEXAS	710,463	2,610,868	431,713
TOTAL	390,180,091	1,378,656,056	235,780,785
	(BARRELS)	CONDENSATE	
LOUISIANA	27,394,271	99,350,253	16,835,804
TEXAS	974,584	3,674,607	612,435
TOTAL	28,368,855	103,024,860	17,448,239
	(BARRELS)	OIL & CONDENSATE	
CALIFORNIA	31,103,548	98,407,829	16,401,306
LOUISIANA	385,760,351	1,376,987,612	235,783,570
TEXAS	1,685,047	6,285,475	1,044,148
TOTAL	418,548,946	1,481,680,916	253,229,024
	(MCF)	GAS	
CALIFORNIA	15,671,479	4,231,299	705,217
LOUISIANA	2,634,014,031	525,451,277	83,373,079
TEXAS	127,357,908	19,965,436	3,327,573
TOTAL	2,777,043,418	549,648,012	87,405,869
	(GALLONS)	GASOLINE AND LPG	
CALIFORNIA	2,115,628	131,712	8,781
LOUISIANA	1,462,879,363	76,751,561	5,659,170
TEXAS	85,672,796	3,679,893	276,415
TOTAL	1,550,667,787	80,563,166	5,944,366
	(TONS)	SULFUR	
LOUISIANA	1,178,400	23,718,311	3,452,117

TABLE 31

OUTER CONTINENTAL SHELF
CALENDAR YEAR 1971

STATE	PRODUCTION	PRODUCTION VALUE($)	ROYALTY VALUE($)
	(TONS)	SALT	
LOUISIANA	370,406	66,673	11,112
TOTAL O.C.S.		2,135,677,078	350,042,488
TOTAL ALL LANDS		2,135,677,078	350,042,488

TABLE 32

OIL AND GAS OPERATIONS

OUTER CONTINENTAL SHELF

CALIFORNIA

	<---- O I L ---->			<---- G A S ---->		
CALENDAR YEAR	QUANTITY BARRELS	PRODUCTION VALUE($)	ROYALTY VALUE($)	QUANTITY MCF	PRODUCTION VALUE($)	ROYALTY VALUE($)
1968	2,059,889	5,222,660	870,444	799,685	215,915	35,986
1969	9,940,844	28,042,929	4,673,822	4,845,851	1,308,380	218,063
1970	24,987,628	72,294,311	12,049,052	12,229,147	3,301,870	550,312
1971	31,103,548	98,407,829	16,401,306	15,671,479	4,231,299	705,217
TOTALS	68,091,909	203,967,729	33,994,624	33,546,162	9,057,464	1,509,578

TABLE 33

OIL AND GAS OPERATIONS

OUTER CONTINENTAL SHELF

CALIFORNIA

CALENDAR YEAR	GASOLINE AND LPG: QUANTITY GALLONS	GASOLINE AND LPG: PRODUCTION VALUE($)	GASOLINE AND LPG: ROYALTY VALUE($)	TOTAL ALL PRODUCTS: PRODUCTION VALUE($)	TOTAL ALL PRODUCTS: ROYALTY VALUE($)
1968	--	--	--	5,438,575	906,439
1969	--	--	--	29,351,309	4,891,885
1970	132,639	8,187	546	75,604,368	12,599,919
1971	2,115,628	131,712	8,781	102,770,840	17,115,304
TOTALS	2,248,267	139,899	9,327	213,165,092	35,513,529

TABLE 34

OIL AND GAS OPERATIONS

OUTER CONTINENTAL SHELF

LOUISIANA

CALENDAR YEAR	OIL QUANTITY BARRELS	OIL PRODUCTION VALUE($)	OIL ROYALTY VALUE($)	CONDENSATE QUANTITY BARRELS	CONDENSATE PRODUCTION VALUE($)	CONDENSATE ROYALTY VALUE($)
1953	940,634	2,770,866	584,088	210,063	719,664	135,453
1954	2,723,173	8,028,326	1,681,702	619,057	1,947,804	361,496
1955	5,869,897	17,312,409	3,538,967	833,631	2,624,334	483,418
1956	10,123,071	29,724,365	6,013,072	878,177	2,738,187	505,938
1957	15,367,279	51,146,960	9,790,301	697,116	2,397,306	432,270
1958	23,709,108	77,266,710	14,482,598	1,059,929	3,470,484	627,780
1959	34,177,272	108,196,671	20,331,582	1,519,992	4,871,845	889,736
1960	47,359,046	139,113,688	27,843,078	2,306,845	7,320,399	1,328,526
1961	61,265,770	192,144,960	35,462,210	3,064,308	9,527,903	1,789,043
1962	84,928,426	264,041,875	48,705,620	4,804,673	14,874,907	2,799,353
1963	98,278,494	313,637,681	55,591,619	6,247,942	19,168,310	3,618,838
1964	114,972,300	352,663,296	64,358,443	7,522,873	22,941,499	4,286,902
1965	136,232,315	417,131,468	75,417,896	8,732,553	26,664,321	4,998,612
1966	174,304,792	535,253,645	95,584,085	13,526,680	41,750,232	7,679,495
1967	204,698,134	630,364,403	112,166,314	14,297,694	42,884,947	7,743,531
1968	248,223,799	769,355,722	136,455,284	15,601,560	50,711,986	9,046,984
1969	283,974,318	925,153,657	162,162,256	16,184,974	56,381,108	9,863,476
1970	311,035,150	1,036,032,944	180,410,505	22,376,342	77,309,209	13,291,113
1971	358,366,080	1,277,637,359	218,947,766	27,394,271	99,350,253	16,835,804
TOTALS	2,216,549,058	7,146,977,005	1,269,527,386	147,878,680	487,654,698	86,706,768

TABLE 35

OIL AND GAS OPERATIONS

OUTER CONTINENTAL SHELF

LOUISIANA

CALENDAR YEAR	<- OIL AND CONDENSATE -> QUANTITY BARRELS	PRODUCTION VALUE($)	ROYALTY VALUE($)	<- GAS -> QUANTITY MCF	PRODUCTION VALUE($)	ROYALTY VALUE($)
1953	1,150,697	3,490,530	719,541	19,881,055	1,546,331	248,351
1954	3,342,230	9,976,130	2,043,198	56,325,083	4,393,968	705,779
1955	6,703,528	19,936,743	4,022,385	81,279,042	7,118,031	1,116,642
1956	11,001,248	32,462,552	6,519,010	82,892,538	6,995,060	1,103,698
1957	16,064,395	53,544,266	10,222,571	82,568,807	7,507,953	1,165,294
1958	24,769,037	80,737,194	15,110,378	127,692,848	15,733,942	2,313,500
1959	35,697,264	113,068,516	21,221,318	207,156,296	37,403,164	5,318,518
1960	49,665,891	146,434,087	29,171,604	273,034,451	52,761,614	7,636,074
1961	64,330,078	201,672,863	37,250,253	318,280,095	64,615,520	9,483,489
1962	89,733,099	278,916,782	51,504,973	451,952,659	92,209,196	13,748,400
1963	104,526,436	332,805,991	59,210,457	564,352,606	106,783,758	16,136,78[illegible]
1964	122,495,173	375,604,795	68,645,345	621,731,438	118,377,080	17,887,512
1965	144,964,868	443,795,789	80,406,508	645,589,469	126,977,562	19,248,110
1966	187,831,472	577,003,877	103,263,580	965,387,849	182,465,908	27,989,727
1967	218,995,828	673,249,350	119,909,845	1,087,262,804	210,606,727	29,186,187
1968	263,825,359	820,067,708	145,502,268	1,413,467,606	272,969,079	45,405,714
1969	300,159,292	981,534,765	172,025,732	1,822,544,142	344,015,027	53,764,395
1970	333,411,492	1,113,342,153	193,701,618	2,273,147,040	414,018,458	65,425,568
1971	385,760,351	1,376,987,612	235,783,570	2,634,014,031	525,451,277	83,373,079
TOTALS	2,364,427,738	7,634,631,703	1,356,234,154	13,728,559,859	2,591,949,655	401,256,818

TABLE 36

OIL AND GAS OPERATIONS

OUTER CONTINENTAL SHELF

LOUISIANA

CALENDAR YEAR	GASOLINE AND LPG: QUANTITY GALLONS	GASOLINE AND LPG: PRODUCTION VALUE($)	GASOLINE AND LPG: ROYALTY VALUE($)	SULFUR: QUANTITY TONS	SULFUR: PRODUCTION VALUE($)	SULFUR: ROYALTY VALUE($)
1960	--	--	--	98,025	1,762,866	295,784
1961	--	--	--	401,521	7,252,931	1,170,733
1962	--	--	--	285,975	5,507,050	835,816
1963	--	--	--	552,573	11,069,637	1,617,471
1964	--	--	--	634,875	12,748,602	1,858,535
1965	--	--	--	1,090,950	23,387,005	3,197,532
1966	--	--	--	1,400,848	32,621,551	4,128,691
1967	--	--	--	1,409,276	37,291,107	4,167,804
1968	--	--	--	1,553,621	53,277,667	4,628,512
1969	222,430,316	9,777,811	714,111	1,232,939	49,129,573	3,684,432
1970	1,027,998,797	49,247,030	3,582,647	1,099,584	24,636,736	3,235,874
1971	1,462,879,363	76,751,561	5,659,170	1,178,400	23,718,311	3,452,117
TOTALS	2,713,308,476	135,776,402	9,955,928	10,938,587	282,403,036	32,263,301

TABLE 37

OIL AND GAS OPERATIONS

OUTER CONTINENTAL SHELF

LOUISIANA

TABLE 38

CALENDAR YEAR	SALT: QUANTITY TONS	SALT: PRODUCTION VALUE($)	SALT: ROYALTY VALUE($)	TOTAL ALL PRODUCTS: PRODUCTION VALUE($)	TOTAL ALL PRODUCTS: ROYALTY VALUE($)
1953	--	--	--	5,036,861	967,892
1954	--	--	--	14,370,098	2,748,977
1955	--	--	--	27,054,774	5,139,027
1956	--	--	--	39,457,612	7,622,708
1957	--	--	--	61,052,219	11,387,865
1958	--	--	--	96,471,136	17,423,878
1959	--	--	--	150,471,660	26,539,836
1960	59,794	10,764	1,792	200,969,331	37,095,254
1961	528,581	95,142	15,857	273,636,456	47,920,332
1962	176,924	31,848	5,308	376,664,876	66,094,497
1963	262,951	47,334	7,889	450,706,720	76,972,598
1964	212,978	38,334	6,389	506,769,811	88,397,781
1965	290,804	52,334	8,724	594,212,690	102,860,874
1966	297,475	53,544	8,924	792,144,880	135,390,922
1967	274,422	49,396	7,422	921,196,580	153,271,258
1968	540,651	97,317	17,030	1,146,411,771	195,553,524
1969	343,060	61,751	10,292	1,384,518,927	230,198,962
1970	269,691	48,544	8,091	1,601,292,921	265,953,798
1971	370,406	66,673	11,112	2,002,975,434	328,279,048
TOTALS	3,627,737	652,981	108,830	10,645,413,777	1,799,819,031

OIL AND GAS OPERATIONS

OUTER CONTINENTAL SHELF

TEXAS

CALENDAR YEAR	OIL: QUANTITY BARRELS	OIL: PRODUCTION VALUE($)	OIL: ROYALTY VALUE($)	CONDENSATE: QUANTITY BARRELS	CONDENSATE: PRODUCTION VALUE($)	CONDENSATE: ROYALTY VALUE($)
1955	1,956	5,905	979	--	--	--
1956	13,284	40,259	6,675	--	--	--
1957	5,792	19,889	3,296	--	--	--
1958	--	--	--	--	--	--
1959	257	847	141	--	--	--
1960	98	284	47	--	--	--
1961	--	--	--	--	--	--
1962	3,483	11,024	1,837	--	--	--
1963	52,804	159,764	26,627	--	--	--
1964	4,953	14,699	2,449	--	--	--
1965	3,747	10,042	1,666	--	--	--
1966	882,598	2,664,147	444,017	--	--	--
1967	1,162,401	3,625,423	604,236	--	--	--
1968	1,732,657	5,535,456	922,577	1,703,385	5,305,062	884,177
1969	1,514,315	5,191,533	865,045	1,377,985	4,454,244	742,372
1970	1,100,107	3,856,600	642,715	1,245,536	4,361,621	726,926
1971	710,463	2,610,868	431,713	1,146,941	4,098,461	683,077
				974,584	3,674,607	612,435
TOTALS	7,188,915	23,746,740	3,954,020	6,448,431	21,893,995	3,648,987

TABLE 39

OIL AND GAS OPERATIONS

OUTER CONTINENTAL SHELF

TEXAS

CALENDAR YEAR	<- OIL AND CONDENSATE -> QUANTITY BARRELS	PRODUCTION VALUE($)	ROYALTY VALUE($)	<- GAS -> QUANTITY MCF	PRODUCTION VALUE($)	ROYALTY VALUE($)
1955	1,956	5,905	979	--	--	--
1956	13,284	40,259	6,675	--	--	--
1957	5,792	19,889	3,296	4,797	480	84
1958	--	--	--	--	--	--
1959	257	847	141	--	--	--
1960	98	284	47	--	--	--
1961	--	--	--	--	--	--
1962	3,483	11,024	1,837	--	--	--
1963	52,804	159,764	26,627	--	--	--
1964	4,953	14,699	2,449	--	--	--
1965	3,747	10,042	1,666	--	--	--
1966	882,598	2,664,147	444,017	42,059,386	6,915,584	1,152,598
1967	2,865,786	8,930,485	1,488,413	99,952,946	17,087,626	2,847,938
1968	3,110,642	9,989,700	1,664,949	109,910,787	18,072,163	3,012,028
1969	2,759,851	9,553,154	1,591,971	127,096,982	20,447,082	3,407,848
1970	2,247,048	7,955,061	1,325,792	133,300,404	20,816,080	3,469,347
1971	1,685,047	6,285,475	1,044,148	127,357,908	19,965,436	3,327,573
TOTALS	13,637,346	45,640,735	7,603,007	639,683,210	103,304,451	17,217,416

TABLE 40

OIL AND GAS OPERATIONS

OUTER CONTINENTAL SHELF

TEXAS

CALENDAR YEAR	<--- GASOLINE AND LPG ---> QUANTITY GALLONS	PRODUCTION VALUE($)	ROYALTY VALUE($)	<- TOTAL ALL PRODUCTS -> PRODUCTION VALUE($)	ROYALTY VALUE($)
1955	--	--	--	5,905	979
1956	--	--	--	40,259	6,675
1957	--	--	--	20,369	3,380
1958	--	--	--	--	--
1959	--	--	--	847	141
1960	--	--	--	284	47
1961	--	--	--	--	--
1962	--	--	--	11,024	1,837
1963	--	--	--	159,764	26,627
1964	--	--	--	14,699	2,449
1965	--	--	--	10,042	1,666
1966	--	--	--	9,579,731	1,596,615
1967	--	--	--	26,018,111	4,336,351
1968	--	--	--	28,061,863	4,676,977
1969	--	--	--	30,000,236	4,999,819
1970	47,255,294	1,925,020	145,721	30,696,161	4,949,860
1971	85,672,796	3,679,893	276,415	29,930,804	4,648,136
TOTALS	132,928,090	5,604,913	422,136	154,550,099	25,242,559

TABLE 41

SUMMARY OF BONUSES, MINIMUM ROYALTIES, RENTALS, SHUT-IN GAS PAYMENTS, AND ROYALTIES
OUTER CONTINENTAL SHELF

State Year	Product	Bonuses	Minimum Royalties	Rentals	Shut-In Gas Payments	Royalties	Total
CALIFORNIA							
1963	Oil & Gas	$ 12,807,587	$ -	$ 938,838	$ -	$ -	$ 13,746,425
1964	Oil & Gas	-	-	938,838	-	-	938,838
1965	Oil & Gas	-	-	817,878	-	-	817,878
1966	Oil & Gas	21,189,000	-	568,658	-	-	21,757,658
1967	Oil & Gas	-	-	34,560	-	-	34,560
1968	Oil & Gas	602,719,262	-	1,089,543	-	906,430	604,715,235
1969	Oil & Gas	-	-	1,056,063	-	4,891,885	5,947,948
1970	Oil & Gas	-	17,280	974,817	-	12,599,910	13,592,007
1971	Oil & Gas	-	51,435	953,913	-	17,115,304	18,120,652
Through 1971	Oil & Gas	636,715,849	68,715	7,373,108	-	35,513,529	679,671,201

TABLE 42

SUMMARY OF BONUSES, MINIMUM ROYALTIES, RENTALS, SHUT-IN GAS PAYMENTS, AND ROYALTIES
OUTER CONTINENTAL SHELF

State Year Product		Bonuses	Minimum Royalties	Rentals	Shut-In Gas Payments	Royalties	Total
FLORIDA							
1959	Oil & Gas	$1,711,872	$ -	$ 397,440	$ -	$ -	$2,109,312
1960	Oil & Gas	-	-	397,440	-	-	397,440
1961	Oil & Gas	-	-	397,440	-	-	397,440
1962	Oil & Gas	-	-	190,080	-	-	190,030
1963-71		-	-	-	-	-	-
Through 1971		1,711,872	-	1,382,400	-	-	3,094,272

TABLE 43

SUMMARY OF BONUSES, MINIMUM ROYALTIES, RENTALS, SHUT-IN GAS PAYMENTS, AND ROYALTIES
OUTER CONTINENTAL SHELF

State / Year	Product	Bonuses	Minimum Royalties	Rentals	Shut-In Gas Payments	Royalties	Total
LOUISIANA							
8/7/53-12/31/53	Oil & Gas	$ -	$ -	$1,271,790	$ 30,650	$ 967,892	$ 2,270,332
1954	Oil & Gas	116,378,476	-	3,516,043	86,950	2,748,977	122,730,446
	Sulfur	1,233,500	-	50,000	-	-	1,283,500
	Total	117,611,976	-	3,566,043	86,950	2,748,977	124,013,946
1955	Oil & Gas	100,091,263	-	2,819,231	122,000	5,139,027	108,171,521
	Sulfur	-	-	50,000	-	-	50,000
	Total	100,091,263	-	2,869,231	122,000	5,139,027	108,221,521
1956	Oil & Gas	-	-	3,259,704	79,950	7,622,708	10,962,362
	Sulfur	-	-	50,000	-	-	50,000
	Total	-	-	3,309,704	79,950	7,622,708	11,012,362
1957	Oil & Gas	-	67,201	2,930,301	110,268	11,387,865	14,495,635
	Sulfur	-	-	50,000	-	-	50,000
	Total	-	67,201	2,980,301	110,268	11,387,865	14,545,635
1958	Oil & Gas	-	184,396	2,140,584	121,218	17,423,878	19,870,076
	Sulfur	-	-	43,990	-	-	43,990
		-	184,396	2,184,574	121,218	17,423,878	19,914,066
1959	Oil & Gas	88,035,121	171,036	1,780,026	84,984	26,539,836	116,611,003
	Sulfur	-	-	43,990	-	-	43,990
	Total	88,035,121	171,036	1,824,016	84,984	26,539,836	116,654,993

TABLE 44

SUMMARY OF BONUSES, MINIMUM ROYALTIES, RENTALS, SHUT-IN GAS PAYMENTS, AND ROYALTIES
OUTER CONTINENTAL SHELF

State / Year / Product		Bonuses	Minimum Royalties	Rentals	Shut-In Gas Payments	Royalties	Total
LOUISIANA							
1960	Oil & Gas	$246,909,784	$299,695	$2,422,790	$49,350	$36,807,678	$286,489,297
	Sulfur	-	-	12,660	-	285,784	298,444
	Salt	75,250	-	7,500	-	1,792	84,542
	Total	246,985,034	299,695	2,442,950	49,350	37,095,254	286,872,283
1961	Oil & Gas	-	291,790	1,984,441	37,100	46,733,742	49,047,073
	Sulfur	-	-	12,660	-	1,170,733	1,183,393
	Salt	-	3,208	-	-	15,857	19,065
	Total	-	294,998	1,997,101	37,100	47,920,332	50,249,531
1962	Oil & Gas	488,923,391	497,202	7,707,267	62,200	65,253,373	562,443,433
	Sulfur	-	-	12,660	-	835,816	848,476
	Salt	-	-	-	-	5,308	5,308
	Total	488,923,391	497,202	7,719,927	62,200	66,094,497	563,297,217
1963	Oil & Gas	-	632,376	7,059,246	52,950	75,347,238	83,091,810
	Sulfur	-	-	12,660	-	1,617,471	1,630,131
	Salt	-	-	-	-	7,889	7,889
	Total	-	632,376	7,071,906	52,950	76,972,598	84,729,830
1964	Oil & Gas	60,340,626	784,993	6,735,693	45,800	86,532,857	154,439,969
	Sulfur	-	-	12,660	-	1,858,535	1,871,195
	Salt	-	-	-	-	6,389	6,389
	Total	60,340,626	784,993	6,748,353	45,800	88,397,781	156,317,553

TABLE 45

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SUMMARY OF BONUSES, MINIMUM ROYALTIES, RENTALS, SHUT-IN GAS PAYMENTS, AND ROYALTIES
OUTER CONTINENTAL SHELF

State / Year / Product		Bonuses	Minimum Royalties	Rentals	Shut-In Gas Payments	Royalties	Total
LOUISIANA							
1965	Oil & Gas	$ -	$ 983,059	$5,604,824	$38,450	$ 99,654,618	$106,280,951
	Sulfur	-	-	12,660	-	3,197,532	3,210,192
	Salt	-	-	-	-	8,724	8,724
	Total	-	983,059	5,617,484	38,450	102,860,874	109,499,867
1966	Oil & Gas	188,010,893	1,327,830	4,736,294	41,700	131,253,307	325,370,024
	Sulfur	-	-	12,660	-	4,128,691	4,141,351
	Salt	-	-	-	-	8,924	8,924
	Total	188,010,893	1,327,830	4,748,954	41,700	135,390,922	329,520,299
1967	Oil & Gas	510,079,178	1,888,758	5,500,516	41,400	149,096,032	666,605,884
	Sulfur	-	-	12,660	-	4,167,804	4,180,464
	Salt	30,564	-	7,485	-	7,422	45,471
	Total	510,109,742	1,888,758	5,520,661	41,400	153,271,258	670,831,819
1968	Oil & Gas	149,868,789	2,140,858	5,275,979	52,300	190,907,982	348,245,908
	Sulfur	-	-	12,660	-	4,628,512	4,641,172
	Salt	-	-	-	-	17,030	17,030
	Total	149,868,789	2,140,858	5,288,639	52,300	195,553,524	352,904,110
1969	Oil & Gas	110,945,535	1,922,340	5,584,162	41,650	226,504,238	344,997,925
	Sulfur	715,150	-	25,787	-	3,684,432	4,425,369
	Salt	-	1,292	-	-	10,292	11,584
	Total	111,660,685	1,923,632	5,609,949	41,650	230,198,962	349,434,878

TABLE 46

SUMMARY OF BONUSES, MINIMUM ROYALTIES, RENTALS, SHUT-IN GAS PAYMENTS, AND ROYALTIES
OUTER CONTINENTAL SHELF

State Year	Product	Bonuses	Minimum Royalties	Rentals	Shut-In Gas Payments	Royalties	Total
LOUISIANA							
1970	Oil & Gas	$ 943,601,798	$ 1,692,274	$ 6,220,862	$ 47,700	$ 262,709,833	$1,214,272,467
	Salt	-	5,000	-	-	8,091	13,091
	Sulfur	-	1,880	27,661	-	3,235,874	3,265,415
	Total	$ 943,601,798	1,699,154	6,248,523	47,700	265,953,798	1:217,550,973
1971	Oil & Gas	$ 96,304,522	$ 1,564,845	$ 5,687,848	$ 32,300	$ 324,815,819	$ 428,405,334
	Salt	-	5,000	-	-	11,112	16,112
	Sulfur	-	1,880	27,661	-	3,452,117	3,481,658
	Total	$ 96,304,522	$ 1,571,725	$ 5,715,509	$ 32,300	$ 328,279,048	$ 431,903,104
Through 1971		$3,101,543,840	$14,466,913	$82,735,615	$1,178,920	$1,799,819,031	$4,999,744,319

TABLE 47

SUMMARY OF BONUSES, MINIMUM ROYALTIES, RENTALS, SHUT-IN GAS PAYMENTS, AND ROYALTIES
OUTER CONTINENTAL SHELF

State / Year / Product	Bonuses	Minimum Royalties	Rentals	Shut-In Gas Payments	Royalties	Total
OREGON						
1964 Oil & Gas	$27,768,772	$ -	$1,276,302	$ -	$ -	$29,045,074
1965 Oil & Gas	-	-	1,276,302	-	-	1,276,302
1966 Oil & Gas	-	-	1,034,382	-	-	1,034,382
1967 Oil & Gas	-	-	137,475	-	-	137,475
1968 Oil & Gas	-	-	34,560	-	-	34,560
1969-71 Oil & Gas	-	-	-	-	-	-
Through 1971	$27,768,772	$ -	$3,759,021	$ -	$ -	$31,527,793

TABLE 48

SUMMARY OF BONUSES, MINIMUM ROYALTIES, RENTALS, SHUT-IN GAS PAYMENTS, AND ROYALTIES
OUTER CONTINENTAL SHELF

State Year	Product	Bonuses	Minimum Royalties	Rentals	Shut-In Gas Payments	Royalties	Total
TEXAS							
8/7/53-12/31/53	Oil & Gas	$ -	$ -	$ 87,840	$ -	$ -	$ 87,840
1954	Oil & Gas	23,357,029	-	289,290	-	-	23,646,319
1955	Oil & Gas	8,437,462	-	537,120	-	979	8,975,561
1956	Oil & Gas	-	-	696,489	-	6,675	703,164
1957	Oil & Gas	-	1,380	289,821	-	3,380	294,581
1958	Oil & Gas	-	-	236,010	-	-	236,010
1959	Oil & Gas	-	-	64,269	-	141	64,410
1960	Oil & Gas	35,732,031	17,280	762,750	-	47	36,512,108
1961	Oil & Gas	-	19,123	679,320	-	-	698,443
1962	Oil & Gas	557,720	20,520	502,200	-	1,837	1,082,277
1963	Oil & Gas	-	35,963	424,440	-	26,627	487,030
1964	Oil & Gas	-	35,350	368,820	-	2,449	406,619
1965	Oil & Gas	-	89,640	337,454	-	1,666	428,760
	Sulfur	33,740,309	-	216,000	-	-	33,956,309
	Total	33,740,309	89,640	553,454	-	1,666	34,385,069

TABLE 49

SUMMARY OF BONUSES, MINIMUM ROYALTIES, RENTALS, SHUT-IN GAS PAYMENTS, AND ROYALTIES
OUTER CONTINENTAL SHELF

State Year Product		Bonuses	Minimum Royalties	Rentals	Shut-In Gas Payments	Royalties	Total
TEXAS							
1966	Oil & Gas	$ -	$ -	$ 2,933	$ -	$ 1,596,615	$ 1,599,548
	Sulfur	-	39,420	151,470	-	-	190,890
	Total	-	39,420	154,403	-	1,596,615	1,790,438
1967	Oil & Gas	-	2,757	244,080	-	4,336,351	4,583,188
	Sulfur	-	-	220,320	-	-	220,320
	Total	-	2,757	464,400	-	4,336,351	4,803,508
1968	Oil & Gas	593,899,046	4,320	1,727,325	-	4,676,977	600,307,668
	Sulfur	-	-	38,880	-	-	38,880
	Total	593,899,046	4,320	1,766,205	-	4,676,977	600,346,548
1969	Oil & Gas	-	-	1,642,275	-	4,999,819	6,642,094
	Sulfur	-	-	4,320	-	-	4,320
	Total	-	-	1,646,595	-	4,999,819	6,646,414
1970	Oil & Gas	-	29,430	1,357,695	-	4,940,860	6,327,985
	Sulfur	-	-	4,320	-	-	4,320
	Total	-	29,430	1,362,015	-	4,940,860	6,332,305
1971	Oil & Gas	-	267,840	1,072,575	-	4,648,136	5,988,551
Through 1971		$695,723,597	$563,023	$11,958,016	$ -	$25,242,559	$733,487,195

TABLE 50

SUMMARY OF BONUSES, MINIMUM ROYALTIES, RENTALS, SHUT-IN GAS PAYMENTS, AND ROYALTIES
OUTER CONTINENTAL SHELF

State / Year	Product	Bonuses	Minimum Royalties	Rentals	Shut-In Gas Payments	Royalties	Total
WASHINGTON							
1964	Oil & Gas	$7,764,928	$ -	$ 466,260	$ -	$ -	$8,231,188
1965	Oil & Gas	-	-	466,260	-	-	466,260
1966	Oil & Gas	-	-	362,880	-	-	362,880
1967	Oil & Gas	-	-	51,840	-	-	51,840
1968	Oil & Gas	-	-	51,840	-	-	51,840
1969	Oil & Gas	-	-	-	-	-	-
1970	Oil & Gas	-	-	-	-	-	-
1971	Oil & Gas	-	-	-	-	-	-
Through 1971		7,764,928	-	1,399,080	-	-	9,164,008

TABLE 51

SUMMATION OF BONUSES, MINIMUM ROYALTIES,
RENTALS, SHUT-IN GAS PAYMENTS, AND ROYALTIES
OUTER CONTINENTAL SHELF

Years States	Bonuses	Minimum Royalties	Rentals	Shut-In Gas Payments	Royalties	Total
1971						
TOTAL ALL STATES	$ 96,304,522	$ 1,891,000	$ 7,741,997	$ 32,300	$ 350,042,488	$ 456,012,307
8/7/53-12/31/71						
TOTAL BY STATES						
California	$ 636,715,849	$ 68,715	$ 7,373,108	$ -	$ 35,513,529	$ 679,671,201
Florida	1,711,872	-	1,382,400	-	-	3,094,272
Louisiana	3,101,543,840	14,466,913	82,735,615	1,178,920	1,799,819,031	4,999,744,319
Oregon	27,768,772	-	3,759,021	-	-	31,527,793
Texas	695,723,597	563,023	11,958,016	-	25,242,559	733,487,195
Washington	7,764,928	-	1,399,080	-	-	9,164,008
GRAND TOTAL	$4,471,228,858	$15,098,651	$108,607,240	$1,178,920	$1,860,575,119	$6,456,[illegible]

TABLE 52

TOTAL OFFSHORE "STATE" AND "FEDERAL OCS"
IN THOUSANDS OF BARRELS (M)

Year	ALASKA Barrels (M)	ALASKA Percent State	ALASKA Percent OCS	CALIFORNIA Barrels (M)	CALIFORNIA Percent State	CALIFORNIA Percent OCS	LOUISIANA Barrels (M)	LOUISIANA Percent State	LOUISIANA Percent OCS	TEXAS * Barrels (M)	TEXAS * Percent State	TEXAS * Percent OCS	TOTAL Barrels (M)	TOTAL Percent State	TOTAL Percent OCS
PRIOR	-	-	-	422,385	100	-	54,803	98	2	-	-	-	477,188	100	-
1954	-	-	-	32,665	100	-	15,926	79	21	10	100	-	48,601	93	7
1955	-	-	-	33,252	100	-	25,731	74	26	156	99	1	59,139	89	11
1956	-	-	-	32,348	100	-	40,906	73	27	140	90	10	73,394	85	15
1957	-	-	-	30,561	100	-	52,835	70	30	256	98	2	83,652	81	19
1958	-	-	-	28,363	100	-	57,381	57	43	470	100	-	86,214	71	29
1959	-	-	-	26,787	100	-	72,793	51	49	499	100	-	100,079	64	36
1960	-	-	-	28,074	100	-	88,122	44	56	567	100	-	116,763	57	43
1961	-	-	-	29,887	100	-	103,197	38	62	292	100	-	133,376	52	48
1962	-	-	-	34,613	100	-	126,801	29	71	803	100	-	162,217	45	55
1963	-	-	-	38,346	100	-	149,087	30	70	669	92	8	188,102	44	56
1964	6	100	-	40,526	100	-	173,709	29	71	578	99	1	214,819	43	57
1965	30	100	-	42,772	100	-	199,293	27	73	557	99	1	242,652	40	60
1966	2,650	100	-	53,294	100	-	243,080	23	77	1,246	29	71	300,270	37	63
1967	15,937	100	-	64,807	100	-	284,033	23	77	3,400	16	84	368,177	40	60
1968	52,530	100	-	85,339	98	2	329,922	20	80	3,400	9	91	471,191	43	57
1969	60,887	100	-	95,145	90	10	365,691	18	82	3,109	11	89	525,832	41	59
1970	70,007	100	-	104,283	76	24	398,378	16	84	3,046	26	74	575,714	37	63
1971	66,152	100	-	102,700	70	30	444,000	13	87	2,900	42	58	615,752	32	68
Through 1971	268,199	100	-	1,327,147	95	5	3,225,688	27	73	22,098	38	62	4,843,132	49	51

SOURCE: Bureau of Mines, Alaska Scouting Service, Conservation Committee of California, Louisiana State Mineral Board, Louisiana Dept. of Conservation, Texas Railroad Commission.

* Texas is estimated in part.

NOTE: California, Louisiana, and Texas estimated for December 1971; final STATE data for December 1971 available in April 1972.

TABLE 53

GAS
TOTAL OFFSHORE "STATE" AND "FEDERAL OCS"
IN MILLIONS OF CUBIC FEET (MMCF)

Year	ALASKA MMCF	ALASKA Percent State	ALASKA Percent OCS	CALIFORNIA MMCF	CALIFORNIA Percent State	CALIFORNIA Percent OCS	LOUISIANA MMCF	LOUISIANA Percent State	LOUISIANA Percent OCS	TEXAS* MMCF	TEXAS* Percent State	TEXAS* Percent OCS	TOTAL MMCF	TOTAL Percent State	TOTAL Percent OCS
PRIOR	-	-	-	-	100	-	91,675	78	22	-	-	-	91,675	78	22
1954	-	-	-	-	100	-	81,325	31	69	3,440	100	-	84,765	34	66
1955	-	-	-	-	100	-	121,279	33	67	6,880	100	-	128,159	37	63
1956	-	-	-	-	100	-	136,527	39	61	6,880	100	-	143,407	42	58
1957	-	-	-	-	100	-	160,472	49	51	13,765	100	-	174,237	53	47
1958	-	-	-	-	100	-	233,967	45	55	24,080	100	-	258,047	51	49
1959	-	-	-	-	100	-	329,280	37	63	24,080	100	-	353,360	41	59
1960	-	-	-	1,113	100	-	408,388	33	67	30,960	100	-	440,461	38	62
1961	-	-	-	5,903	100	-	458,481	31	69	13,760	100	-	478,144	33	67
1962	-	-	-	10,671	100	-	588,361	23	77	41,280	100	-	640,312	29	71
1963	-	-	-	25,769	100	-	706,545	20	80	30,960	100	-	763,274	26	74
1964	-	-	-	35,323	100	-	783,474	21	79	30,960	100	-	849,757	27	73
1965	10	100	-	40,770	100	-	871,124	26	74	27,520	100	-	939,424	31	69
1966	1,200	100	-	46,839	100	-	1,265,899	24	76	59,259	29	71	1,373,197	27	73
1967	8,324	100	-	46,732	100	-	1,655,223	34	66	127,473	22	78	1,837,752	35	65
1968	22,844	100	-	86,565	99	1	2,057,291	31	69	154,631	29	71	2,321,331	34	66
1969	44,393	100	-	81,326	94	6	2,478,745	26	74	240,212	47	53	2,844,676	31	69
1970	82,369	100	-	71,225	83	17	2,800,104	19	81	264,420	50	50	3,218,118	25	75
1971	83,750	100	-	60,800	74	26	3,219,000	18	82	407,000	69	31	3,770,550	26	74
Through 1971	242,890	100	-	513,036	93	7	18,447,160	226	74	1,507,560	58	42	20,710,646	30	70

SOURCE: Bureau of Mines, Alaska Scouting Service, Conservation Committee of California, Louisiana State Mineral Board, Louisiana Dept. of Conservation, Texas Railroad Commission.
* Texas is estimated in part.

NOTE: California, Louisiana, and Texas estimated for December 1971; final STATE data for December 1971 available in April 1972.

TABLE 54

TOTAL UNITED STATES AND OUTER CONTINENTAL SHELF PRODUCTION
OF CRUDE OIL & CONDENSATE, AND GAS
PERCENTAGE OF OCS PRODUCTION OF TOTAL U. S. PRODUCTION

Year	CRUDE OIL AND CONDENSATE PRODUCTION (Thousands of Bbls.)			GAS PRODUCTION (Millions of Cu.Ft.)		
	Total U.S.	Total OCS	OCS % of U.S.	Total U.S.	Total OCS	OCS % of U.S.
1953	2,357,082	1,151	.05 %	8,396,916	19,881	.24 %
1954	2,314,988	3,342	.14	8,742,546	56,325	.64
1955	2,484,428	6,705	.27	9,405,351	81,279	.86
1956	2,617,283	11,015	.42	10,081,923	82,893	.82
1957	2,616,901	16,070	.61	10,680,258	82,574	.77
1958	2,448,987	24,769	1.01	11,030,298	127,693	1.16
1959	2,574,590	35,698	1.39	11,619,951	207,156	1.78
1960	2,574,933	49,666	1.93	12,771,038	273,034	2.14
1961	2,621,758	64,330	2.45	13,254,025	318,280	2.40
1962	2,676,189	89,737	3.35	13,876,622	451,953	3.26
1963	2,752,723	104,579	3.80	14,666,559	564,353	3.85
1964	2,786,822	122,500	4.40	15,462,143	621,731	4.02
1965	2,848,514	144,969	5.09	16,039,753	645,589	4.03
1966	3,027,763	188,714	6.23	17,206,628	1,007,447	5.86
1967	3,215,742	221,862	6.90	18,171,325	1,187,216	6.53
1968	3,329,042	268,996	8.08	19,322,400	1,524,178	7.89
1969	3,371,751	312,860	9.28	20,698,240	1,954,487	9.44
1970	3,517,450	360,646	10.25	21,920,642	2,418,677	11.03
1971	3,478,000	418,549	12.03	22,799,000	2,777,043	12.18

SOURCE: Total United States Production - MINERALS YEARBOOK, Bureau of Mines.
1971 Total United States Production data are preliminary and subject to change.

TABLE 55

C. SUPPLY

Question C.1.

What are the best available estimates of the volumes of crude oil, natural gas, natural gas liquids, and other minerals by type, on the Outer Continental Shelf lands (between the seaward boundary of submerged lands under state jurisdiction and the seaward edge of the U. S. continental rise), for areas adjacent to each coastal state, by region, and for the total OCS area? Estimates should be provided of total and recoverable

a) Known or proved reserves,

b) Marginal and

c) Submarginal potential resources

(or for a similar gradation of resource categories by recoverability and uncertainty; definitions should be provided for each category).

Answer:

Oil and gas, sulfur, salt

The most complete estimates have been prepared by the U. S. Geological Survey. This work was done in 1968 for the Public Land Law Review Commission investigations and published as an appendix to the reports resulting from those investigations (see appendix 1). The report is available from the National Technical Information Service as Public Land Law Review Commission Study of Outer Continental Shelf Lands of the United States, Volume IV (Appendices), November 1969: PB 188 717. The legal assumptions in this study may not represent Administration policy.

This study covered all of the minerals (26, see tables 5 and 8, appendix 1) thought to have had some commercial value at that time or potential value in the near future. There were not enough data available, however, to treat most of them with respect to the technology and economics of the recovery of their known and potential resources. Those that could be separated into categories of recoverability were crude oil, natural gas, and natural gas liquids, sulfur, and salt, and it is doubtful whether this list could be refined or expanded even today. Note that the term marginal used in the report referred to has since been changed to paramarginal.

Although this USGS study is the only one that presents data by the categories outlined in the question, the Potential Gas Committee (PGC, 1971), a gas industry committee, and the National Petroleum Council, (NPC, 1970), an advisory group to the Secretary of the Interior, have produced more recent estimates of potential resources of gas and oil, respectively, for the continental shelves of the conterminous U. S. These estimates are carefully made and probably well within reason for the areas covered. The offshore area covered by the PGC is that from the shore line to 600 feet of water depth (200 meters, approximately) and from there to the 1,500 foot water depth (495 meters) with estimates reported separately for each zone for each major coastal region. The estimates for the Alaskan offshore are not reported separately.

The offshore area covered by the NPC extends from the shore line to the 2,500 meter water depth (8,250 feet) but is not broken down into zones by depth, although the estimates are reported separately by major coastal regions; estimates for the Alaskan offshore, however, are not reported separately.

The estimates of the PGC are for undiscovered recoverable natural gas by classes of reliability; those of the NPC are for undiscovered oil-in-place from which a recoverable quantity is calculated. Recently, an attempt was made by the USGS to put the PGC and NPC estimates into the same economic framework as those of the USGS. The results are given in appendix 2, attached; because of lack of data, however, estimates of paramarginal resources alone could not be made and so had to be lumped into the overall submarginal category.

Question C. 2.

Inasmuch as recoverability is influenced by technological and economic factors, what influence can be anticipated on the foregoing estimates from

a) Technological advances,

b) Price changes?

Answer:

a) Technological advances will serve in many ways to influence the estimates given under part 1. Technological advances can be expected to be forthcoming in the fields of exploration, drilling, production, refining, and transportation. Advances in any of these categories can be expected to make undiscovered resources known, to make para- and submarginal resources recoverable, and to make materials of no present value into resources. Of primary importance now, however, are the improvements needed, and anticipated, in the techniques of exploration, drilling, and production.

Advances are anticipated in the ability to detect stratigraphic traps by geophysical techniques. Historically stratigraphic traps have supplied approximately one-third of the recoverable oil and gas found in the U. S. However, at this time none of the oil and gas in stratigraphic traps is produced from the Gulf of Mexico offshore (the only area for which data on offshore discoveries and production are reported separately). If stratigraphic traps could be found there, the recoverable reserve might be increased by one-third or approximately 18 billion barrels of oil (based on the NPC estimate) and 95 trillion cubic feet of natural gas (based on the PGC estimate 1/). Similar benefits might be expected for the other offshore areas.

Improvement in drilling and production techniques should help to move at least some of the resources of oil and gas in the zone between 200 and 2,500 (600-8,200 feet) meters from the para- and submarginal to the recoverable category. Recent developments in the Santa Barbara Channel 2/ indicate that this might become feasible in the near future.

Improvements in the technology of recovery of oil and gas, such as secondary and tertiary recovery, are not anticipated to have much effect on the Gulf Coast OCS. Recovery of oil in the Gulf Coast is already high (up to an average of 40-45 percent of oil-in-place) due to modern pressure maintenance practices. Primary gas recovery is approximately 80 percent at this time. What effect improved recovery methods will have on oil production from the other OCS areas cannot be anticipated at this time because of lack of experience.

b) Price changes will presumably have major effects on the exploration for and production of minerals in the U. S. but their potential effects on the OCS are not clear.

1/ NPC and PGC estimates were used for this example because they are made for structurally trapped oil and gas only in the Gulf Coast area.

2/ Plans are underway to develop what is probably a giant oil field (at least 100 million barrels) discovered in 1969 in a water depth of 1,000 feet, and another good oil and gas discovery was made in 1970 in water 1,050 feet deep (Oil and Gas Journal, 10/7/70 p. 30, 32, and 7/14/69 p. 49)

At current price levels it appears that industry is willing to invest in OCS oil and gas because there are, obviously, excellent opportunities for finding large deposits even though the cost of operations is higher offshore than on. The petroleum industry seems to have been willing to support twice yearly lease sales in the Gulf of Mexico, for example. Once bought, a lease must be evaluated as rapidly as possible so that the company(s) involved may move on.

Price reductions will inevitably cause a reduction in the total domestic effort on exploration, new secondary recovery projects, and maintenance of stripper wells. However, price reductions might not affect the total effort on the OCS because, as stated above, the opportunities for return are the best on the OCS and the domestic industry will be interested always in maintaining a hedge in domestic oil production if at all possible.

Price increases would result in additional recovery of known oil and gas by encouraging additional pressure maintenance, development drilling, and by lowering abandonment levels. As far as new development is concerned, higher prices might have the effect of increasing the size of individual bonus bids as well as increasing exploration and development drilling and development of long-term production.

With respect to sulfur, increased prices would result in additional recovery from known sulfur deposits. At this time, however, by-product sulfur recovered from sour oil and gas has resulted in a depressed price and a decreased demand for sulfur.

With respect to other mineral resources there is not enough experience at this time to be able to indicate what reasonable changes in prices might accomplish.

Other minerals

No estimate of volumes for non-energy minerals are available for OCS areas other than sulfur and salt.

D. INFORMATION FOR DECISION-MAKING AND MANAGEMENT

Question D. 1.

What kinds of information, including geological and geophysical information, do the Federal agencies review, evaluate or consider in connection with identifying those areas most appropriate for an OCS lease sale and for determining the individual tracts offered in such sales? What is the source of such information?

Answer:

General sale areas are identified at the time of the formulation of the five-year tentative OCS lease schedule. In the updating and revision of this schedule, the following information is being used in the supporting analysis.

a) Economic data involving the future demand for oil and gas on a regional and national basis, willingness of industry to explore, and the cost of alternative supplies of oil and gas. Source: Bureau of Mines, Office of Oil and Gas, Federal Power Commission, BLM contract studies, industry polls and trade and Government publication.

b) Geologic estimates of potential reserves on a regional basis including separate estimates for each OCS area. Source: Geological Survey.

One a sale area has been identified, the Department gathers and reviews the following kinds of data for use in the selection of specific tracts.

a) Geological, engineering, and geophysical data used to determine resource estimates of oil and gas for broad geographic areas of the shelf, and refined reserve estimates of oil and gas for individual lease tracts. This data is collected from information obtained from lessees, in accordance with 30 CFR 250, such as well logs, core analysis, paleosamples, cores, well tests, production information and geophysical surveys. Some data is purchased from commercial sources, some is obtained from other Governmental, educational, and research investigations, and some limited geologic sampling is done by the Department.

b) Nomination data from private industry indicating areas and specific tracts of potential interest for development of oil and gas.

c) Pipeline data including location, size and capacity and projections of future pipelines from Government and industry records.

d) Historical lease sales data including ownership, relinquishments, bonuses and rentals, per acre bids, all from Government records.

e) Pre-sale evaluation data including estimates of reserves for individual lease blocks, which have been prepared by the Department.

In addition to the above data, a detailed environmental analysis is prepared which concentrates on the following items of information.

a) Biological data on the areas under consideration for lease including marine organism, and existing pollution conditions in the area from Government sources and private studies.

b) Oceanographic and meterological data including waves, winds, currents, tides, water depth obtained from Government records and private studies.

c) Demographic data including growth rates from Government records.

d) Transportation data including shipping, pipelines, terminals.

e) Other resource use data including commercial fishing, sports fishing, boating, national parks, beaches, wildlife sanctuaries from Federal and State sources.

Question D. 2.

Using such information, to what extent can the most promising acreage be identified, and with what degree of confidence can recoverable petroleum reserves be estimated prior to drilling

a) In a geological province;

b) In a sale area; and

c) In a lease tract?

Answer:

The Department has had considerable success in selecting the most promising acreage in a geological province and sale area. This is evidenced by the fact that in the general sales held in the last 5 years over 75% of the total number of tracts that were offered were leased.

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An interbureau pre-sale tract evaluation agreement defines the respective roles of BLM and GS in the economic, engineering, and geologic evaluations for each tract in a sale and provides a procedural review of the entire process.

The Government uses the best information it has to estimate resources prior to drilling. Ability to identify the most promising acreage is directly related to 1) knowledge of the area, and, 2) understanding of the trapping mechanism effective in a given area (i. e., structural, stratigraphic, or combination).

In geologically well-known areas, the resources in a province or lease area can be estimated within an order of magnitude, using previous history and projections of trend and environment. In relatively unknown areas, estimated resources can be seriously in error. The actual reserves discovered as a result of the 1968 Texas OCS sale were previously overestimated by the Department by a factor of 2 and by industry (the successful bidders) by a factor of 10. The reserves found to date as a result of the December 1970 Louisiana sale appear to be about 30% more than estimated by the Department.

In general, the degree of confidence in estimating recoverable petroleum reserves, in a specific lease tract prior to drilling (except for drainage tracts where much more reliable information is available prior to drilling) is not very high. The structure can be very promising, based on geophysics, but not have adequate reservoirs or have the reservoirs mostly filled with water instead of oil.

Question D. 3.

What are the advantages and disadvantages, from the point of view of maximizing resource development, lease revenues, safety and environmental protection, and from the standpoint of cost, of using the present informational system for identifying promising acreage prior to lease sales compared to:

a) The Federal Government conducting its own expanded geological and geophysical surveys,

b) Purchasing such information from private surveyors,

c) Requiring members of the petroleum industry to submit on a confidential basis their exploratory data and resulting assessment,

d) Developing new sources of information, in addition to geological or geophysical information,

e) Any combination of these alternatives?

Answer:

a) An effective geologic program for appraising resources preliminary to leasing should consist of two phases of study: 1) A regional systhesis of a province or segment of the OCS to identify those areas that, on the basis of geologic structural patterns, have high potential for resources; and, 2) Detailed study of the areas of high potential to make quantitative estimates of resources. Both phases of study include use of all existing geologic data. Critical to both phases of study on the OCS are high quality geophysical data and specifically deep penetration seismic reflection profiles collected with multichannel receiving systems. For phase 1, a grid spacing on the order of 4 to 8 miles will suffice for many areas, but will be too broad for complex and smaller structures in some areas; for phase 2, where dollar values must be assigned to lease tracts, grid spacing of one mile or less is necessary if the evaluations are to have reasonable validity.

The disadvantage of the Federal Government collecting its own data either by contract survey or with its own ships and equipment is the higher cost relative to purchase of geophysical data from private contractors on a proprietary basis. The ratio of the cost disadvantage will vary depending on the circumstances. Data suitable for regional analysis are usually collected for or by industry on a 4 to 8 mile spacing and at this stage are commonly collected for a number of companies in what is known as a group shoot. If the number of companies is large, the Federal Government can buy data at a relatively low price per mile ($14). If only a few companies are involved, the price will, of course, be considerably higher ($50-$75 per mile). For closer spaced work the companies group either in very small combines or contract for exclusive data; in either case the cost per mile is relatively high. If Government-owned or leased ships and equipment are used, the cost may become less than the cost of contracting with private surveyors on an exclusive basis after 2-3 years of opeation.

Advantages

1) Data gathered by the Federal Government could be used for preparing publications and other forms of disclosure to the public.

2) A systematic and efficient plan of geologic study, resource appraisal and leasing of the OCS could be established by the Federal Government. The current pattern is dependent primarily on industry preference.

3) More information for environmental impact statements could be obtained. Currently all of the geophysical data purchased on a proprietary basis must be excluded from such statements.

4) A program of regional geologic study of all of the OCS could be planned and carried out on a systematic time basis for the preparation of geologic and resource analysis maps and topical reports. Considering the growing impact of environmental considerations in the political arena, such studies may become critical to future development plans on the OCS.

b) This is the present informational system used by the Geological Survey, both for regional petroleum resource appraisals and for lease evaluations.

Advantage

Lower cost when done on a non-exclusive basis.

Disadvantages

1) Data acquired by this route are proprietary and thus cannot be used for systematic preparation of OCS reports and maps for public disclosure.

2) No systematic geologic study of the OCS can be made by this route because the acquisition of data is tied to oil industry preference. Consequently, coverage of data is not uniform.

3) Data thus acquired can be used only for the purpose of petroleum appraisal and lease management, excluding the wide variety of problems that should be covered in systematic OCS studies.

c) Geophysical data would be available to the Government at only the cost of reproduction. To the extent that individual companies surveyed and appraised the same areas, the sum of their observations and interpretations would represent a broader spectrum of expert opinion than could be provided by a single organization.

Disadvantages

All of the disadvantages inherent in the use of proprietary data would still exist unless the Federal Government took the additional step of requiring that the data be placed in the public domain after a specified period of time.

d) Geologic and geophysical data, coupled with company nominations for tracts, provide the best means of identifying promising acreage prior to lease sales.

e) The following are examples:

1) New Federal regulations requiring that all geophysical data acquired by industry be filed with the Geological Survey and that after a specified period of time such data be declared in the public domain. Regulations if so instituted could provide for the use of data so acquired only for preparing geological maps and reports at a scale of 1:250,000 (1 inch to 4 miles) and stipulate that the seismic records would not be reproduced in publications. This approach would have the disadvantage of still being tied to the industry pattern of exploration.

2) A combination of Federal surveying and purchase of proprietary data whereby the Geological Survey would be funded for planning a long-range systematic study of all of the OCS on a regional basis of 1:250,000 acquiring, either with its own equipment or on contract with geophysical survey companies, state of the art multichannel data on a grid or density spacing suitable to a 1:250,000 scale of study. Such a plan would provide for the regional overview necessary to delineate areas of high resource potential and would provide data for environmental impact reports. The more closely spaced data needed for lease appraisal and management would be purchased on a proprietary basis. This approach would allow the Federal Government to acquire the multichannel data necessary to carry out meaningful and systematic geologic studies on the shelf. Furthermore, for 1:250,000 studies the grid of multichannel data could be infilled with single-channel data that are much less expensive to acquire, yet are very useful if used with multichannel data.

E. PRESENT DECISION-MAKING AND MANAGEMENT PROCEDURES

Question E. 1:

What is the procedure currently used by the Federal agencies for determining, on a short range (one-year), intermediate range (five-year), and long range (five years and beyond) basis

a) The demand or need for OCS production?

b) The sequence, size and timing of sales?

c) The location, size, and shape of specific tracts offered for lease?

Answer:

a) In determining the need for OCS production on a short, intermediate, and long range basis, an analysis is made of future regional supply-demand imbalances. Future demand for oil and gas is projected initially on a national and a regional basis. Estimates are then made of future supply from both non-OCS sources and from existing OCS leases. Regional deficits are identified and new OCS sales are proposed which can best help to meet our Nation's future energy needs.

b) The sequence, size and timing of lease sales can induce or inhibit a competitive market which in turn affects the government's receipt of fair market value. Two general sales of 300,000-600,000 acres each have been scheduled per year. In addition, another factor which affects the timing of sales is the avoidance of multiple-use conflicts; for example, efforts are made to avoid calls for nominations and announcements lease sales during peak fishing seasons.

c) Determination of the location, extent and timing of acreage to be offered at lease sales is based on geological, engineering, economic and environmental data.

During the development and updating of the Department's tentative OCS leasing schedule, general sale areas are identified and tentative acreage figures for each sale are developed, based on broad resource knowledge. As stated previously, generally the range of sale size is 300,000-600,000 acres.

In the specific tract selection process, the Department gathers and reviews more detailed geological, engineering, economic and environmental information on areas proposed for sale. Based on this review a more refined estimate of the potential supply of hydrocarbons is made and the size of the sale (in acreage) is modified as necessary.

The general rule is to select (a) drainage tracts, and then a mixture of (b) tracts in moderately developed areas, and (c) rank wildcat tracts. Drainage tracts have the highest priority.

The environmental implication of all tracts that are selected for leasing consideration is preliminarily reviewed and analyzed at this stage. Environmental impact statements are then prepared and public hearings held. As a result, some tracts may be deleted for environmental reasons.

Current law precludes the offering of individual lease tracts in excess of 5,760 acres. We usually offer full size blocks and attempt to cover all of a given geological structure (or prospect) with the number of blocks necessary to offer the entire structure at one time.

Question E. 2:

What is the procedure currently used by the Federal agencies for taking into account recreational, fish and wildlife, and other environmental values in choosing tracts to be leased?

Answer:

In the tract selection process, the environmental impact of all tracts that are selected for leasing consideration is reviewed and analyzed in a general way. After tracts are selected, detailed environmental analysis of tracts are made, environmental statements are prepared and public hearings held.

In view of the recent Louisiana offshore sale court decision, we will interpret the requirements of NEPA as set out by the Court of Appeals decision, Natural Resources Defense Council, Inc., et al, V. Rogers C.B. Morton, January 13, 1972.

F. LEASE ADMINISTRATION

Question F. 1.

What, in general, are the current procedures for lease supervision and inspection? Are there concrete indications of improved surveillance and compliance over past experience? To what extent has the risk of accidents such as those which occurred near Santa Barbara and offshore Louisiana been reduced, and to what factors are reductions (if any) due?

Answer:

The regulations under which Outer Continental Shelf Oil and Gas Operations are conducted were revised effective August 22, 1969, to provide more stringent requirements in regard to safety of operations and to minimize the danger of oil pollution from those operations. The regulations are implemented through OCS Orders which set forth requirements on specific items of equipment and operating procedures. These Orders are issued by the Regional Oil and Gas Supervisor after approval by the Chief, Conservation Division. Continual review of the Orders is conducted to insure they are kept current. Latest revisions of the Gulf Coast Orders were made effective August 28, 1969, and October 30, 1970, and the Pacific Coast Orders effective June 1, 1971. Discussions are currently being held preparatory to further up-dating.

In the Santa Barbara Channel daily inspections of operations are made on Platforms "Hillhouse" on lease OCS-P 0240 and Platforms "A" and "B" on lease OCS-P 0241; these include the drilling and workover rigs, proper testing of safety and BOPE equipment, personnel BOPE drills, and proper procedures being used and recorded in tour sheets. The inspection also includes pollution, housekeeping and the use of accepted oil field practices.

Once a week, platforms "Hogan" and "Houchin" on lease OCS-P 0166 are inspected in addition to the daily inspection on leases OCS-P 0240 and OCS-P 0241. In brief, the inspection of the production facilities includes visual inspection of their controls; the different process vessels; the gas compressors and the associated controls, the different manifolds; headers and associated control equipment, antipollution systems, and sewage, waste water and solid waste disposal systems.

In addition to the daily and weekly inspections cited above, semiannual inspections are performed on each platform and onshore facility. Detailed inspection and physical testing of each control on every item of equipment is performed, insuring its conformance to OCS regulations.

In the Gulf of Mexico, due to the magnitude of operations, platforms are inspected less frequently than they are in the Santa Barbara Channel. Although the items inspected on a drilling or producing operation are essentially the same as in the Santa Barbara Channel it has been found necessary to modify the inspection program.

To insure consistent interpretation and enforcement of the OCS Orders and regulations in the Gulf Coast Region, the substance of these requirements has been expressed as a list of Potential Incidents of Non-Compliance (PINC). This list of PINC's reflect the existence of potentially hazardous conditions if specified equipment is missing or inoperable or if specified procedures are not followed. Survey inspectors conduct inspections daily of drilling and producing operations throughout the Gulf of Mexico using a standard check list (inspection form) to determine if Incidents of Non-Compliance (INC's) exist. The standard check list assures that checks on the existence and operability of required safety and pollution control equipment along with field and office records which reflect the oil company's operational procedure are made without overlooking critical items. Enforcement action is taken if an INC is found. The enforcement action (warning or a shut-in of operations) for an INC relates to the degree a particular item contributes to unsafe operations, hazardous conditions, environmental damage or resource waste. Periodically inspections are conducted on sites chosen on a random basis during a one week interval. Tabulation of the results of these inspections provides an indication of the degree of compliance with OCS Orders and Regulations throughout the Gulf of Mexico OCS.

The inspection program initiated in the Santa Barbara Channel during 1969 and the modified Gulf of Mexico inspection program started during 1971 have produced significant results.

Incidents of noncompliance with regulations and orders have been greatly reduced.

The number of small oil leaks and spills has been cut in half.

Several major accidents, particularly fires, have been avoided as the result of the installation of new safety systems.

Research has been stimulated, resulting in improved safety devices and systems.

Although it has not been possible to date to quantitatively define the risk involved in drilling and producing operations, operations are being conducted more safely now than in the past. This is evidenced by the above. Improvement in operations has resulted from the following actions that have been taken since the Santa Barbara blowout:

We have strengthened our OCS Regulations to require additional safety features on platforms and pipelines; testing of safety devices prior to, and during, production use; more careful control of drilling and casing operations; prior approval of plans and equipment for exploration and development drilling; suspension of any operation threatening life, property, or damage to other resources or the environment; reporting of all leakage and spills; and control and total removal of pollutants at the lessee's expense.

We have increased our inspection capability by more than doubling our staff, and by utilizing helicopter support and a radio communication system in the Gulf Coast area.

We have standardized our inspection procedures; provided a statistical basis for inspection strategy; and increased the number of unannounced inspections and, thereby, our visibility, which in itself serves as a deterrent to violations of orders.

We have participated in the development of inter-agency contingency plans for oil spill cleanup.

Question F. 2.

What measures (including in-house and consultant studies under way or recently completed) have the Federal agencies taken or planned regarding improvement of OCS administration?

Answer

A study on quality control and hazard analysis has been conducted for the Geological Survey by a team of NASA experts from the Marshall Space Flight Center, the Mississippi Test Facility, and the Michoud

Assembly Facility. The report of this study was released on December 8, 1971, and we are now in the process of evaluating its several recommendations.

An operational safety study is being undertaken by the Marine Board of the National Academy of Engineering. A final report of this study is expected this fall. In the meantime, the Board is keeping us informed of its tentative findings.

An internal systems study of our lease management operations, in particular our regulatory controls, inspection criteria, and enforcement policies is now nearly complete. We have already incorporated some of the recommendations into our inspection program.

In addition to such studies and consultations, we are requesting the Secretary's permission to establish a continuing Advisory Committee on Safety of OCS Petroleum Operations. This committee will advise the Director of the Survey in matters related to safety and pollution control in operations on Federal lands of the Outer Continental Shelf, and will serve as an independent audit of the effectiveness of our operations and procedures.

We are also in the process of contracting for a hazards analysis of selected existing systems on drilling and production platforms. This is being done in order for us to be in a better position to determine the desirable parameters of such an analysis as a requirement of lessees prior to commencing operations.

The acceleration of the OCS oil and gas leasing schedule, concurrently with our intensified effort to adequately protect the marine environment, require an increase in BLM staff in Washington and New Orleans and a greatly accelerated research program. The BLM FY 1972 budget supplement provided additional staff in Washington principally to prepare environmental impact statements for OCS oil and gas lease sales. It also provided two additional positions in New Orleans to begin an inventory of all existing pipelines on the OCS and coastal marshes and to develop specifications for the construction and laying of these pipelines.

The FY 1973 budget which is now before the Congress provides for an addition of three environmental analysis teams composed of five men each, to be initially headquartered in New Orleans, and several contract research studies. These study teams will gather data and conduct analysis that will provide inputs and back up for the preparation of environmental impact statements required for lease sales.

G. JURISDICTIONAL ISSUES

Question G. 1.

What jurisdictional issues remain unresolved regarding

a) The seaward limits of the OCS ?

b) The seaward limits of state jurisdiction ?

c) The authority of the Secretary of the Interior

i) to suspend and extend leases ?
ii) to promulgate "conservation" regulations ?
iii) to permit or authorize the use of the OCS for purposes other than mineral development ?

What is the effect of the lack of resolution of any such issues on the effectiveness with which the OCS is administered; to what extent are they or can they be responsible or delays in lease sales ?

Answer:

a) Article I of the Convention on the Continental Shelf, 15 U.S.T. (Part I) 1471, defines the term "continental shelf" as "the seabed and subsoil of the submarine areas adjacent to the coast but outside the area of the territorial sea, to a depth of 200 meters or, beyond that limit, to where the depth of the superjacent waters admits of the exploitation of the natural resources of the said areas." This is accepted by the Department as the definition of the seaward limit of the OCS. However, discussions concerning international marine matters are now being held at the United Nations preparatory to the 1973 Law of the Sea Conference, the results of which may affect the seaward limits of the OCS. United States representatives are involved in the discussions.

b) The limits of State jurisdiction have not been determined exactly in any area. The seaward limits of the Atlantic coast States' jurisdiction are involved in litigation now as well as those of Florida, Louisiana, California and Alaska. No further comment on this litigation would be appropriate at this time.

c) (i) The Secretary's authority to suspend lease operations in the interest of conservation and to extend leases when operations have been so suspended is involved in the present case of Gulf Oil Corp. v Morton, Civil No. 71-1669 FW, U.S. District Court, Central District of California. No further comment would be appropriate at this time.

(ii) The authority of the Secretary to promulgate conservation regulations has not been challenged, but the question of what is covered by the term "conservation" is an additional issue in the Gulf case.

(iii) The use of the OCS for nonmineral purposes is not involved in any pending legal disputes.

The litigation involving the seaward limits of the coastal states inevitably affects the holding of lease sales in those areas. The other issues mentioned in this question have not delayed the holding of lease sales.

Question G.2.

Provide a summary of pending proposals for offshore terminals, supertanker facilities, offshore nuclear facilities, and other developmental projects which in whole or in part would be located on the OCS. What, if any, Federal permits and/or licenses are required under present law for these projects? Is additional Federal legislation dealing specifically with proposals of this nature required or desirable?

Answer:

a. The Geological Survey has received a plan of development for the Santa Ynez unit area in the Santa Barbara Channel. The plan contemplates OCS loading terminals should planned shore facilities not be available.

b. The BLM has had a recent inquiry regarding the erection of a ship terminal on the OCS near the mouth of the Mississippi River offshore Louisiana.

c. There are no pending proposals before AEC or the Office of Oil and Gas at this time.

d. There have been several concepts proposed for such facilities and our general comments on this question are:

1. There are over 50 foreign ports and terminals being built worldwide, capable of handling giant dry bulk ships and supertankers of over 200,000 DWT, however, none of these are proposed for U.S. waters. In June 1971, Louisiana officials denied a proposal for an offshore port in the Gulf of Mexico. There are approximately 700 deep

draft ships of over 100,000 DWT in operation in the world that cannot enter U.S. ports. Only Long Beach and Puget Sound ports can be entered by 100,000 dwt vesses.1 There has been a Sea Grant Program report "Work Plan for a Study of the Feasibility of an Offshore Terminal in the Texas Gulf Region" published in June 1971 that could apply to any U.S. coastal state.

2. The military has a wide variety of projects utilizing the ocean floor which range from communication and navigational aids to early warning systems. Although there have been proposals for undersea Long-Range Missile Systems, these programs involve complicated problems of technology as well as disarmament considerations at the 17 Nation Geneva talks.

3. Congress has directed the Corps of Engineers to make a study of commercial navigation channel and harbor requirements along the Gulf Coast, including, but not limited to offshore facilities. This study requirement is contained in a resolution adopted May 2 , 1971, by the Public Works Committee of the United States Senate and a number of more localized resolutions approved by the Public Works Committee of the Senate and the House of Representatives.

Question G. 3.

What formal or informal procedures are used by the Federal agencies to ascertain and consider the interests and views of individual coastal States regarding Federal leasing and management decisions for OCS lands?

Answer:

The Department desires to maintain a close working relationship with the involved staets in regard to Federal leasing and management decisions for the natural resources of the OCS lands. In conducting resource inventories and planning studies prior to leasing decisions, we will continue to work closely with appropriate state agencies. In the preparation of environmental impact statements for proposed OCS lease sales, we consult with the involved states about their problems and concerns in the process of preparing the draft environmental statement. In the formal review procedures for environmental statements, states are invited to review both the draft and final statements. States also participate in the public hearings which are held for the draft environmental statements. All state comments are considered in the decision-making process concerning OCS leasing and management.

Question G.4.

What should the role of State government be with respect to Federal decision-making concerning

a) Exploration
b) Leasing
c) Environmental regulations on OCS lands bordering the States' jurisdiction?

Answer:

The role of State governments in the decision-making process of OCS leasing offshore their boundaries is advisory. The State's views are carefully considered prior to leasing decisions, particularly insofar as environmental matters are concerned.

In OCS areas in which no previous leasing or development has taken place, it is especially important that the States be consulted. The Secretary of the Interior has personally met with Governors of Atlantic coastal States to discuss this issue in detail. Close coordination with the States will continue until a final decision to lease or not to lease is made.

H. ECONOMIC COSTS

Question H. 1.

What has been the average cost (exclusive of bonuses, royalties, and other "rents") of

a) Exploration,
b) Development, and
c) Production

of petroleum (oil, natural gas and natural gas liquids) from the Outer Continental Shelf?

Answer

Average cost of OCS oil production (exclusive of bonuses, royalties and other rents)

	Gulf of Mexico ($/B)
Exploration	
Geophysical, geological, etc.	.15
Development	
Well drilling, etc.	.77
Production	
Operating expenses	.59
Total	$1.51

Question H. 2.

How have these average economic costs compared to the average economic cost of

a) Petroleum from domestic onshore areas, and

b) The landed prices of imports?

Answer

a) Average economic costs for onshore production (exclusive of bonuses, royalties and other rents)

	$/B
Exploration	.17
Development	.77
Production	.64
Total	$1.58

b) Landed prices of foreign crude vary considerably by country of origin, the producing company, by mode of contract for transportation and by volume, quality and gravity of the crude oil in question.

As a guide, however, to landed prices of selected foreign crude oils on the U.S. East Coast, the following Table is a best estimate for the present time and under present conditions. The f.o.b. prices are based on the latest available reported prices with increases due to OPEC agreement to dollar revaluation added on. The tanker freight rates are based on AFRA (average freight rate assessment) rates for the second quarter (used by OPEC in their calculation of temporary freight premiums) set at W 75.4. The crudes range in gravity from 34^{o} to 40^{o} and sulphur content varies widely so that no true cost comparison can be made. It is also important to note that tanker rates have softened considerably over the past 12 months with concomitant easing of AFRA rates from W 94.4 this time last year to the W 75.4 cited above.

Question H. 3.

What are the anticipated economic costs of petroleum produced from future OCS leases and how will these costs compare with:

a) The anticipated costs of alternative sources of hydrocarbons from onshore areas (including new energy sources such as liquid or gaseous products of coal and oil shale), and

b) With the landed prices of imports?

Answer

The anticipated economic costs of petroleum produced from future OCS leases (ex bonuses, etc)

	$/B
Exploration	.15
Development	.87
Production	.59
Total	$1.61

a) The anticipated costs of alternative sources of hydrocarbons from onshore areas:

1. Stimulation of additional gas production

2. Increased onshore exploration, leasing and production

3. Alternative fuels and synthetic

   a. Oil Shale

   b. Tar Sands

   c. Coal Gasification

   d. Coal Liquefaction

a. 1.) Stimulation of Additional Gas Production

Unregulated intrastate buyers have been able to secure practically all new supplies of gas, but at prices generally higher than the price of interstate gas, suggesting that broader price increases would be likely were a free market allowed to exist for interstate gas as well. The extent of additional production which could be stimulated, and the costs of such production, are difficult to determine in the absence of firm data on the price elasticity of gas supply.

An example from recent experience may illustrate the sorts of increases required. The example is the Ohio intrastate market, chosen because it is close to market areas, although not a large producer of gas. Between 1969 and 1971, Ohio intrastate wellhead prices increased from 24¢ to 38¢ per MCF, or more than 59 percent. During the same period there was a 73 percent increase in well completions. Since rates of return of gas transmission companies are regulated, city-gate prices would presumably rise as an increment of well-head price, rather than in proportion to it. Thus the $.14/mcf increase in well-head price ($.24 to $.38/mcf) would be added to an average city gate prices of about $.40/mcf. There are, however, significant undiscovered resources of natural gas in the United States.

Nuclear Stimulation: It is estimated that 300 trillion cubic feet of natural gas in the Rocky Mountains, not now recoverable economically, could be made recoverable by nuclear stimulation technology. Economic analysis indicate that this gas could be recovered at wellhead prices of 30¢ to 60¢ per MCF, and delivered to markets at 55¢ to 85¢ per MCF.

a.2.) Increased Onshore Exploration, Leasing, and Production

Additional oil production could be obtained from onshore resources in the lower 48 States by a variety of methods. Subsidies or other economic incentives could add to onshore domestic productive capability, but there have been few studies of the cost or effectiveness of such programs. Alternatively, certain additional Federal oil resources onshore could be leased. Any new and significant onshore production to be added would be from sources not now considered economic or available for lease. Increased rate of onshore production from known fields would hasten reserve depletion without discovery of new fields.

Economic Incentives: Additional production from onshore sources other than the Naval Petroleum Reserves and the North Slope would likely be from existing provinces where significant additional production is not now deemed economic. To stimulate such additional production would require an explicit subsidy for onshore production, or a general rise in prices. Either measure--subsidy or price rise--would impose additional costs on the consumer and the economy. Incentives are usually interpreted to mean price rises or favorable tax treatment, but are rarely quantitative. There is a frequently quoted consensus of independent operators that crude oil prices would have to rise $.50 to $1.00 per barrel to induce a substantial rise in exploratory activity.

a.3.) Accelerated Production of Alternative Fuels & Synthetics

Oil Shale. There is no commercial production of shale oil in the United States at this time. Government and private research have developed mining and retorting oil shale technology to a point where shale may be considered a practical future energy source. However, since development is now only in the pilot plant stage, oil from shale probably will not be available in significant quantities before 1980. Most research groups have estimated a price in the range of $5.00-$5.50 per barrel with present technology. 1/

Tar Sands. There are substantial reserves of tar sands in Canada, and technology for commercial-scale exploitation is very nearly at hand. The more attractive tar sand deposits are in Canada and most of the supply from this source will originate there. U.S. development of tar sands will have to await improved technology or increased price.

Coal Gasification. While no coal to pipeline-gas process has yet reached commercial production in the United States, several companies are studying commercial application of a variety of conversion processes, some of which have been known for a number of years. The Department of the Interior is investigating various processes for producing pipeline quality gas from coal. The Office of Coal Research has erected two coal gasification pilot plants and has funded a third. Research by the Bureau of Mines has culminated in the development of a fourth process ("Synthane") for which a pilot plant is being designed; a construction contract could be let in the autumn of 1972. Most processes predict a price range between $.80 to $1.00 per MCF.

Coal Liquefaction. In the Department of the Interior, the Bureau of Mines and the Office of Coal Research (OCR) are conducting research on the conversion of coal to a general petroleum substitute. OCR has two pilot plants in existence and is shortly to begin construction of a third--each using a different process. Other processes are being investigated on a smaller scale.

Question H.4.

To the extent that OCS production is an alternative to imports, what is the expected net impact per unit of petroleum production upon the U.S. balance of payment? (The balance of payments impact of imports includes net foreign investment and foreign earnings of U.S. petroleum companies, and producer country imports from the U.S. financed by these petroleum revenues.)

1/ At current crude oil prices, a 100,000 b/d operation, as estimated by the Bureau of Mines, could yield a 12 percent rate of return.

Answer

Assume all incremental increases in imports must come from the Middle East. Increased imports to 1975 are in the range of 4 MB/D and by 1980 in the range of 7 MB/D, according to most estimates.

		Middle East			
			Millions of Dollars		Dollars Per Barrel
1975	Net one time capital outflow		- 304		-0.21
	Annual proximate outflows		-3,825		-2.62
	Oil @ $1.92 /B	-2,803		-1.92	
	Freight @ $.70 /B	-1,022		-0.70	
	Annual purchases of U. S. Goods		+ 432		+0.30
	Third Country return flow		+ 768		+0.53
			-2,929		-2.00
1980	Net "one time" outflow		-1,029		-0.40
	Annual prximate outflows		-7,690		-3.01
	Oil @ $2.31 /B	-5,902		-2.31	
	Freight @ $.70 /B	-1,788		-0.70	
	Annual purchases of U. S. Goods		+ 756		+0.30
	Third Country		+1,344		+0.53
			-6,619		-2.58

I. NATIONAL ENVIRONMENTAL POLICY ACT (NEPA) AND THE OCS

Question I.1.

In view of the recent Louisiana offshore sale court decision, what changes in procedures, if any, do the Federal agencies contemplate to satisfy NEPA environmental impact statement requirements?

Answer:

In view of the recent Louisiana offshore sale court decision, the Department will comply with the requirements of NEPA as interpreted by the Court of Appeals Decision (Natural Resources Defense Council, Inc., Et. Al., v. Rogers C. B. Morton, January 13, 1972).

Question I.2.

In light of existing and projected demands for energy and the simultaneous requirement to protect the marine environment, what alternative sources of energy, other than OCS petroleum from future leases, are readily available and at what economic costs and environmental risks?

Answer:

A discussion of alternative sources of energy, other than OCS petroleum from future leases, including the economic costs and environmental impact associated with each alternative, has been prepared by the Bureau of Land Management in its draft environmental impact statement for the proposed East Louisiana OCS sale. Copies of this statement will be made available by the first week in April, 1972. This would also apply to question K 5 (a).

Question I.3.

What would be the economic, security of supply, and environmental consequences of alternative strategies for the scheduling of OCS resource development (e.g., postponing development and consumption of these resources until the need for them is greater, due to increased costs or unavailability of imported oil)?

Answer:

Without leasing there would be no exploration for new deposits, no development of them. The OCS could not continue to contribute its optimum share of hydrocarbons to meet the nation's needs. Gas, in particular, is in critical supply and to deny leasing will deny discovery of new supplies of gas along with oil.

Commencing with the present and anticipating the future, it is likely that the security of supply will become more precarious. Because present production is close to capacity, the Nation will become increasingly dependent, in the intermediate term, on imports. To delay leasing now will intensify this dependence in degree and will meantime remove the incentive for future exploration by directing venture capital into other channels.

The economic consequences are not easily quantified but devolve upon two general areas. First, the Federal government is denied the lease-bonus payments, rentals, and royalties accruing to production, and industry must turn to other investment opportunities, especially abroad. Many of these alternative may be less desirable eccnomically and hence contribute to rising energy costs to the consumer. Secondly, the Nation loses the financial gain from the process of petroleum development, in terms of drilling platform, production, and pipeline equipment construction. In the process it loses to other areas the necessary physical equipment that would otherwise be available for domestic use. This loss may be especially severe as regards the mobile ships and platforms used for exploratory work.

A delay in leasing offshore will avoid potential environmental costs in developing a virgin area resulting from erection of platforms and the construction of pipelines to carry the hydrocarbons ashore. However, if demand is to be met from alternative sources, then society must bear the environmental costs of developing these alternatives. The potential environmental impacts associated with the most feasible current alternatives are described in the draft environmental impact statement for the proposed 1972 East Louisiana OCS sale which will be made available after April 1.

J. ENVIRONMENTAL PROTECTION

Question J.1:

What are the nature and magnitude of environmental risks and problems related to OCS oil and gas development in:

a) Geophysical exploration?

b) Drilling and production?

c) Undersea pipeline construction and operation?

d) Tanker operation?

e) Port and processing facilities?

f) Onshore pipeline construction and operation?

Answer:

a) There is no evidence of any significant environmental risk or problems connected with geophysical exploration related to oil and gas development on the OCS. The three basic types of surveys that are conducted with respect to geophysical operations involve seismic, magnetic, and gravity surveys with seismic reflection surveys accounting for approximately 95% of all marine geophysical exploration. These surveys do not involve drilling, explosive, sampling or disturbance of the sea bottom, with the exception of an exploding charge which is rarely used anymore to generate sound waves for seismic operations. Even though the process of creating sound waves by exploding a charge of dynamite has become outdated and is seldom used, the U.S. Geological Survey would not authorize the use of such an explosive charge that would have a detrimental effect on the environment. The complete change-over from explosives to air guns, vibroseis or "sleeve exploders" has been accomplished to overcome ecological problems associated with the dynamite shooting. Tests have been conducted to determine the effect of compressed air charges on oysters, water, water bottoms, chemical composition, chemical stratification and general hydrological characteristics. Generally, there was no indication of any damage to the oysters, water and water bottoms. Chemical analysis showed that the air charges had little or no effect on the chemical composition of the waters. However, stratification of chemicals existing before the tests was found to be less pronounced after the test.

b) The drilling for, and production of, hydrocarbons will probably always pose a risk to the environment. Oil siplls may result from natural disasters, equipment failure and human error. The use of more sophisticated equipment and the reliance on "fail safe" devices will help to reduce equipment and human error. Strict enforcement of operating regulations and closer policing by regulatory bodies will contribute toward reducing the risk to the environment. These factors will not, however, completely eliminate the risk.

Chronic waste discharges in water from offshore production are found in the presence of a small amount of oil in produced water. Regulations currently control this discharge to 50 parts per million. This small amount of pollution does not produce an immediate adverse effect upon the environment. The unknown factor is the long range effect of the added impact of this form of pollution to others present. Work is currently being conducted to effectively reduce the permissible amount of oil discharged with produced water.

Accidental waste discharges from offshore operations occur in the form of oil spills. Spillage may be substantial, or in the form of a minor or series of minor spills.

Both short and long term effects can be expected from a major spill. Short term effects in an estuarine or shallow water zone may be obvious in terms of destruction to marine and wildlife. Short term effects in deep waters may not be so readily apparent, but may have a pronounced impact because life in the deeper regions is not as diverse as that found in shallow areas. Long term effects of a major spill or of a series of minor spills is more subtle. The damage may be hidden in the destruction of food sources or the loss of larvae resulting in the reduction or elimination of a generation of organisms.

Offshore oil and gas production does not contribute significantly to air pollution or siltation.

Oil and gas production offshore has resulted in some conflicting land use and concern for navigation safety. These conflicts have been minimized with strict compliance with regulations governing the location of structures and pipelines and cleanup operations upon abandonment of locations. Supporting facilities, necessarily located on shore, will add to the congestion on land.

To some, the offshore structures of the oil and gas industry do produce an adverse environmental effect from an aesthetic point of view. These structures detract from the natural appearance of beach areas from which they are visible. This is, however, a short term impact as structures are removed upon depletion of production.

c) The risk to the environment from the construction of undersea pipelines is small, affecting the marine life in the immediate vicinity, and is of short duration. The main risk involved is that of an oil spill resulting from a rupture of the line while in operation. This probability may be reduced by requiring adequate burial. The magnitude of the spill may be reduced through the use of pressure sensitive devices to shut off transport when a rupture occurs. The impact on, and risk to, the environment does increase greatly at those points of landfall for the offshore lines.

d) The environmental impact of tanker operations can result from the following operations:

- Loading
- Shoreside ballast treatment (at the loading end)
- Tank cleaning operations
- Accidental discharges
- Off loading

The danger from oil spills is much greater from tanker accidents than from offshore production. Tanker traffic in the U.S. ports is already enormous. Accurade figures on the influx of oil into the world's waters are not available, but the various estimates that have been made agree that the contribution from offshore operators is relatively small. The major contributions are from marine vessels and automobile crank case oil disposal, with lesser amounts from other sources. The 1970 Pollution Incident Reporting System (PIRS) data indicate that approximately 0.00015% of the oil handled in the U.S. was spilled during transfer operations and that an average of 0.0091 spills per operations occurred. 1/

In the restricted waters surrounding harbors and ports, the 1970 experience indicates that about 0.00009 percent of the oil handled is accidently discharged and that an average of 0.003 accidental discharges per operation occur.

1/ Environmental Impact Statement for the Trans-Alaska Pipeline, Vol. 4

The worldwide tanker casualty analysis indicates that 0.019? percent of the oil transported is spilled, exclusive of transfer operations.

The above oil pollution from tanker operations can be viewed as both chronic and accidental.

e) The environmental impact resulting from port facilities would result mainly from the construction of pipelines from the terminals to refineries and storage facilities. Pipeline construction causes short-term damage to bottom resources through siltation. It also causes damage to marshland areas through disruption of normal water flow patterns and relationships between fresh and saline water. Damage to both bottom and marshlands can be minimized by laying pipelines in corridors.

Environmental risk from these operations would be those attendant to normal pipeline operation, e.g., pipeline leaks and more importantly, breaks from construction, anchor dragging etc. The risks can be minimized by clearly designating pipeline locations and by the use of automatic shut-down equipment that would detect any sudden drop in pressure on the line to first shut off pumping equipment and then automatically closing sectionalized valves to minimize the quantity of oil released.

Environmental risks are also attendant to unloading operations in port, mostly as a result of human error. This risk is included in the discussion of tanker operations above.

Environmental risk and problems of processing facilities include air pollution and waste water discharge. We do not have precise data on the scope of these problems.

f) The environmental risk from onshore pipelines is greatest in coastal marshes and estuaries. In those areas where lines can be buried, disruption of the local environment may be only temporary. However, in many cases the lack of available back-fill material may necessitate canal dredging operations. These operations contribute to marsh destruction by erosion, acceleration of fresh water drainage, fostering salt water intrusion, and destruction of vegetation. Accidental discharge of oil through a rupture in the line, though localized in nature, would have a severe impact on the environment because of the difficulty of removal.

Question J.2 A:

Summarize experience with environmental effects of offshore oil and gas operations in:

a) Gulf Coast

b) California

c) Cook Inlet

d) Overseas

For each of the above areas indicate the number of wells drilled, the number of mishaps which have occurred and the consequence of each such mishap to the state of the ambient marine and estuarine environment.

Answer:

a) There have been 13,500 wells drilled offshore on State and Federal issued leases in the Gulf of Mexico since 1938. During this interval of time there have been seven mishaps from offshore drilling and production operations on the OCS which posed an environmental threat.

West Delta Block 117. Well A-5 blew out and caught fire on January 20, 1964. The well continued to burn until January 27, 1964. Approximately 500 barrels of oil went into the Gulf of Mexico, but there was no report of any environmental damage.

Pipeline between West Delta Block 73 and Grand Isle Block 18 fields. On October 26, 1967, it was discovered that this pipeline had developed a leak. The field delivering production to the pipeline was shut-in and the leak was located October 28. It was estimated that the volume of oil lost to the Gulf waters was 160,000 barrels. The leak was caused by a break in the pipeline apparently caused by its being bent by an anchor. Although there were reports of a heavy oil slick there were no reports of oil reaching the shore or of any injury to wildlife. The prevailing winds and currents in the area at the time of the pipeline break pushed the slick seaward where it was dispersed by evaporation and emulsification in the rough seas of the Gulf of Mexico.

Ship Shoal Block 72. On March 16, 1969, well No. 3 blew out spilling an estimated 2,500 barrels of oil into the Gulf waters until the well was capped on March 19, 1969. There was no apparent environmental damage from the spill.

Main Pass Block 41, Platform "C". This was a major fire which started February 10, 1970, and destroyed the platform. After the fire was extinguished oil flowed into the Gulf waters for a period of 21 days. Total pollution was estimated at 30,500 barrels. As a result of containment and control efforts and northerly winds which prevailed much of the time the wells were flowing, very little oil reached any land mass. No oil reached the oyster beds or shrimp spawning grounds in the bay areas, and there were no reported bird deaths. Only two instances were reported of any oil reaching land. These were on March 2, when approximately 20 barrels washed upon Breton Island and on March 16 when 20 to 30 barrels reached Breton and Grand Gosier Islands. The contaminating oil on the islands was removed with straw and burned.

Galveston Block 189. An explosion occurred on the A platform on May 28, 1970. Nine people were killed in the ensuing fire and approximately 100 barrels of oil escaped to sea. Fifty barrels of oil washed onto Galveston beach where it was removed immaculately. There was no lasting environmental damage reported.

South Timbalier Block 26. On December 1, 1970, an explosion and fire occurred on the "B" platform, a drilling and production site. The platform was totally destroyed and 13 well completions contributed to the fire until controlled by drilling of 11 relief wells. The last well was capped on April 17, 1971. Allowing the wells to remain on fire prevented a greater amount of oil to be discharged to the Gulf than actually occurred. Even so, an estimated 53,000 barrels of oil entered Gulf waters during this period. No damage to any wildlife was found. Small amounts of oil did reach coastal islands on occasion. Cleanup crews were on standby during the entire containment operations and prevented shoreline damage from the oil.

Eugene Island Block 215 "B" platform. On October 16, 1971, this platform suffered an explosion and fire with wells continuing to burn until December 10, 1971. Approximately 450 barrels of oil were lost into the Gulf. The oil did not reach any beach area and was dispersed by the seas. No environmental damage was reported.

Pelican Island. During the interval between November 3 and 27, 1967, an estimated 550 to 700 ducks (scaup) were killed by oil. Investigation did not reveal any offshore pollution incidents which could have been responsible for an oil accumulation in this area. The Louisiana Wildlife and Fisheries Commission Biologist investigating the incident was of the opinion the kill occurred in an onshore pond. Subsequent investigation did not reveal the source of the oil.

Other incidents have been reported in the Grand Isle area when oil has washed ashore, but has not been identified from offshore operations.

On January 25, 1970, an oil emulsion washed ashore at Grand Isle, Louisiana. The amount of oil forming the slick was estimated at 300 plus barrels. The source of the slick was not determined, but an analysis of the oil show that it was a refined oil and not crude oil. Therefore the source was not from offshore operations. Oil companies operating offshore cleaned the beaches however, and there was no report of environmental damage.

Periodically a black tarry material has fouled the beach at Grand Isle and has been a source of consternation to swimmers and surf fishermen. Repeated attempts to identify the source of this pollution have been unsuccessful. Similar conditions have been found on Florida's West Coast beaches. Many theories have been expressed as to the origin of the oil including cargo from tankers sunken in the Gulf of Mexico during World War II. This may be similar to the pollution sighted by Thor Hyderdahl in the Atlantic Ocean during his voyages on Ra I and II.

b) There have been an estimated 2,500 wells drilled offshore California on State and Federal issued leases. Only two mishaps posed serious environmental threats.

Santa Barbara Channel Platform A blowout. On January 28, 1969, Union Oil Company of California, prior to setting the second casing string, lost control of well A-21 and a blowout occurred. The blow out preventor was promptly activated and effectively controlled the flow of mud and gas from the casing of the well. However, the capping beds were hydraulically fractured when the blowout preventors were closed, causing fluids from the deeper formations to flow up the hole to shallower formations of the Dos Cuadras structure and then to the ocean floor. The well was brought under control on February 8, 1969, by forcing high density mud down the wellbore.

According to Geological Survey estimates, about 10,000 barrels of oil escaped into the waters of the Santa Barbara Channel during the initial 10-day period while well A-21 was being brought under control.

The Geological Survey has estimated that continued oil seepage from the fractured Dos Cuadras structure continued at a rate of approximately 30 barrels per day during the four month period following the blowout. Survey estimates indicate that the seepage was reduced to about 15 to 20 barrels per day in mid-July, 1969, through remedial operations. The seepage has been further reduced by fluid withdrawals and pressure reduction to a present rate of 5 barrels per day. To date, total seepage has amounted to approximately 18,500 barrels, a small part of which was contained by sea floor devices to avert pollution.

With the exception of bird life swelling on shore and tidelands, the University of Southern California (USC) biologists reported that there has been very little damage to the ecology of the Santa Barbara Channel. On March 31, 1969, the bird population in the Santa Barbara Channel was estimated at 12,000. A dead bird cumulative count through May 1969 was 3,686.

The USC biologists found no evidence that other marine fauna were affected by either short term or long term effects of the Santa Barbara spill. Even though some animal deaths can be reasonably attributed to oil, it is not clear whether the oil was from the spill area or from natural seeps. Neither USC nor the Department of the Interior could find evidence that morality of seals, sea elephants, or whales was more than normal, nor that any deaths were due to oil contamination. Fish life counts and commercial catches showed no decline for comparable periods of February to July in the years 1968 and 1969. Though algae and marine grass in intertidal zones of the Channel Islands were damaged, they had almost fully recovered by August 1969. It was the conclusion of the USC biologists that the Santa Barbara spill caused minimal, if any permanent damage to the normal ecology of the Santa Barbara Channel.

Santa Barbara Channel Pipeline Break. On December 16, 1969, a pipeline serving lease OCS-P 0241 developed a leak. An estimated 900 barrels of oil were lost to the sea. Some oil did reach the beaches and was cleaned-up by the oil company. There was no reported environmental damage.

c) In the Cook Inlet there have been a total of 247 wells drilled from 14 platforms all on State issued leases.

Only one significant mishap has occurred in this area. In 1962 a well producing oil and gas suffered a blowout and burned for 14 months until it was killed by a relief well. No estimate was made of the amount of oil lost to the waters of the inlet, but there was no environmental damage reported. Wave action and rough seas dispersed and dissipated the oil.

During the period 1965-1971 an estimated 4,680 barrels of oil went into the seas from small leaks and spills. These occurrences have been greatly reduced in the last few years due to more stringent regulations issued by the State of Alaska. A study of the effect of crude oil on the environment of the Cook Inlet was made by the University of Alaska. The report concluded there had been no damage to the marine fauna of this important fishing area.

Although there have been several instances of oil being washed ashore which has resulted in degradation of the bird population, none of these incidents has been identified as resulting from off-shore drilling or producing operations. There have been other incidents of spillage from tankers, dock facilities and ships carrying fuel oil.

d) The number of offshore wells drilled worldwide is not available. However, there were 800 wells drilled during 1971 in offshore waters outside of the United States. There has been only one oil spill incident reported during this period.

> Rakish Field-Persian Gulf. Information received to date is sketchy, but indicates a well suffered a blowout on December 6, 1971, and blew out of control for 22 days at a location 20 kilometers off the Iranian mainland. The well was flowing oil in the Gulf at rates estimated between 6,000 and 10,000 barrels per day. Total oil spill has been estimated at more than 200,000 barrels. We have no indication as to the cause of the blowout and there have been no reports of environmental damage except for the killing of sea snakes.

Question J. 2 B:

What different or additional environmental effects are anticipated in connection with operations offshore in:

a) Atlantic Coastal areas

b) Gulf of Alaska

c) Bristol Bay

d) Arctic Ocean

Answer:

a) The subsurface geology of this area is such that hazards encountered while drilling should be less than either the Gulf of Mexico or the Santa Barbara Channel. The George's Bank area, offshore New England is a renowned commercial fishing area. Drilling platforms erected in this area could present a conflict with the fishing industry. The densely populated littoral zone along the Atlantic Ocean indicates the people of the area to be extremely coastal minded.

b) Probably the most serious problems in operational activities and equipment design in the Gulf of Alaska will be caused directly or indirectly by weather and sea conditions. Average annual wave heights up to a reported 60 feet have been estimated as almost three times as severe as those in the Gulf of Mexico. Storm activity and high surface winds on rare occasions reach 70-100 mph. Low air and water temperature will necessitate special protective design features on fixed structures.

c) Like the Gulf of Alaska, Bristol Bay and the Bering Sea present a hostile environment because of weather and sea conditions. In addition the north part of the Bering Sea is subject to vast ice floes and heavy ice ridges. Storms occurring in the Bering Sea cause high tides along the coastal areas. Bristol Bay is a major domestic fishing area for salmon and oil operation could result in a conflict with this industry.

d) The Arctic Ocean is composed of the Chukchi Sea and the Beaufort Sea. The western boundary of the United States OCS is the international boundary between the U.S. and the U.S.S.R. Again weather and sea conditions present a hostile environment for operations. The area is subject to a winter ice pack and a polar ice cap. Only during the months of July and August is the Beaufort Sea free of ice while the Chukchi Sea is free of ice during the summer months. Studies are now being conducted by the Coast Guard as to the effects of crude oil on a specific type of plankton which forms the basis of the food chain for all marine fauna in this area.

Question J. 3:

What, in summary, are:

a) Treaty

b) Federal statutory

c) Regulatory and lease-contract

provisions governing liability of OCS leases for damages and cleanup costs arising from oil and gas operations conducted pursuant to OCS leases?

Answer:

Although the OCS Act contains no specific provision applicable to a lessee's liability for damages and cleanup costs arising from oil and gas operations under an OCS lease, by regulation (30 CFR 250.43 (b)) a lessee is absolutely responsible for the control and removal of a pollutant arising from drilling or production operations which damages or threatens to damage aquatic life, wildlife, or public or private property. 30 CFR 250.43 (c) provides that the lessee's liability to third parties, other than for cleanup, "shall be governed by applicable law."

Question J. 4:

What follow-up action was taken by Interior, the Environmental Protection Agency, the Coast Guard and other Federal agencies after each OCS mishap and what interagency agreements and plans, related to coordinated Federal handling of any future OCS mishaps, have been made as a result of these experiences?

Answer:

The Department of the Interior, after consulting with other agencies revise its OCS leasing and operating regulations, 30 CFR Part 250 and 43 CFR Pa 3300, as well as the Pacific Region OCS Orders, after the Santa Barbara Channel spill to provide more stringent controls on operations and better safeguarding of the environment. Following the Chevron Main Pass 41 fire, Gulf Coast OCS Orders Nos. 8 and 9 were revised and strengthened. In addition more personnel were added in order to inspect operations more frequently, and six full time helicopters were contracted to provide more effective transportation for these personnel as well as for increased pollution surveillance. Each OCS mishap is investigated in order to determin the cause, if possible, and to determine if further improvement is needed i the area of safety and anti-pollution. The Environmental Protection Agenc has conducted various studies on the possible environmental impact of some of the major mishaps. The Coast Guard holds formal investigations on OCS mishaps where its area of responsibility is involved.

Interior, Coast Guard, and EPA are three of the primary agencies involved in the National Oil and Hazardous Substances Pollution Contingency Plan issued in 1970. It was revised in 1971 as a result of the experiences gained from various major spills, including those on the OCS. Some of the regional contingency plans in effect cover the OCS areas, with the Coast Guard responsible for on-scene coordination in the event of a major spill. Further, the Department of Transportation and the Department of the Interior have entered into a memorandum of understanding specifically defining their respective responsibilities and authority in oil spill response measures involving OCS operations.

Question J. 5:

What quantitative information is available about the total costs of past mishaps on the OCS, including oil and gas lost, private and government cleanup costs, loss of fish and wildlife, damage of tourism, reduced property values, and administrative costs?

Answer:

Mead and Sorenson in their paper titled "The Economic Cost of the Santa Barbara Oil Spill: have the most definitive information on the total costs of that OCS mishap. They estimated the various costs and losses for that spill as follows:

Oil and gas lost	$ 130,000
Private (Union, et al) cleanup and control costs	10,487,000
Loss of fish and wildlife	32,400
Damage to commercial fishing industry	804,250
Damage to tourism	Negligible
Property value loss	1,197,000
Administrative costs	639,000
Recreational value lost	3,150,000
TOTAL --	$ 16,439,850

The Main Pass 41 fire was estimated to have cost Chevron about $10 million for drilling relief wells, estinguishing the fire, and containment and cleanup equipment. An estimated additional $5 million was necessary for restoration of damaged facilities, loss of oil and gas, and returning the wells to production. There were no private or governmental cleanup costs, no indicated loss of fish or wildlife, damage to tourism, or reduced property values. Several suits by oystermen, shrimpers and fishermen alleging possible damage have been dismissed or otherwise unsuccessful to date. As a result of a Grand Jury investigation, Chevron was fined $1 million for failure to comply with the storm choke requirements. Estimates were not made of administrative costs for the governmental agencies involved.

Shell's losses in the Bay Marchand fire have been estimated in excess of $30 million including loss of oil and gas production, drilling relief wells, containment and cleanup costs, and restoration of damaged facilities. There were no private or governmental cleanup costs, no indicated loss of fish or wildlife, damage to tourism or reduced property values.

The recent Amoco fire off the Louisiana coast was estimated to cost in excess of $15 million under conditions similar to the Shell fire.

Question J. 6:

What contingency plans and cooperative arrangements have been effected by industry regarding accidents in offshore oil and gas operations? How would these affect response time, total cost, and environmental impact? Are further measures desirable or required?

Answer:

More than 70 contingency organizations or cooperative arrangements presently exist in the United States principally for the purpose of combating waterborne oil pollution. Two of these, Clean Seas, Inc., in the Santa Barbara Channel and the Offshore Operators Committee in the Gulf of Mexico deal primarily with contingencies involving OCS oil and gas operations. In addition, negotiations are now being finalized between the offshore operators in the Gulf of Mexico and a private service organization to provide an even more efficient response to oil spills in that area.

The response time to oil spills will be much faster, the total costs lowered and the environmental impact reduced by these arrangements. The only further measures desirable or required are continued improvement in containment, collection and cleanup devices and more reliable response procedures as indicated by additional experience in this area.

Question J. 7:

What additional geological, biological, engineering or other information is necessary with regard to improving the environmental safety aspects of offshore oil and gas operations? Is there research that ought to be completed before any further offshore leasing? Are there specific instances or areas in which leasing should be postponed pending completion of further studies? What time, effort and costs would be involved in this research?

Answer:

The Geological Survey is currently contracting for shallow high-resolution seismic data which will be used to delineate near surface structural configuration in the Gulf of Mexico. This will assist in the determination of any subsurface hazards which should be considered in the design of casing programs and the setting of production platforms. As areas are identified where additional engineering studies would be beneficial in advancing the safety aspects of oil and gas operations they are being undertaken. The Survey is entering into a contract for hazards analysis which will be used to establish criteria for industry requirements. Future planning in this area will also be guided by the recommendations from the quality control and hazards analysis study conducted for the Geological Survey by the National Aeronautics and Space Administration; operational safety study being undertaken by the Marine Board of the National Academy of Engineering; and the year-long internal systems study of the lease management program.

We do not believe that any further offshore leasin g should be deferred pending additional research, nor are there specific instances or areas in which leasing should be postponed pending completion of further studies. An informal canvassing of the oil industry last year showed its confidence in present technology to conduct drilling and producing operations safely in all areas considered for leasing.

Additional research is needed on both the short-term and long-term effects of oil pollution on the marine environment in estuaries and in deep water. Such research should include the effects of chronic low level oil pollution as well as large accidental spills. Research is also needed on technique of pipeline construction and location so that adverse effects on march land can be minimized.

We believe that it is important to initiate base-line studies in OCS areas where oil and gas production has not been initiated. Such studies would include the existing level of hydrocarbon content in the water, sediments and in the tissue of marine organisms. The effects of future developments could be more accurately analyzed if such base-line data were available.

Although the above studies are necessary, existing evidence does not indicate that development in any areas should be delayed until such studies are completed. Planning studies prior to decisions to lease will attempt to identify such areas.

As with any other pollutant, the total volumes are of utmost concern. Oil spillage from OCS operations, while significant, does not approach the contribution from tankers. It is difficult, therefore, to evaluate the separate effects of OCS spillage.

Stringent enforcement of tanker discharge regulations and OCS operations is the critical factor with regard to improvement of environmental safety aspects. In conjunction with this enforcement, port waste discharge facilities for tankers should be expanded and the ultimate recycling or disposal of waste tanker oil should be resolved.

Question J. 8:

What is the state of scientific knowledge on the effect of oil spills on fish and wildlife and the marine environment? What is the level of Federal fundi for research and development in this area? Are there research opportunitie which are not being pursued for lack of funding?

Answer:

Additional research is needed on both the short-term and long-term effects of oil spills on the marine environment for both estuary and deep water areas. Research on long-term effects is particularly sparse. As noted in J. 7, above, baseline studies of existing hydro-carbon levels are recommended in areas where no leasing has been undertaken.

The most complete and up-to-date summary of scientific knowledge of oil spill effects on fish and wildlife and the marine environment is that presente in the TAPS environmental impact statement. The general conclusion is tha oil can cause damage to marine ecological systems. The degree and extent the damage would depend upon the volume of oil spilled or discharged and its persistence and dispersion in the environment.

After considerable debate and controversy the emerging philosophy concerning oil pollution appears to be keyed along much broader research aspects than before. The occasional spectacular spill followed by a crash research program concerned with live/dead ratios and other immediately visible effects of oil pollution, is being overtaken by more deliberate research concerned with chronic pollution levels, the persistence and ultimate fate of the oil, and its effect on biota, including the food chain culminating in man.

Present funding in this area is limited and most of it is budgeted to the Environmental Protection Agency. The petroleum industry also is contributing.

We consider that the research opportunities are underfunded. There is need for a research program to: 1) gather base line biological data for all our coastal areas; and 2) to conduct detailed research on the effects of oil in both chronic (low-level) and acute(high-level) exposure on various elements of the biota. Current and past research in these areas is an insignificant part of what it should be in view of the need to expand production and transportation of petroleum products in the marine environment.

K. SANCTUARIES

Question K. 1.

How many times has the authority granted to the President in the Outer Continental Shelf Act to withdraw areas of the OCS from leasing been used to establish marine preserves?

a) Where are the areas, when were they withdrawn or designated, and what is their size?

b) What, if any, proposals for further withdrawals or designations are under active consideration?

c) What criteria govern decisions to establish a marine preserve?

Answer

The only marine preserve on the OCS is the Santa Barbara Channel Ecological Preserve which was established under Public Land Order 4578 on March 25, 1969. This order withdrew approximately 20,000 acres from all forms of disposition including mineral leasing and reserved this designated area for use for scientific, recreational and other similar uses as an ecological preserve. In addition, about 30,000 acres of contiguous OCS lands were designated as a buffer zone to the ecological preserve and will be withheld from mineral leasing.

The Department has currently under consideration a request by the University of Texas for the withdrawal of about 45,000 acres offshore Texas from all forms of disposition, including mineral leasing, to be used for educational and research purposes. Baseline studies are also being conducted on the Gulf of Alaska and the Atlantic. These studies are addressing the question of what criteria should be used in the identification of marine preserves. Once criteria have been established, the weighting of criteria may vary from area to area, depending upon the unique characteristics of the region in question. Our objective is not only to identify areas for leasing but also to select areas for alternate uses.

Question K. 2.

Should the Congress determine, on a case by case basis, the circumstances under which tracts of OCS lands should be established as marine preserves or sanctuaries?

Answer

The Department has no objection to a Congressional delineation of the circumstances under which tracts of OCS and other lands might be established as marine sanctuaries. Section 12(a) of the Outer Continental Shelf Lands Act provides such direction, in that the Secretary is authorized to withdraw from mineral leasing particular areas of the Outer Continental Shelf, or, in the exercise of his discretion, to withhold certain tracts within an area otherwise available for leasing. We endorse the case-by-case approach, and believe it important, as Assistant Secretary Dole has informed the Committee relative to S. 1446, "that the Secretary retain his discretionary authority to designate certain areas of the Outer Continental Shelf which, in his judgment, after consideration of all relevant factors, should be withdrawn or withheld from mineral leasing".

Question K. 3.

Are there instances in which highly promising OCS acreage should be permanently reserved from development for recreational, ecological, or aesthetic reasons? What cost-benefit standards should be applied to proposals for reservations of this type? What other standards or considerations should be applied to proposals for reservations of this type?

Answer

We believe that there are instances where highly promising OCS acreage should be permanently reserved from development for recreational, ecological, or aesthetic reasons. In our OCS planning studies which are conducted prior to a decision to initiate leasing in an area, we are attempting to identify areas which should be preserved from mineral development. We have not developed cost-benefit criteria to be applied to marine preserves. The recreational, aesthetic, ecological and other scientific benefits that could be derived from carefully selected marine preserves may not be translated readily into cost-benefit terms. Instead, the rare or unique qualities of such areas must be evaluated in terms of the total supply of such areas which are available for study or enjoyment. Areas with unique or rare qualities should be preserved unless similar areas are already under adequate protection. In many cases, the results of development on fragile ecosystems would be irreversible.

In many instances, these may not pose conflicts with promising OCS acreage. In other cases, conflicts that may arise would be resolved on some basis of national priority, in which case cost-benefit standards, as currently used, may not be applicable. Perhaps standards presently used in the Antiquities Act may be applied for special biological, recreational and aesthetic standards or need to be developed based on extensive surveys of all resources involved.

Question K. 4.

What role do coastal States play with respect to Federal determinations concerning the establishment of marine sanctuaries on OCS lands seaward of the State's jurisdiction?

Answer

In establishing marine sanctuaries on OCS lands, the States with jurisdiction adjacent to the OCS must be fully involved in the environmental and other studies necessary for evaluating the merits of the marine sanctuaries. The Department will work closely with the States in identifying and analyzing marine sanctuaries.

Question K. 5.

If a short term (two-year) or long term (five- to ten-year) moratorium were established and all OCS operations were suspended:

a) From what probable alternative sources would petroleum demand be filled?

b) To what extent, if any, would these alternatives reduce the risk of coastline oil pollution?

c) What new environmental risks would be associated with alternative sources of supply?

Answer

The Department is in the process of analyzing the alternative energy sources applicable to the proposed OCS oil and gas lease sale offshore Eastern Louisiana. This analysis will be available when the environmental impact statement for this sale is published early in April.

L. STRATEGIC RESERVE

Question L.1.

What consideration has been or should be given to development of OCS tracts and holding production in ready reserve in the event of disruptions in foreign or other sources of supply?

Answer:

The concept for development of OCS tracts as shut-in or ready reserves in case of foreign supply disruption was first propounded within the Oil Import Administration of the Department of the Interior about two years ago. A similar concept was later evolved from outside, which would entail the shutting in of presently developed fields with excess spare capacity.

Such concepts are simple in theory but face economic, policy, and engineering difficulties in practice. To shut in presently-producing fields, with the exception of Naval Petroleum Reserve No. 1, which is produced only at nominal levels, would merely exacerbate present crude oil supply problems. Domestic production is now very close to full capacity; to shut any of it down would necessitate increased imports in like amount, thereby negating any ready reserve aspect. Such an action would entail severe equity-payment problems in nearly all the fields, for multiple lease-ownership is the general rule. Finally, most producing companies have geared both present and future investment decisions to volumetric production of their properties.

In the case of OCS properties, and because of the nature of lease blocking, most individual fields have one or few producing companies and a single lessor, the Federal government. Exploration for new fields, however, entails capital investments based upon assured rates of return; the economic parameters of the decision-making process must be defined and definable. To offset exploration and development costs as well as the costs of a transportation network to achieve full ready reserve status will entail capital needs that could not be offset merely by the exchange of barrels of oil not produced with equal increments of imported oil. In addition, of course, the total supply posture becomes steadily more heavily weighted toward imported oil while the incentive for additional exploration for additional deposits is minimized.

APPENDIX 1

POTENTIAL MINERAL RESOURCES OF THE UNITED STATES OUTER CONTINENTAL SHELF

By V. E. McKelvey, F. H. Wang, S. P. Schweinfurth and W. C. Overstreet, of the U. S. Geological Survey, Department of the Interior, Washington, D. C., March 11, 1968.

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I. Sand and gravel

I. Abstract

At this early stage in exploration of the outer continental shelves of the United States (considered here to extend from state limits to a depth of 2500 meters, taken as approximating the geologic boundary of the continental margin), appraisal of the character, distribution, and magnitude of their potential mineral resources must be based largely on knowledge of the extent and character of minerals in analogous geologic settings on land, rather than on direct knowledge of their occurrence under the sea. With a few exceptions, estimates of the magnitude and character of mineral resources can only be qualitative or semiquantitative at best, but even so they may serve to identify near term targets for exploration and development. To give economic perspective to the resources identified, estimates of them are classified in terms that reflect the degree of certainty of knowledge of their existence and character--i.e. known (including measured, indicated, and inferred) and undiscovered--and the feasibility of their recovery compared to present economic and technologic conditions--i.e. recoverable, marginal, and submarginal. Reserves are considered to include only known presently recoverable materials; resources include other known and undiscovered materials of prospective value. As a further framework of evaluating shelf resources, the potential mineral resources of the outer continental shelves are considered to lie in four domains: 1) sea water--excluded from further consideration because, as a circulating fluid, the amount overlying the outer shelves does not define the potential; 2) surficial deposits that can be mined by dredging; 3) fluids or soluble minerals in underlying rocks that can be extracted through drill holes; and 4) bedrock deposits that must be mined by underground methods.

Oil, gas, and natural gas liquids have by far both the greatest current production and future potential of all shelf minerals. Proved reserves are 2.9 billion barrels of oil and natural gas liquids, and 30.3 trillion cubic feet of gas. There is no satisfactory basis for estimating undiscovered recoverable resources, but previous estimates as well as those made here suggest a range from 35 to 220 billon barrels of liquids and 170 to 1100 trillion cubic feet of natural gas, with some still much larger amount in the marginal and submarginal category. Oil sha e off the California and Alaska coasts conceivably might some day yield oil by in situs extraction methods but must be considered submarginal now. If efficient methods for gassifying coal in place are

developed, gas might be some day recoverable from coal off the coasts of Alaska, Washington, and Oregon; for the present, however, these resources are also submarginal.

Known sulfur reserves in salt dome deposits are believed to be about 37 million tons; undiscovered deposits doubtless occur in the Gulf shelves, but because the origin of the sulfur may be related to near surface and near land processes, the salt domes known to be present far from shore may not be sulfur-bearing. Undiscovered minable resources are, therefore, conservatively estimated as of the order of 40-50 million tons. Recoverable amounts of sulfur are also present in California crude oil, and undiscovered recoverable resources in this form are also considered to be of the order of 40 million tons. Sulfur in other possible sources, such as gypsum and sulfides, almost surely is present in large amounts but has no prospective value.

Salt in Gulf Coast salt domes is probably present in huge amounts recoverable at low cost, but because of the large amounts available on land it has no prospective value except in local offshore use for processing sulfur. Potash salts, also recoverable from drill holes, are probably present in the Permo-Jurassic salt basin beneath the Gulf shelf, but there is no basis now for estimating their potential. Geothermal energy, also recoverable by drill hole methods, is another potential resource that cannot be evaluated now.

Among the surficial sediments, phosphorite deposits off the coast of California have some promise for early development and 100 million tons or so are classed as known marginal resources and far larger amounts are submarginal. Equally large resources are present on the Atlantic shelf but because of the proximity of large minable deposits on land they must be classed as submarginal. Manganese oxide nodules and pavements on the Blake Plateau probably amount to more than a billion tons, but because they cannot be treated economically now they must be classed as submarginal for the present. Deposits of glauconite, carbonaceous mud, and diatomaceous ooze are extensive on the shelves but have no prospective value. Barite and metal rich sediments of the type recently found in the Red Sea may be present on U. S. shelves, but there is no evidence of them and no basis now for estimating their magnitude.

Oyster shell, coral, lime mud, sand, and gravel are now mined in many places from near shore waters, and although deposits on the outer shelves probably must be classed as marginal for the time being, they have considerable prospective value for use in the vicinity of coastal cities in areas where suitable land sources are sparse.

No offshore resources of placer minerals are known that are minable now, but undiscovered minable resources of the order of millions of ounces of gold, perhaps hundreds of thousands of ounces of platinum, and thousands of tons of tin may exist off the coast of Alaska, and minable deposits of gold and platinum may also occur off the coast of southern Oregon and northern California. Millions of tons of chromite and other heavy minerals probably lie off southern Oregon and northern California, but are submarginal now because both the Cr_2O_3 content and Cr:Fe ratio are too low to yield an acceptable product. Large magnetite and ilmenite placers probably occur off southeastern Alaska, but also are submarginal now. Large deposits of ilmenite and a diverse assemblage of other minerals almost certainly occur on the Atlantic and Gulf shelves in deposits similar to those being mined now on the Atlantic coastal plain, but because land reserves are probably cheaper to mine the Atlantic placers are considered marginal for the present.

A considerable variety of mineral deposits doubtless occur in the subsurface of the shelves in sedimentary and crystalline rocks. As a group, those deposits of sedimentary origin--coal, phosphorite, oil shale, gypsum, and others--probably have no prospective value on the U. S. shelves. Large metalliferous deposits in the basement rocks or deposited in the shelf sediments as replacements or other kinds of deposits related to hydrothermal activity probably also occur beneath the shelf subsurface and could be mined by underground methods with existing technology. Except for magnetic ore bodies, which can be identified by magnetic surveys even though deeply buried, exploration and evaluation technology is not well enough developed to discover and efficiently appraise such deposits now, but as a group sub-shelf metalliferous ore bodies of multimillion dollar size deserve attention as targets for exploration and development.

Compared to the 130 or so commodities that comprise the spectrum of minerals currently used in the United States, the list of minerals that have immediate or even near term prospective value on the shelves is short indeed. Even if usable shelf resources were to consist only of the petroleum fluids, however, their potential contribution to the Nation's future security and prosperity would be enormous and would

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more than justify efforts to bring about their efficient development.

The full potential of the shelves, however, must be recognized to be far greater than can be foreseen at this stage of their investigation from an analysis, such as that reported here, of occurrences of specific minerals, for our understanding, of shelf geology now is simply too scant to reveal its full possibilities. Considering that the rocks beneath the shelves are perhaps roughly comparable in their mineral content to those beneath the lands, their full potential is perhaps better understood from a comparison with what has already been found on the land. The total value of mineral production from the United States from 1880 to 1967 is roughly $800-900 billion in 1968 constant dollars--an average of $220,000-$250,000 per square mile. Mineral production is still growing in the United States, and it is not possible to begin to predict what will be the value of the minerals that this piece of real estate will eventually yield. But assuredly it will be far greater than that already obtained.

The potential mineral wealth of continental lands, then, is enormous, and the shelves are sufficiently large and similar enough in their geology to say that they too have an enormous potential mineral wealth, even though it is not possible now to say where and how much it is or to visualize how to find and extract it. This is not to say that a square mile of shelf land has a present value of $X million dollars--on the contrary all but a fraction of shelf lands have no present mineral value whatsoever, for with the present state of knowledge and technology they cannot be mined economically. But it is to say that the shelves do contain large quantities of minerals that will make a valuable contribution to the U.S. economy--provided the investment is made in acquiring the knowledge necessary to find and extract them efficiently.

II. Introduction

At the request of the Public Land Law Review Commission, the Geological Survey summarizes here its current appraisal of the character, distribution, and magnitude of the potential mineral resources of the outer continental shelves bordering the United States. Except for the parts of the shelves off the coasts of Louisiana, Texas, and California, where exploration for oil and gas has been in progress for several decades, the search for minerals on the continental shelves has begun only recently. Similarly, geologic investigation of the shelves is also in an early stage. Knowledge on which to base an appraisal of the resource potential of the shelves is therefore scant, and the appraisals here are based in large part on knowledge of the extent and character of minerals in similar geologic settings on land. But even though most of the estimates are only qualitative or semi-quantitative, they may be useful in defining broad targets for future exploration and technologic development.

III. Definition of the limits of the outer continental shelves

The area of the continental shelves of concern here is that under the jurisdiction of the Federal government. The shoreward boundary has been fixed by legislation and Supreme Court decisions as 3 nautical miles (3.5 statute miles) from shore, except along Texas and the Gulf side of Florida where it corresponds to the 3 league (10.5 miles) limit that constitutes the historical boundaries of those states. Considering sovereign rights for exploiting mineral resources, the 1958 Geneva "Convention on the Continental Shelf" defined the continental shelf to refer "(a) to the seabed and submarine areas adjacent to the coast but outside the area of the territorial sea to a depth of 200 meters, or, beyond that limit, to where the depth of the superjacent waters admits of the exploitation of the natural resources of said areas: (b) to the seabed and subsoil of similar submarine areas adjacent to the coasts of islands." Inasmuch as experimental drilling has already been successfully undertaken at a depth of 11,700 feet, it is assumed here that the limits of the continental shelves are likely to be taken as extending to their bathymetric and geologic boundaries, or to some arbitrarily established depth or distance from shore that approximates them. For practical purposes in the waters bordering the United States, the continental shelves as they would be defined bathymetrically lie largely within the 2500 meter contour and conversely not much of the ocean floor and continental rise extend coastward beyond this same contour.

For the purpose of this report, then, subsea resources are discussed in terms of two areas: 1) that between the 3.5 statute mile limit (10.5 along Texas and Florida) and the 200 meter contour; and 2) that between the 200 and 2500 meter contours. The size of these areas are shown in Table 1.

Table 1 - Area (thousands of square statute miles)

	Between 3.5 miles (10.5 for Texas and Fla.) limit and 200 meter contour	Between 200 and 2500 meter contour
Hawaii	0.4 (1)	3.6
Alaska	560	212.2
Washington, Oregon, and California Coast	15.4	76.2
Gulf Coast	107.5	84.2
Atlantic Coast	122	102.5
Total	805.3	478.7

(1) Includes State land

The land area of the United States and its territories is 3,615,000 square statute miles. The outer continental shelf to the 200 meter contour is thus 22 percent as large, and that to the 2500 meter contour is 35 percent as large. The shelves thus represent a substantial addition to the United States resource potential.

IV. Concepts and limitations of reserve and resource estimates

The paucity of data on the geology of the continental shelves severely limits the accuracy of appraisal of their reserves and resources, but the limitation is only one of degree, for even in well explored countries and areas there are two inescapable uncertainties that prevent the attainment of a high degree of accuracy in reserve and resource estimates (McKelvey, 1968). One is that most mineral deposits lie hidden beneath the earth's surface and are difficult to examine in a way that yields accurate knowledge of their extent and qualit and that permits accurate appraisal of the cost of their recovery. The other is that the kinds and qualities of usable minerals are constantly changing as economic conditions change and as the advance of technology permits recovery of materials that were once too low in grade or too inaccessible to mine, and to utilize materials that once were not usable for anything. The quantity of usable resources is therefore not fixed but changes with changes in technologic and economic conditions. These intrinsic uncertainties make for a low order of precision and accuracy in resource estimates, for there are neither standard nor reliable methods for quantitatively appraising the unseeable and the unimaginable.

Because of the magnitude of usable resources changes with geologic knowledge of their extent, with technologic advance, and with changes in external conditions, it must be understood that resource estimates are dated and must be periodically revised. To be most useful in appraising problems of future supply, establishing targets for exploration and research, classifying Federal mineral lands for leasing, disposition or exchange on a fair market or equal value basis, and for other types of public and private planning, resource estimates should differentiate between deposits that are known and well explored and those that either have not been sufficiently explored or have not as yet been discovered but are believed to exist on the basis of geologic evidence. And they should include but distinguish between deposits that are minable or recoverable at present costs and those that cannot be mined now but might be recovered under more favorable economic or technologic conditions.

The system of resource classification and nomenclature shown in Table 2 illustrates these objectives and also serves as a framework for the various estimates discussed in this report. In this system, estimates of reserves and resources are defined in terms that indicate, on the one hand, the degree of certainty about the existence of the materials and, on the other hand, the economic and technical feasibility of recovering them. In keeping with generally established usage in both the mining and the petroleum industries, the term <u>reserves</u> refers to economically recoverable material in known deposits. The term <u>resources</u>, on the other hand, refers in addition to materials that may be recoverable in the future, including those in deposits that are as yet undiscovered, as well as those that are known but cannot be recovered now. These concepts are integrated into the classification shown in Table 2, in which the certainty of the estimate diminishes from left to right and the feasibility of recovery diminishes from top to bottom. Of the terms already used to indicate the degree of certainty with which the amount is known--such as <u>proved</u>, <u>probable</u>, or <u>possible</u>, and other parallel but not

Table 2 -- <u>Classification of mineral resource estimates</u>
(modified slightly from McKelvey, 1968)

	In known deposits or districts			In undiscovered districts	Total
Recoverable under current economic and technologic conditions	Known recoverable reserves			Undiscovered recoverable resources	Potential reserves and resources
	Measured reserves*	Indicated reserves*	Inferred reserves*		
Recoverable at prices as much as 1.5 times those prevailing now or with comparable advance in technology	Known marginal resources			Undiscovered marginal resources	Potential marginal resources
Recoverable at prices greater than 1.5 times those prevailing now or with comparable advance in technology	Known submarginal resources			Undiscovered submarginal resources	Potential submarginal resources
Total	Known resources			Undiscovered resources	Potential resources

*The terms <u>measured</u>, <u>indicated</u>, and <u>inferred</u> may also be applied to known marginal and submarginal resources where knowledge of them is sufficiently detailed to warrant differentiation in the degree of certainty of the estimates.

necessarily equivalent qualifiers (Blondel and Lasky, 1956; Lovejoy and Homan, 1965, p. 57)--measured, indicated, inferred and undiscovered are used in this report, except for estimates (mainly for oil and gas) reported by other groups. Definitions of the first three of these terms are those agreed upon by the Geological Survey and the Bureau of Mines in 1943 (see U.S. Geol. Survey, 1958, p. 59), as follows:

Measured reserves or resources are those "for which tonnage is computed from dimensions revealed in outcrops, trenches, workings, and drill-holes, and for which the grade is computed from the results of detailed sampling. The sites for inspection, sampling, and measurement are so closely spaced and the geologic character so well defined that the size, shape, and mineral content are well established. The computed tonnage and grade are judged to be accurate within limits which are stated and no such limit is judged to differ from the computed tonnage or grade by more than 20 percent." Although estimates of the measured or proved category involve no speculative projection, their accuracy depends somewhat on the geologic character of the deposit and on the stage of development. According to Ferry (1965), for example, estimates of proved reserves of petroleum made in the early stages of production may have a margin of error of as much as 25 percent, but as production advances the margin of error usually decreases to a few percent.

Indicated reserves or resources are those "for which standard units of measure are computed partly from specific measurement, samples, or production data, and partly from projection for a reasonable distance based on geologic evidence. The sites available for inspection, measurement, and sampling are too widely or otherwise unappropriately spaced to outline the ore completely or to establish its grade throughout." Because they involve the element of geologic projection, the margin of error in such estimates is likely to vary widely, depending on the nature of the deposit and the extent of the background of knowledge and experience with its habits. For example, in reporting its estimates of indicated reserves of uranium-vanadium deposits on the Colorado Plateau, the Geological Survey stated that "Because of the variations in thickness and grade of the ore and the scarcity of sample data, the indicated reserves in any single reserve block might actually amount to as much as twice or as little as one-half of the calculated tonnage. The limit of error of the total tonnage for several blocks, however, is apt to be considerably lower, perhaps not more than 25 percent of the calculated tonnage." (Bush and

Stager, 1956, p. 137.) Revised estimates based on detailed exploration and mining of about 30 deposits showed that the realization ratio (i.e. the ratio of the true tonnage to the estimate) averaged about 1.15; all of the deposits studied actually contained more than one-half the orginally estimated tonnage and a little more than 25 percent of them contained more than twice the amount originally estimated. This tendency for geologists and engineers to be conservative in estimates that involve geologic projection is well known.

Inferred reserves or resources are those "for which quantitative estimates are based on broad knowledge of the geologic character of the deposit and for which there are few, if any, samples or measurements. The estimates are based on an assumed continuity or repetition for which there is geologic evidence; this evidence may include comparison with deposits of similar type. Bodies that are completely concealed may be included if there is specific geologic evidence of their presence. Estimates of inferred ore should include a statement of the spacial limits within which the inferred ore may lie." Needless to say, the accuracy of individual estimates varies widely, but on the whole they are likely to err on the low side because of the tendency already mentioned for conservative appraisal of the extent of deposits for which few measurements are available. If the geologist has enough information to make a quantitative estimate at all, the chances are that subsequent exploration will show a much larger amount, perhaps by a factor of several times.

Reserves and resources in all of these categories refer to known deposits or to deposits inferred to be present in known host rocks and structures that contain them elsewhere in a specific district or field. Within an unknown or only partly explored region or country, additional, as yet undiscovered deposits, some of which are of minable quality, are likely to be present also. Not all of these undiscovered deposits will be found even on intensive exploration, but semiquantitative estimates or even qualitative appraisals of their magnitude constitute a target that may direct exploration and indicate whether or not it is worthwhile. Unfortunately satisfactory methods for making such estimates are as yet not well developed.

Known and undiscovered deposits may include materials that are not recoverable under present economic conditions, and many of them, in fact, have been closely enough appraised to be classed as measured, as many disappointed investors will attest. The degree-of-certainty terms are therefore used in conjunction with the feasibility-of-recovery categories shown in Table 2: reserves being those recoverable under locally prevailing economic and technologic conditions; marginal resources, those recoverable at prices as much as 1.5 times those prevailing now or with comparable advance in technology; and submarginal resources, those recoverable at prices greater than 1.5 those prevailing now. Potential resources, then, are the sum of known and undiscovered reserves and marginal and submarginal resources.

The choice of the factor of 1.5 as that separating marginal from submarginal reserves and resources is arbitrary, of course, and it may seem unrealistic to define as "marginal" those materials recoverable at as much as a 50 percent increase in price. But at a given time over the world, mineral prices not uncommonly vary within such a range--the price of oil in the United States, for example, is now about 1.5 times that on the world market and the price of coal in Europe is about 1.5 times that in the United States--over the short term there is often a similar variation within a given area. Individual increments in technologic advance that change marginal resources into recoverable reserves generally take place within this range also. Decreases in prices, of course, can also change minable reserves into marginal resources, as has happened many times in the metals industries when mines have had to close because of a drop in price. New discoveries or technologic advances that make available large and low cost sources may have a similar effect on individual deposits. The main historical pattern, however, has been to add reserves from the undiscovered, marginal, and submarginal categories as a result of progress in exploration and technology.

The importance of attempting to appraise submarginal resources, not with the expectation that prices will rise to levels that will make them competitive but that technology will advance to lower the costs of producing them, is well shown by past achievements. Judged on the scale of quality or accessibility, the history of the minerals industry records countless examples of technologic advances that have made available materials that once would have cost many times more than they do now. The cut-off grade for copper ore in its first uses was nearly 100 percent; by the end of the 19th century it was about 4 percent and it is now only 0.4 percent in the large porphyry deposits. Examining another dimension, the depth limit of drilling has been extended from a few hundred feet in the early stages of oil exploration to more than 25,000 feet now, making available oil and gas that probably would not have been obtainable at any price in 1900. Similarly, development of techniques for the subsea exploration and production of oil and gas opened up an entire geographic domain that was not accessible at all before, much less at costs within a factor of 1.5 those prevailing several decades ago. In view of past accomplishments it would not be unreasonable to count among potential resources many materials that might be judged to cost 10 times as much, or even more, to mine than would be economic with available technology.

To what cost limits, then, should account be taken of submarginal resources? Sea water and country rock represent potential future resources for all the elements. Sea water, in fact, is an already economic source for some, and certain igneous rocks are prospective sources for a few others, notably uranium and thorium. But for most minerals, other sources less costly to process are so large that estimates of the amounts present in the earth or its component rock masses serve no economic purpose, even though they may have geochemical meaning and validity. To apply a standard cost limit to submarginal resources, however, is impractical, partly because the cost of recovering them is rarely known and partly because it is not only cost but also prospective need and market opportunities that influence the effort that is likely to advance technology to the point when a presently submarginal deposit will prove workable. The limits to resources included in the submarginal class can therefore only be subjectively determined, guided by current concepts of what kinds of materials have prospective value.

Some indication of the economic value of reserves and resources in these various categories and of the effort that is required to change resources to reserves may be seen from the way they are treated in the market place. Submarginal resources generally have no present economic value other than that of the land as it is appraised for other uses. Marginal resources are bought and sold on an acreage rather than a unit basis and at a price that may be a few times that of the land for low quality uses but may be well below that of land usable for agriculture. Inferred and indicated reserves are also generally sold on an acreage rather than a unit basis and the value may range from 10 to 100 times or more than that of the land for unselected uses increasing with increasing certainty of the presence of recoverable ore. The transaction covering the sale of proved or measured reserves may be stated in terms of a specific property; but the price reflects the units present, and is likely to be many times that of indicated and inferred reserves. This large range in the value of resources and reserves reflects on the one hand the progressive reduction in the risk that an investment, discounted in proportion to the time expected for development, will yield a profitable return, and on the other hand the cost of the work required for process development and exploration.

Unlike the forecasts of ultimate production sometimes attempted for various minerals, particularly petroleum, there is no judgment or prediction in estimates of potential resources as to how much of a given material will ultimately be found and recovered profitably, nor can there be, for that will be a function not only of future technologic advances affecting the discovery and extraction of each mineral, but also the future availability of alternate sources and substitute materials, as well as political, social, and economic conditions. Nor are such estimates to be taken as a final resource inventory, for developing knowledge and changing requirements continually modify the concepts of the nature and extent of usable materials. Instead, estimates of potential resources merely represent a dated appraisal--certain to be revised--of how much is in the ground, qualified by an indication of the degree of certainty and the feasibility of recovering it compared to present prices and technology.

Applied to the estimates of the potential resources of the U.S. continental shelves, these concepts of reserves and resources are perhaps more an indication of the scientific and technologic research and exploration that will be required to fully appraise and develop subsea mineral resources than they are an explanation of the estimates presented. As will be seen, the shelves contain large potential resources of many minerals, most of which at present must be placed in the undiscovered submarginal category.

V. Mineral domains of the continental shelves and their exploitability

As a geologic and technologic framework for evaluating the potential resources of the outer continental shelves, it is convenient to differentiate the main components of the marine terrane into a) sea water, b) surficial sediments on and immediately beneath the sea floor, c) interstitial fluids and soluble minerals in underlying rocks that can be extracted through drill holes, and d) bedrock deposits that must be mined by underground methods.

As shown in Table 3, the sea is an enormous reservoir of dissolved salts. Several minerals--magnesium and magnesium salts, bromine, sodium chloride, and fresh water--are recovered from it now, and at times iodine and potash have been produced from seaweed. The value of their annual world production is now about $165 million (Cruickshank and others, 1968), and that of United States production alone is about $117 million. Although the sea is relatively uniform in its content of major elements, it is by no means homogeneous in its content of minor ones, and local stagnant waters, such as those in some of the Red Sea deeps, are rich enough in certain elements to deserve consideration as potential ore bodies (Mero, 1966). Conceivably some such waters may exist along the United States, but inasmuch as the outer shelves are mainly a part of the circulating open sea, the amount of sea water overlying them does not define the potential, and it is not meaningful to estimate the sea water potential in terms of shelf resources. Sea water is therefore not considered further here except to say that it does not appear to be feasible to recover elements with lower concentrations than boron under present economic and technologic conditions (McIlhenny and Ballard, 1963). Davies and others (1964), however, believe that it would be possible to recover uranium from sea water at a cost of $13 a pound; Mero (1966) thinks silver is now recoverable with ion exchange techniques; and it is not unlikely that processes will be developed to extract other elements, particularly as by-products of sea water conversion or power plants (Mero, 1965, p. 43-50).

Several minerals in surficial sediments on the ocean bottom can be recovered by dredging and are already being sought and exploited. World production includes tin, iron sands, diamonds and other heavy minerals, lime shells, lime mud, sand, and gravel with an annual value now of about $180 million (Cruickshank and others, 1968), of which U.S. production makes up about $50 million. Dredging is currently economically feasible in waters less than about 150 feet in depth, but systems for use in depths up to 600 feet are in near prospect and systems usable at depths of 12,000 feet or so are expected to be available in the 1980's (Cruickshank and others, 1968). Offshore dredging currently costs half-again as much or more as comparable operations onshore, and for low value materials it is therefore economic only in areas where similar or substitute materials are not available on land and where sea conditions are ideal. Moreover, most of the current dredging is

Table 3 -- Concentration and amounts of 60 of the elements in sea water (after Mero, 1965)

Element	Concentration (mg/l)[1]	Amount of element in sea water (tons/mile^3)	Total amount in the oceans (tons)
Chlorine	19.000.0	89.5 . 10^{6}	29.3 . 10^{15}
Sodium	10.500.0	49.5 . 10^{6}	16.3 . 10^{15}
Magnesium	1.350.0	6.4 . 10^{6}	2.1 . 10^{15}
Sulphur	885.0	4.2 . 10^{6}	1.4 . 10^{15}
Calcium	400.0	1.9 . 10^{6}	0.6 . 10^{15}
Potassium	380.0	1.8 . 10^{6}	0.6 . 10^{15}
Bromine	65.0	306,000	0.1 . 10^{15}
Carbon	28.0	132,000	0.04 . 10^{15}
Strontium	8.0	38,000	12,000 . 10^{9}
Boron	4.6	23,000	7,100 . 10^{9}
Silicon	3.0	14,000	4,700 . 10^{9}
Fluorine	1.3	6,100	2,000 . 10^{9}
Argon	0.6	2,800	930 . 10^{9}
Nitrogen	0.5	2,400	780 . 10^{9}
Lithium	0.17	800	260 . 10^{9}
Rubidium	0.12	570	190 . 10^{9}
Phosphorus	0.07	330	110 . 10^{9}
Iodine	0.06	280	93 . 10^{9}
Barium	0.03	140	47 . 10^{9}
Indium	0.02	94	31 . 10^{9}
Zinc	0.01	47	16 . 10^{9}
Iron	0.01	47	16 . 10^{9}
Aluminum	0.01	47	16 . 10^{9}
Molybdenum	0.01	47	16 . 10^{9}
Selenium	0.004	19	6 . 10^{9}
Tin	0.003	14	5 . 10^{9}
Copper	0.003	14	5 . 10^{9}
Arsenic	0.003	14	5 . 10^{9}
Uranium	0.003	14	5 . 10^{9}
Nickel	0.002	9	3 . 10^{9}
Vanadium	0.002	9	3 . 10^{9}

Table 3 -- (contined)

Element	Concentration (mg/l)[1]	Amount of element in sea water (tons/mile^3)	Total amount in the oceans (tons)
Manganese	0.002	9	$3 \cdot 10^9$
Titanium	0.001	5	$1.5 \cdot 10^9$
Antimony	0.0005	2	$0.8 \cdot 10^9$
Cobalt	0.0005	2	$0.8 \cdot 10^9$
Caesium	0.0005	2	$0.8 \cdot 10^9$
Cerium	0.0004	2	$0.6 \cdot 10^9$
Yurium	0.0003	1	$5 \cdot 10^8$
Silver	0.0003	1	$5 \cdot 10^8$
Lanthanum	0.0003	1	$5 \cdot 10^8$
Krypton	0.0003	1	$5 \cdot 10^8$
Neon	0.0001	0.5	$150 \cdot 10^6$
Cadmium	0.0001	0.5	$150 \cdot 10^6$
Tungsten	0.0001	0.5	$150 \cdot 10^6$
Xenon	0.0001	0.5	$150 \cdot 10^6$
Germanium	0.00007	0.3	$110 \cdot 10^6$
Chromium	0.00005	0.2	$78 \cdot 10^6$
Thorium	0.00005	0.2	$78 \cdot 10^6$
Scandium	0.00004	0.2	$62 \cdot 10^6$
Lead	0.00003	0.1	$46 \cdot 10^6$
Mercury	0.00003	0.1	$46 \cdot 10^6$
Gallium	0.00003	0.1	$46 \cdot 10^6$
Bismuth	0.00002	0.1	$31 \cdot 10^6$
Niobium	0.00001	0.05	$15 \cdot 10^6$
Thallium	0.00001	0.05	$15 \cdot 10^6$
Helium	0.000005	0.03	$8 \cdot 10^6$
Gold	0.000004	0.02	$6 \cdot 10^6$
Protactinium	$2 \cdot 10^{-9}$	$1 \cdot 10^{-5}$	3,000
Radium	$1 \cdot 10^{-10}$	$5 \cdot 10^{-7}$	150
Radon	$0.6 \cdot 10^{-15}$	$3 \cdot 10^{-12}$	$1 \cdot 10^3$

[1] After Goldberg (1963)

limited to shallow coastal waters, and where usable deposits are present near shore they will probably be mined in preference to those of the outer shelves.

Oil, gas, sulfur, potash, salt, brines, and geothermal energy are recoverable by drill-hole extraction methods. Current world production of petroleum fluids offshore has an annual value of about $3.8 billion, and that from U.S. waters alone about $1.16 billion. Offshore sulfur production in the United States has an estimated annual value of about $15 million. Although salt is plentiful in offshore salt domes, beds, and brines, its abundance in land sources and the ease with which it can be evaporated from sea water in many areas have made offshore operations uneconomic except for local use in the processing of sulfur. Potash and sulfur have considerable potential in offshore deposits and perhaps there is some potential also for geothermal energy offshore. Without doubt, however, oil and gas have the greatest potential value of all subsea resources.

Mineral deposits in consolidated rocks

Hard rock minerals, either in sedimentary rocks deposited in the present shelf environment or in older rocks of the continents that are now submerged or lie beneath shelf sediments, have been mined beneath the shelf in many countries from entries on land, islands, and artificial islands. World production from these sources has a current annual value of about $350 million. Coal mined in Nova Scotia, Taiwan, United Kingdom, Japan, and Turkey makes up the bulk of this production, but subsea iron ore is mined in Finland and in the past nickel-copper ore, tin, gold, and limestone have been mined from such installations, under a water cover of as much as 400 feet and at distances from shore of as much as 3 miles (Austin, 1966 and 1967).

Except for Austin's excellent presentation of the "rock-site concept" for manned undersea operations, the possibility of subsea mining of mineral deposits in sedimentary or igneous rocks has not received much notice in discussions of marine mining, but the technology necessary to enter the sea bed either by vertical shaft or tunneling is, as Austin emphasizes, already fully developed. Because tunneling costs on the order of $1 to $1.5 million a mile, sea bed entry at distances of more than a few miles from shore would be better accomplished by vertical shaft from an artifical island or by use of big-hole drilling and a lock system to seat the exposed part of the tube, after which the mine would be open to the atmosphere. Austin estimates that the cost of the shaft might be twice that of comparable installations on land, but no special costs or techniques are required otherwise. Land underground mining techniques can thus be fully transferred now to the sub-shelf environment in water depths of at least a few hundred feet. Any mineral that occurs in large, thick deposits beneath a cover of impervious rock and hence lends itself to low-cost underground mining, and that is worth more than $10-$15 a ton, is therefore recoverable from much of the sub-shelf under present economic and technologic conditions. Prospecting and ore-body delineation methods are not adequate to find and appraise many such deposits now, but in terms of the potential the shelves must be regarded as containing undiscovered deposits of many minerals large and rich enough to be recoverable now. It is worth noting also that it is only in such sub-ocean mining operations that the characteristics of the ocean site begin to change from liabilities to assets as compared to land mining. The "tide water" site, removed from scenes and environments which a land operation might despoil, with an unlimited source of water and unlimited grounds for disposal of rock waste, has some advantages not only for the mine but the processing plant as well.

Only oil, gas, natural gas liquids, salt, and sulfur are being produced now from the outer continental shelves of the United States and these are the only minerals for which measured reserves can be reported. Oyster shell, sand, and gravel are currently mined in some U.S. estuaries and coastal waters, and lime mud is being mined from near shore waters in the Bahamas. No similar deposits are being exploited from the outer continental shelves of the United States, however, and prospective deposits of these minerals on the outer shelves must be considered marginal now. Undiscovered recoverable resources can be projected for some placer minerals but phosphorite, manganese oxide, and most of the other mineral resources in surficial sediments are marginal or submarginal now. Although difficult to find and appraise, large metalliferous bed-rock deposits offer the best prospects, next to the minerals extractable by drillhold methods, for recovery under existing economic and technonologic conditions.

The mode of occurrence and potential resources of minerals in these various domains are summarized in the following sections.

VI. Minerals accessible to drill-hole extraction methods

A. Petroleum

1. Past production and proved reserves.--Oil, natural gas, and natural gas liquids are by far the most valuable resources now produced from the continental shelves, and they are the resources that have the greatest prospective value for the future as well. As shown in Table 4, cumulative production from U.S. shelves through 1966 totalled about 2.2 billion barrels of oil and natural gas liquids and about 7 trillion cubic feet of natural gas. All the offshore production from Alaska and California has come thus far from areas under state jurisdiction, but the bulk of the production from the Gulf--863 million barrels of petroleum liquids and 4.5 trillion cubic feet of natural gas--has come from the outer continental shelf. Remaining proved reserves at the end of 1966 for the total offshore area of the Gulf were about 2.9 billion barrels of liquids and 30.3 trillion cubic feet of natural gas; remaining proved reserves for the Gulf outer shelf alone were about 1.9 billion barrels of liquids and 22.2 trillion cubic feet of natural gas. Remaining proved reserves as of December 31, 1966, for all the continental shelves were about 4.3 billion barrels of liquids and 31.3 trillion cubic feet of natural gas.

2. Potential resources.--Although petroleum from the outer shelves has only been produced thus far from the Gulf of Mexico, each of the other shelves, except the Hawaiian shelf, has extensive areas that are broadly favorable for petroleum. Parts of the Arctic Ocean, Bering Sea, and Pacific Ocean shelves of Alaska, for example, are contiguous with known petroliferous areas; seismic surveys already have identified extensive areas broadly favorable for petroleum in each of them, and the rich discoveries already made on state lands in Cook Inlet support the speculation that offshore Alaska has a large petroleum potential. Onshore production and preliminary exploration on state and federal leases offshore Washington and Oregon are not so encouraging but large broadly favorable areas identified from seismic surveys remain to be tested. The Eel River, Santa Cruz, and Santa Maria basins in central and southern California all have onshore production and have offshore extensions that have a promising potential for petroleum. The continental borderland south of Point Conception in California, an area of more than 20,000 square miles, has many favorable structures--including extensions of the Los Angeles and Ventura basins,

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Table 4- Past production and proved reserves of petroleum on the United States continental shelves to December 31, 1966.

Area	Crude Oil (millions of barrels of 42 U.S. gallons) Cumulative Production Shelf	Crude Oil Cumulative Production OCS only	Crude Oil Proved Reserves OCS	Crude Oil Proved Reserves Shelf	Natural Gas (trillions of cubic feet) Cumulative Production Shelf	Natural Gas Cumulative Production OCS	Natural Gas Proved Reserves OCS	Natural Gas Proved Reserves Shelf	Natural-Gas Liquids (millions of barrels of 42 U.S. gallons) Cumulative Production Shelf	Natural-Gas Liquids Cumulative Production OCS	Natural-Gas Liquids Proved Reserves OCS	Natural-Gas Liquids Proved Reserves Shelf
Alaska	—	—	—	—	—	—	—	—	—	—	—	—
(Cook Inlet)	(4.35)[1]	—	—	(536)[1]	(.01)[6]	—	—	(.05)[2]	NA	—	—	NA
Atlantic	—	—	—	—	—	—	—	—	—	—	—	—
Gulf			1,622[2]	2,278[3]			22.2[2]	30.3[3]	75[2]	(4)	338[2]	615[3]
(La. & Texas)	1,237[2]	863[2,4]			6.4[3]	4.5[2]						
Pacific	—	—	—	—	—	—	—	—	—	—	—	—
(S. Calif.)	874[4,5]	—	—	1,400[3,4]	.5[7]	—	—	1[3]	(4)	—	—	(4)
Totals[8]	2,111	863	1,622	3,678	6.9	4.5	22.2	31.3	75	—	338	615

(1) Oil and Gas Journal, 1/30/67, p. 161
(2) Conservation Division, 2/68
(3) API-AGA, 7/67
(5) California Oil World, 1/31/68
(6) Alaska Construction and Oil, 3/68, p.53
(7) Nelson and Burke, 1966

two of the four major oil provinces in California--and submarine oil seeps and tar mounds have been found in many parts of the area. The recent bids on the OCS tracts offered by the Federal Government in the Santa Barbara Channel area--a total of $603 million for the highest bids on 75 tracts aggregating only about 575 square miles--eloquently testifies to the oil industry's optimism concerning the potential of this are an analysis of the crude oil potential of the near offshore area (0-600 feet) of southern California from Santa Barbara County to Orange County based on reserves of crude oil already found in the equivalent adjacent onshore area indicates that 7 billion barrels of recoverable oil may be present in that area alone (Rubel, 1966). If so, the most favorable estimate--12 billion barrels--of recoverable crude oil made in this report (Table 6) for all of the U.S. Pacific shelf to a depth of 200 meters may be highly conservative.

The production already coming from the Gulf OCS similarly speaks for its potential, but it is worth adding that geophysical studies show the continuation of a thick sedimentary section over most of the area (Ewing and Ewing, 1966), and that numerous diapiric structures (Ewing and Antoine, 1966; Uchupi, 1967) and oil seeps (Pepper, 1958) have been identified even in the deeper parts of the shelf and slope. As yet there has been no production on the Atlantic coastal plain, but offshore seismic studies and drilling indicate a thicker sedimentary section and several major structures that are favorable for the occurrence of petroleum in several large areas between southern Florida and Georges Bank (Maher, 1967; Emery, 1965 a,b; Bunce and others, 1965). In short, the favorable area for the presence of petroleum on the U.S. shelves is large. In fact, it appears to be nearly 55 percent as large as the area of favorable ground on land and to contain a volume of sediments that is about 90 percent as large as that in which petroleum occurs on land.

Satisfactory methods for appraising the magnitude of potential petroleum resources have not yet been developed even for well explored areas. The chief concern on the part of the petroleum industry thus far has been with proved reserves--economically recoverable petroleum the existence and magnitude of which has been demonstrated by drilling. The Interstate Oil Compact Commission (Torrey, 1966) has also made several estimates of oil originally in place in proved acreage, and of oil in proved acreage that might be recovered under various assumptions as to the use and improvement of secondary recovery methods. The American Petroleum Institute (API) in 1967 started reporting oil originally in place in proved acreage, as well as "indicated" reserves that might be recovered from proved acreage by improved or widened secondary recovery practice. Although not published as a part of IOCC or API estimates, many individuals and organizations, recognizing that "revisions" and "extensions" account for much of the additions each year to proved reserves, commonly double proved reserves as a sort of a rule of thumb approach to estimating the magnitude of oil in known fields.

Beyond these estimates related to proved acreage, interest in petroleum resources has mainly focused on "ultimate production"--a forecast of the total petroleum that will be ultimately found and recovered. Three basic methods have been used for this purpose: 1) projecting statistics on past production, gross additions to proved reserves, discovery data, and related phenomena, using the logistic (Hubbert, 1966) or Gompertz (Moore, 1966) curve; 2) projecting exploration experience from explored to unexplored areas on the basis of geologic comparability (Weeks, 1961 and 1965; Hendricks, 1965); and 3) extrapolating the results of exploratory drilling to unexplored areas on the basis of the amount of drilling required to adequately explore the ground believed favorable for oil exploration (Zapp, 1962; Hendricks, 1965).

As previously mentioned, the concept of ultimate production is not a meaningful one, for it is impossible to forecast the results of human decisions and achievements that will determine how much oil will be found, how much will be recovered, and how much will be obtained more economically from synthetic or foreign sources (McKelvey, 1966; 1968). To see and evaluate the target for exploration, research, and development it is much more important to have some idea of how much petroleum is in the ground and how it is distributed. Estimates as to how much will be found or recovered under various assumptions can then follow and will be in proper perspective.

Man cannot see into the ground, of course, and there is no way of obtaining accurate knowledge of the amount of petroleum in the ground even when extensive geologic data are available. In extensively explored areas, estimates can be built up from proved acreage into some of the additional categories shown in Table 2 on the basis of local knowledge of the geology, past experience, and assumptions concerning advance in recovery techniques, but even there the problem of appraising the extent of as yet undiscovered resources is one that can only be approached by some sort of extrapolation. For the shelves at this date, discovery experience is not sufficient to support projections based on past production, additions to proved reserves, and other historical trends.

Estimates must therefore be based on extrapolation of experience from land, and the estimates shown in Tables 5 and 6 are based on the second and third methods listed above, as described by Hendricks (1965). Both tables show total potential resources of petroleum in place, along with an estimate of currently recoverable known and undiscovered resources based on stated assumptions, as judged from the drilling required to explore favorable areas (Table 5) and from the application of degree of favorability criteria to known areas (Table 6). The assumptions and procedures on which these estimates are based are given in the explanations accompanying them.

As may be seen from a comparison of these tables, the amounts of petroleum fluids in place in the OCS part of the U.S. continental margins suggested by these methods are, respectively, about 1,400 and 1,700 billion barrels of liquids and 3,200 and 4,400 trillion cubic feet of natural gas. The difference arises from the inherent difference in the methods of calculation. The first method, summarized in Table 5, is based on the assumption that petroleum will occur with equal frequency in all sedimentary rocks, whereas the second method recognizes that some areas contain much more petroleum than others. Recoverable resources, under the assumptions stated (see Table 5) by the two methods are, of course, in similar proportion--180-220 billion barrels of liquids and 820-1,100 trillion cubic feet of gas. Note that resources beyond 200 meters are not assumed to be recoverable now. The maximum water depth for current production is about 100 meters, but exploration is proceeding to 200 meters, and the recent California OCS lease sale included some tracts in waters greater than 350 meters in depth.

Weeks (1965) has estimated petroleum resources for the continental shelves of the World and North America to a depth of 1,000 feet (330 meters) on the basis of the favorability of various areas for the occurrence of oil and gas, but he did not break down his estimates for the individual areas and he presents an estimate of what

Table 5.--Potential Petroleum Resources of the United States Outer continental shelf, based on extrapolation of results of drilling (see explanation below), estimated from data to January 1, 1966

(OCS--limit of state jurisdiction to 200 and 2500 meter isobaths)

	Total potential resources in the ground			Recoverable resources under current economics & technology (including cumulative production and proved reserves only for Texas and La.)			Marginal and sub-marginal resources		
	Crude oil	Natural gas	NGL	Crude oil	Natural gas	NGL	Crude oil	Natural gas	NGL
Alaska									
OCS to 200m	217	543	16	54	271	8	163	272	8
200 - 2500m	156	390	12	---	---	---	156	390	12
Pacific									
OCS to 200m	30	75	2	8	38	1	22	37	1
200 - 2500m	148	370	11	---	---	---	148	370	11
Gulf									
OCS to 200m	240	600	18	60	300	9	180	300	9
200 - 2500m	189	472	14	---	---	---	189	472	14
Atlantic									
OCS to 200m	169	423	13	42	211	6	127	212	7
200 - 2500m	143	357	11	---	---	---	143	357	11
Totals (rounded)									
OCS to 200m	660	1,640	50	160	820	25	490	820	25
200 - 2500m	640	1,590	50	---	---	---	640	1,590	50

Crude oil and natural gas liquids (NGL) in billions of barrels of 42 U.S. gallons. Natural gas in trillions of cubic feet.

Explanation to Table 5

The method used for calculating these estimates follows that described in U.S. Geological Survey Circular 522, "Resources of oil, gas and natural-gas liquids in the United States and the World", by T.A. Hendricks. However, the estimates given here cannot be compared directly with those in Circular 522 because the areas of the entire continent and continental margin to 2,500 meters depth favorable for petroleum were used in this calculation, whereas, Hendricks used only the favorable areas of the continent and part of the continental shelf. The present estimates are based on a 40 percent recovery factor for oil in order to reflect anticipated near term gains in recovery technology (NPC, 1967), and to compare with Hendricks.

Total oil in place was calculated for the entire area of favorable rock of the United States and then prorated to the two zones of each offshore region on the basis of area and average sediment thickness. Gas and natural-gas liquids were estimated by applying the ratios used by Hendricks of 2,500 cubic feet of gas per barrel of oil in place and 30 barrels of natural-gas liquid per million cubic feet of gas. The estimate of total oil in place is based on the extrapolation of U.S. drilling-discovery experience on the basis that the 1.3 billion feet of exploratory drilling undertaken thus far has led to the discovery of 404 billion barrels of oil in place (Torrey, 1966), and that one exploratory well per 2 square miles is required to test favorable ground. Additional exploratory drilling needed to test unexplored rocks is approximately 12 billion feet. The size of the favorable areas and average thicknesses of sediment assumed for each region are as follows:

Alaska

0 - 200 meters --	300,000 sq. mi.
(State jurisdiction approx.	10,000 sq. mi.)
200 - 2,500 meters --	212,200 sq. mi.
Total	512,200 sq. mi.
Average sediment thickness:	6,500 feet

Pacific

0 - 200 meters --	20,400 sq. mi.
(State jurisdiction approx.	5,000 sq. mi.)
200 - 2,500 meters --	76,200 sq. mi.
Total	96,600 sq. mi.
Average sediment thickness:	17,000 feet

Gulf

0 - 200 meters --	119,500 sq. mi.
(State jurisdiction approx.	12,000 sq. mi.)
200 - 2,500 meters --	84,200 sq. mi.
Total	203,700 sq. mi.

Average sediment thickness: 26,000 feet; however, 20,000 feet used in calculations because that appears to be the lowest average depth at which oil will be found in commercial quantities. Gas is produced from greater depth, but the method used is based on a gas-oil ratio for quantities of gas.

Atlantic

0 - 200 meters --	132,000 sq. mi.
(State jurisdiction approx.	10,000 sq. mi.)
200 - 2,500 meters --	102,500 sq. mi.
Total	234,500 sq. mi.

Average sediment thickness: 12,000 feet

Continental U.S. 1,923,000 sq. mi.

Average sediment thickness: 7,000 feet

Total U.S. Continental margins

0 - 200 meters --	571,900 sq. mi.
200 - 2,500 meters --	475,100 sq. mi.
Total	1,047,000 sq. mi.

Average sediment thickness: 12,000 feet

Total area of U.S. land and offshore for calculations: 2,970,000 sq. mi.

Average sediment thickness: 9,000 feet

The estimate of recoverable resources is based on the assumptions that: (1) The amount of petroleum in the unexplored rocks will range from at least as much as has been discovered to nothing so that the average incidence for all unexplored rocks will be one-half that of the explored rocks. (2) Economic incentive will justify exploratory drilling of at least one third of the unexplored rocks. (3) Future exploration will be concentrated in the most favorable one-half of the unexplored rocks which will contain three-fourths of the remaining petroleum. (4) Approximately five-eighths of the petroleum in place will be discovered based on an additional 4 billion feet of exploratory drilling. Of this at present approximately 40 percent of the oil and 80 percent of the gas and natural-gas liquids could be produced. (5) Petroleum exploration, drilling, can be carried out almost anywhere on the continental shelf but that exploration of most of the continental slope will not be attempted in the near future.