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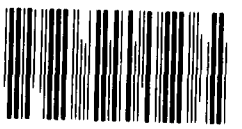
Briefing Report to the Honorable
Pete Wilson
United States Senate

July 1986

OFFSHORE OIL AND GAS RESOURCES

Differences in Estimates by Interior and Industry for Offshore California



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

RESOURCES, COMMUNITY,
AND ECONOMIC DEVELOPMENT
DIVISION

July 10, 1986

B-223477

The Honorable Pete Wilson
United States Senate

Dear Senator Wilson:

In your letter of February 6, 1986, you expressed concern about differences between the Department of the Interior's and industry's estimates of the oil and gas resources contained in federal lands offshore California. Accordingly, you asked us to examine the procedures and assumptions used to develop these estimates. On April 8, 1986, we briefed your office on our review and, as subsequently agreed, are providing this briefing report on the results of our work.

As you are aware, many of industry's procedures and assumptions used to estimate offshore oil and gas resources are considered proprietary and were not provided to us. For that reason, this briefing report, as agreed with your office, focuses on Interior's methodology used to develop estimates of offshore oil and gas resources (see section II), Interior's assumptions used to estimate undiscovered oil and gas resources (see section III), Interior's estimates of oil and gas resources offshore California and two industry estimates (see section IV), and the relevant differences between Interior's procedures and assumptions used to estimate resources in the Gulf of Mexico and offshore California (see section V).

We found that Interior used various computer models to select values from a range of geologic, engineering, and economic parameters in order to generate a range of resource estimates for offshore California. Applying additional assumptions to this range, Interior estimated that unleased federal lands offshore California contained almost 2.5 billion barrels of undiscovered recoverable oil equivalent.[1] Of this amount, Interior estimated

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[1]Oil equivalent is a term used to describe the combined energy-equivalent of oil and gas. It is determined by adding the energy-equivalent of gas to the oil.

that almost 1.6 billion barrels (64 percent) were contained in lands which were under a leasing moratorium until fiscal year 1986. Although industry's methods of estimating undiscovered offshore oil and gas resources were quite similar to Interior's methods, Interior's estimates were lower than the two industry estimates of 5 billion and 5.5 billion barrels of oil equivalent.[2] The American Petroleum Institute concluded that the variance between Interior's and industry's resource estimates is due almost entirely to differences in subjective geological judgments.

In evaluating Interior's estimates, we interviewed Interior officials in Washington, D.C., and the Pacific Regional Office and collected and reviewed various documents relating to Interior's methodology and assumptions used to estimate offshore resources. We also interviewed representatives from the American Petroleum Institute, the Western Oil and Gas Association, and oil and gas companies active in offshore California to discuss their procedures used to estimate offshore oil and gas resources. We briefed Interior officials on the contents of this briefing report and considered their comments. As agreed with your office, we did not request official comments from Interior.

As arranged with your office, unless you publicly announce its contents earlier, we plan no further distribution of this report until 30 days from its issue date. At that time, we will send copies to the Secretary of the Interior and other interested parties. If you have any questions regarding the attached information, please call me at (202) 275-7756.

Sincerely yours,

Michael Gryszkowiec
Associate Director

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[2]We identified only two industry estimates which were not considered proprietary information: one reported by the American Petroleum Institute in a 1985 study and the other cited by the Secretary of the Interior in a 1985 letter which did not name the industry source.

Contents

ABBREVIATIONS

BBO	Billion Barrels of Oil
COST	Continental Offshore Stratigraphic Test (COST) Well
MMS	Minerals Management Service
OCS	Outer Continental Shelf
PRESTO	Probabilistic Resource Estimates - Offshore
TCF	Trillion Cubic Feet of Gas

BACKGROUND ON INTERIOR'S PROGRAM FOR LEASING LANDS OFFSHORE CALIFORNIA

The Outer Continental Shelf Lands (OCS) Act (67 Stat. 462), as amended, is the primary legislation governing the leasing of federal offshore lands for oil and natural gas exploration and production. Under the Act, the Secretary of the Interior is responsible for preparing, maintaining, and periodically revising a 5-year OCS leasing program. Interior's current leasing program calls for 41 lease sales through June 1987, which includes nearly the entire OCS--about 1 billion acres. Interior is currently developing its next 5-year leasing schedule for mid-1986 through mid-1991, which is intended to be more flexible, to adjust to changing market conditions, than the current program.

A major element of Interior's 5-year offshore leasing program is the amount of undiscovered oil and gas resources estimated to exist in the federal offshore lands. These resource estimates are used to determine the economic value if an area is offered for leasing. In addition, the estimates of oil resources are used in Interior's oil-spill model, which predicts coastal effects in the event of a spill. Oil and gas resource estimates are also used to assess the infrastructure necessary to produce the resources if discovered. Large resource potential in an area could signal an increase in industry growth with corresponding social and demographic changes.

The leasing of federal lands offshore California for oil and natural gas exploration and production has been controversial for many years. For example, the fiscal year 1982 Department of the Interior Appropriations Act prohibited leasing on approximately 736,000 acres of federal lands offshore California. In fiscal year 1983, this leasing moratorium was expanded to about 35 million acres. The moratorium acreage increased to almost 37 million acres during fiscal years 1984 and 1985. Reduced fish

catches and tourism, environmental concerns, and interference with the Department of Defense are cited as some reasons for opposing leasing offshore California.

The leasing moratorium was lifted for fiscal year 1986 while the Secretary of the Interior and certain members of the Congress try to negotiate an agreement as to which federal lands offshore California should be offered for lease. However, one of the stumbling blocks in negotiating an agreement has been a lack of consensus as to which federal lands contain the highest potential for discovering oil and natural gas resources.

INTERIOR'S METHODOLOGY FOR ESTIMATING OFFSHORE OIL AND GAS RESOURCES

Interior's estimates of offshore resources are generated from a mathematical computer model named PRESTO, an ancronym for Probabilistic Resource Estimates-Offshore. PRESTO simulates an exploratory drilling program for each offshore area having resource potential. If resources are found, the model calculates the amount that would be discovered. After all the potential areas have been analyzed, PRESTO sums the hypothetical resources discovered and starts another simulated drilling program for the planning area. Typically, PRESTO simulates 5,000 drilling programs and generates 5,000 resource estimates for each area. Interior reports high, low, and mean estimates out of the range of 5,000 estimates. The National Research Council[3] reviewed Interior's methodology during 1984-86 and concluded that it was appropriate for estimating undiscovered offshore resources.

There is a great deal of uncertainty as to the quantities of undiscovered oil and gas resources that may be present in any offshore planning area. Because of these uncertainties, Interior's Minerals Management Service (MMS) estimates resources as a range of values rather than a single estimate based on probabilistic procedures and techniques.

MMS' PRESTO simulates an exploratory drilling program for each planning area by "drilling" each prospect in the area.[4]

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[3]The National Research Council was established by the National Academy of Science in 1916 to advise the federal government on science and technology.

[4]A prospect is an unexplored geological structure having the potential for containing oil and gas resources. A planning area is a large subdivision of an offshore area used by MMS to identify lands to be offered for lease and may contain hundreds of prospects.

After analyzing all the prospects in an area, PRESTO starts another simulated drilling program which may have completely different discoveries and resource estimates for the area.[5]

IS THE PROSPECT DRY?

PRESTO evaluates each prospect to determine whether it contains oil and gas resources or not (referred to as dry). Based on MMS' review of geological and geophysical data, it assigns a degree of risk associated with finding resources in an area and each prospect within the area.[6] These risks are used in PRESTO to determine whether an individual prospect is dry. For example, PRESTO generates a random number, which is compared to the MMS assigned risk for the prospect. If the random number is less than the risk, the prospect is considered dry. Assuming that the risk was 25 percent dry and the random number was less than .25, the prospect is dry. If the random number is greater than the risk, the prospect is considered as having oil and gas resources. For example, a prospect with an MMS risk of 25 percent and a random number between .25 and 1.00, would not be considered dry.

IS THE PROSPECT ECONOMICAL?

If the prospect is not dry, PRESTO calculates how much oil and gas it contains, based on MMS estimates of the size of the resources and how much can be recovered. After computing the expected oil and gas resources, PRESTO will determine whether they are large enough to warrant production.

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[5]Not all simulated drilling programs will result in the planning area having economic resources, especially in high-risk frontier areas. Some simulated programs could result in all the prospects having no resources or being uneconomical for production.

[6]MMS may also assign a geologic risk at a zone level with each prospect. A zone is a rock layer or layers with similar characteristics, such as age and type of rock, contained in a prospect.

Using another MMS model called MONTCAR, MMS determines the minimum economic field sizes[7] for the planning area. MONTCAR is a discounted cash flow analysis program which can be used to calculate the amount of resources needed to balance various operating costs. Different minimum economic field sizes can be calculated for different levels of cost identified by various water depths, distances from shore, drilling depths, or adverse environmental conditions. This allows the minimum economic field size to be tailored to the location of the prospect.

If PRESTO determines that the resources for the prospect exceed the minimum economic field size, the estimated resource values are stored in the computer for later use. If the estimated resources are less than the minimum amount required to be commercially produced, PRESTO sets the resources for that prospect to zero.

PRESTO'S OUTPUTS

After resources have been estimated for the first prospect, PRESTO proceeds to the second prospect and repeats the resource estimate procedures until all prospects have been evaluated. PRESTO sums the estimated productive resources for all prospects, yielding a single estimate of undiscovered economically recoverable resources for the area. Then, PRESTO goes back to the first prospect, starts the process (or trial) again, and continues for the number of trials specified by MMS--usually 5,000.

By the time PRESTO has evaluated the last prospect on the last trial, a large number of possible outcomes have been stored by the computer. For example, 5,000 producing trials would generate a range of 5,000 resource estimates for the planning area. The zero estimates are eliminated and the range of positive estimates is sorted, ranked, and divided into 99 percentiles, which are used to arrive at the high, mean, and low resource estimates for the area.

PRESTO's estimates are considered conditional resource estimates of the quantities of oil and gas resources that may be found and developed given the condition that economically recoverable resources are present in the planning area. These conditional estimates are adjusted to incorporate MMS' assessment of the probability that the planning area may be non-productive.

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[7]Minimum economic field size is the smallest amount of oil and gas resources contained in a prospect or prospects needed to assure profitable production.

INDUSTRY'S METHODS ARE SIMILAR TO MMS'

Companies' methods of estimating undiscovered oil and gas resources are generally similar to those used by MMS. Geological, engineering, and economic data are used to estimate economical recoverable oil and gas resources for a planning area. Risk probabilities that resources exist in the area are assigned to either individual prospects or to large sections of the planning area, depending on the amount of data available.

One of the largest offshore exploration companies explained that it uses geological, geophysical and engineering data to model the subsurface and estimate the recoverable oil and gas resources. By varying some of the input data, the company estimates minimum, most likely, and maximum volumes of expected resources. This distribution represents the range of resources expected if the area contains resources. The company assigns a risk of finding oil and gas resources to either individual prospects or to larger areas depending on the amount of geophysical, geologic, and well data available. The risks are used to account for the possibility that the area has no resources.

The National Research Council reported on the various methods used by MMS and others to generate estimates of undiscovered oil and gas resources offshore.[8] The Council concluded that MMS' methodology was appropriate but it was excessively detailed for some assessment areas, particularly where little data are available. It also made a number of other recommendations for improving MMS' resource assessments and for releasing MMS' documentation on critical decisions points to the general public. These recommendations are under review by MMS.

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[8]National Research Council, Offshore Hydrocarbon Resource Estimation: The Minerals Management Service's Methodology, 1986.

SECTION III

ASSUMPTIONS INTERIOR USED TO DEVELOP ESTIMATES OF UNDISCOVERED OIL AND GAS RESOURCES

Interior incorporates a wide range of geologic, engineering, and economic information to develop its resource estimates. Interior uses geologic data to identify potential oil and gas resources and to determine how large they are. Interior uses a variety of engineering data to develop exploration and production scenarios for the area, such as the timing and costs of production. Finally, Interior uses economic data, such as expected oil and gas prices, in estimating how large the resources would have to be to justify economical production. We found that many of the geologic, engineering, and economic assumptions can be highly subjective based on the amount, type, and quality of the data used. The American Petroleum Institute has concluded that the discrepancy between Interior's and industry's resource estimates is due to differences in subjective geological judgments.

MMS' USE OF GEOLOGIC AND GEOPHYSICAL DATA

The first phase of MMS' assessment of undiscovered offshore resources is the acquisition of geological and geophysical data from companies exploring and developing offshore oil and gas. Under the OCS Lands Act Amendments of 1978 (Public Law 95-372) companies exploring for and developing offshore oil and gas must provide MMS access to these data. Geological data used by MMS are obtained from existing oil and gas wells and provide information about the characteristics of the different rock layers beneath the earth's surface, helping identify those types of rock necessary for oil and gas to be present. MMS also uses data from Continental Offshore Stratigraphic Test (COST) wells, which are joint ventures sponsored by industry to drill for geologic

information in unexplored areas. If no oil or gas wells are near a prospect, geophysical data become the primary type of data used for resource evaluation purposes. One type of geophysical data is obtained by sending sound (seismic) waves into the earth. By measuring the varying speeds at which these sound waves are reflected by underground rock layers, judgments are made about prospect's oil and gas potential.

MMS uses geologic and geophysical data to identify potential oil and gas resources and to develop estimates of the volume of recoverable resources. However, the reliability of any resource estimate depends on what is known about subsurface geology, which is based on the amount of previous exploration in the area. In the Central and Northern California areas, less exploration has taken place than in Southern California. Thus, there is less data for estimating resources in these areas. The status of the industry exploration activities offshore California is shown in table III.1.

Table III.1: Exploration Activity Offshore California

Planning area	Activity
Southern California	Approximately 47,100 line-miles of seismic data have been obtained from the Southern California planning area. Two COST wells have been completed: one in 1975 and another in 1978. To date, 262 exploratory wells have been completed.
Central California	Approximately 26,400 line-miles of seismic data have been obtained from the Central California planning area. Twelve exploratory wells were drilled between 1964 and 1967.
Northern California	Approximately 16,400 line-miles of seismic data have been obtained from the Northern California planning area and seven exploratory wells which were completed between 1964 and 1966.

In appendix E to Interior's Secretarial Issue Document for the proposed 5-year offshore leasing program, MMS' Pacific Regional Office rated the adequacy of the geologic and geophysical data used to develop regional resource estimates as shown in table III.2.

Table III.2: Adequacy of Geologic and Geophysical Data for Resource Estimates for Offshore California

Planning area	Data rating
Southern California	Fair to Excellent
Central California	Poor to Good
Northern California	Poor to Good

MMS' USE OF ENGINEERING DATA

MMS uses a variety of engineering data in estimating the minimum economic field sizes and undiscovered oil and gas resources for a planning area. The sources for these data are published and unpublished reports, well data, technical literature, communications with industry representatives, and contract studies. Based on its review of the data, MMS develops exploration and production scenarios for the planning area. The scenarios consider the following factors:

--timing and scheduling of development and production (e.g., delay before drilling, delay after drilling, number of wells drilled, scheduling of the production platform, etc.);

--type of production engineering needed based on the type of petroleum resources and geology of the area (e.g., oil and gas recovery factors, well spacing, production rate, ratio of oil and gas, etc.); and

--costs of production (e.g., drilling costs, operating costs, platform costs, transportation costs, pipeline costs, etc.).

MMS' USE OF ECONOMIC DATA

MMS uses a variety of economic parameters in estimating the minimum economic field sizes and undiscovered resources for a planning area. The sources for these parameters are government and industry publications, communications with industry representatives, and other economic reports. Some economic parameters used in MMS' July 1984 resource assessment follow:

--public and private after tax discount rate,

--inflation rate,

--oil and gas prices, and

--price adjustment rates for different qualities of crude oil.

Uncertainty about the future path of oil prices brings into question the applicability of MMS' resource estimates generated in 1984 because these estimates are based on higher prices and expectations than current ones. Current oil prices are less than one-half of the prices used by MMS to generate the 1984 estimates. The effect is that, under PRESTO, lower prices and price expectations reduce the number of oil and gas prospects economically ready for production and, thus, reduce the estimated economically recoverable resources for a planning area.

ESTIMATE DEPENDS ON THE DATA

Industry officials told us that the process of estimating undiscovered offshore oil and gas resources depends on the amount, type, and quality of the data available. Also, they said that the process is highly interpretive and can be quite subjective, particularly in the assessment of geological and geophysical data. The American Petroleum Institute concluded that the discrepancy between industry's and Interior's estimates can be explained almost entirely by differences in subjective geological judgments.

ESTIMATES OF UNDISCOVERED ECONOMICALLY RECOVERABLE OIL AND GAS RESOURCES OFFSHORE CALIFORNIA

Based on July 1984 data, Interior estimated that unleased federal lands offshore California contained almost 2.5 billion barrels of undiscovered recoverable oil equivalent. Of this amount, Interior estimated that almost 1.6 billion barrels (64 percent) were contained in lands which were under the leasing moratoria until fiscal year 1986. Interior's estimates, however, tended to be lower than the two industry estimates given to us, which were 5 billion and 5.5 billion barrels of oil equivalent.

Interior's most recent appraisal of undiscovered recoverable oil and gas resources offshore California was made by MMS in July 1984. Undiscovered recoverable resources are resources estimated to exist outside known oil and gas fields which can be economically produced using existing technology and assuming current price and cost relationships. MMS issues both a conditional estimate, which assumes that the area contains oil and gas resources, and a risked estimate, which reflects the probability that the area does not contain resources. Table IV.1 shows conditional unleased and undiscovered economically recoverable resource estimates for MMS' three planning areas offshore California.

Table IV.1: MMS Estimates of the Unleased and Undiscovered Economically Recoverable Oil and Gas Resources Offshore California

Planning area	Conditional oil[a] 95% case	Mean case	5% case	Conditional gas[b] 95% case	Mean case	5% case
Southern California	0.58	1.22	2.01	0.96	1.92	3.01
Central California	0.18	0.56	1.01	0.29	0.79	1.38
Northern California	0.15	0.42	0.76	1.17	1.86	2.48

[a]Billion Barrels of Oil (BBO)

[b]Trillion Cubic Feet of Gas (TCF)

From 5,000 productive trials, PRESTO generates 5,000 resource estimates. This range of estimates is sorted, ranked, and divided into 99 percentiles, which are used to arrive at the high (5 percent case), mean, and low (95 percent case) resource estimates. The mean case represents the "expected" value of recoverable resources. For the low estimate (95 percent case), 95 percent of the resource estimates generated by PRESTO are greater than the estimate. In the high estimate (5 percent case), only 5 percent of the estimates generated by PRESTO are greater than the estimate.

MMS estimates the degree of uncertainty associated with finding oil and gas in an area by assigning a risk factor to the conditional estimates. The resources are then said to be risked. In effect, MMS' conditional resource estimates are reduced to incorporate MMS' assessment of the probability that the area may not contain oil and gas resources. Table IV.2 shows MMS' estimate that the unleased federal lands offshore California contain a total of 2.47 billion risked barrels of oil equivalent.

SECTION IV

Table IV.2: Risked Mean Estimates of Unleased Oil and Gas Resources Offshore California as of July 1984

Planning area	Oil			Gas			Risked barrels of oil equivalent - billions
	Conditional mean Oil-BBO	Marginal probability that resources exist	Risked mean Oil-BBO	Conditional mean Gas-TCF	Marginal probability that resources exist	Risked mean Gas-TCF	
Southern California	1.22	1.00	1.22	1.92	1.00	1.92	1.56
Central California	0.56	0.65	0.36	0.79	0.65	0.51	0.46
Northern California	0.42	0.60	0.25	1.86	0.60	1.12	0.45
			1.83			3.55	2.47

In any oil and gas resource assessment, the reported estimates of undiscovered oil and gas resources should be considered speculative and may not accurately reflect the oil and gas resources that will ultimately be discovered in any region. Interior and industry officials maintain that exploratory drilling is the only reliable means to determine how much oil and gas resources exist offshore California.

Interior's mean estimates for offshore California are lower than other estimates reported by the American Petroleum Institute and an industry estimate cited by the Secretary of the Interior in a 1985 letter to Representative Yates. These estimates are shown in table IV.3. The Western Oil and Gas Association has not issued any recent estimates for offshore California. Other industry representatives were unable to release their estimates because they are considered proprietary information.

Table IV.3: Other Estimates of Undiscovered Economically Recoverable Oil and Gas Resources Offshore California

Source of estimates	Billion barrels of oil equivalent
American Petroleum Institute, The Effects of a Ban on Leasing the California Outer Continental Shelf on Oil and Gas Development and the Nation's Economy, December 1985.	5.0
Secretary of the Interior's Letter to Representative Yates, August 27, 1985, citing an unnamed industry source.	5.5

Based on Interior's estimates, most of the undiscovered economically recoverable oil and gas resources offshore California are in areas which have been under a leasing moratorium. The first moratorium on offshore California was enacted by the Congress as a provision of Interior's fiscal year 1982 appropriation. Since then, the area included under moratorium offshore California has increased from 736,000 acres to 36.6 million acres in 1985.[9] Reduced fish catches and tourism, potential environmental damage, and interference with the Department of Defense are cited as reasons for opposing leasing offshore California. On the other hand, Interior has maintained that the moratorium has kept significant oil and gas resources from being explored and developed, as shown in table IV.4.

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[9]Congress lifted the moratorium for offshore California in fiscal year 1986 pending the results of the current negotiations between Interior and certain members of the Congress on leasing lands offshore California.

Table IV.4: Risked Mean Estimates of Unleased Oil and Gas Resources in the Offshore California Leasing Moratorium Area as of July 1984

Planning area	Oil		Gas	
	Risked mean oil-BBO	Percent of total unleased resources	Risked mean gas-TCF	Percent of total unleased resources
Southern California	0.53	43.4	0.76	39.6
Central California	0.36	100.0	0.51	100.0
Northern California	0.25	100.0	1.12	100.0
	1.14	62.3	2.39	67.3

DIFFERENCES BETWEEN INTERIOR'S METHODOLOGY AND ASSUMPTIONS BETWEEN REGIONS

MMS uses the same methodology (PRESTO) for estimating undiscovered resources in each of the offshore planning areas. MMS may vary its assumptions based on the interpretation of geologic and geophysical data for each region, specific characteristics of each region, different exploration and production scenarios needed in each region, and variances in economic factors. For example, oil prices tend to be lower in California than in the Gulf of Mexico based on the type and quality of oil. Therefore, MMS used different prices and price expectations for offshore California and the Gulf of Mexico. Also, transportation costs differed between planning areas, with costs offshore California higher than in the Gulf of Mexico. These variances will affect the size of resources that are needed to be economical for production. For example, it is economical to produce smaller oil and gas fields in the Gulf of Mexico than offshore California. Because these smaller fields cannot be economically produced in areas such as offshore California, these resources are not counted as undiscovered, economically recoverable resources.

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