

124841
2/28/84
2/28/84

BY THE U.S. GENERAL ACCOUNTING OFFICE

Report To The Chairman, Subcommittee On Environment, Energy, And Natural Resources, Committee On Government Operations House Of Representatives

Plans To Award Additional Financial Assistance To The Union Oil Company Oil Shale Program

The U.S. Synthetic Fuels Corporation plans to provide up to \$2.7 billion in assistance to Union Oil Company of California for phase II of its oil shale program. Union's phase I project had been guaranteed up to \$400 million in assistance in July 1981. This report provides answers to a number of specific programmatic, financial, and technical questions concerning both the phase I and phase II projects.



029664
122841

GAO/RCED-84-187
JULY 23, 1984

Request for copies of GAO reports should be sent to:

U.S. General Accounting Office
Document Handling and Information
Services Facility
P.O. Box 6015
Gaithersburg, Md. 20760

Telephone (202) 275-6241

The first five copies of individual reports are free of charge. Additional copies of bound audit reports are \$3.25 each. Additional copies of unbound report (i.e., letter reports) and most other publications are \$1.00 each. There will be a 25% discount on all orders for 100 or more copies mailed to a single address. Sales orders must be prepaid on a cash, check, or money order basis. Check should be made out to the "Superintendent of Documents".



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

RESOURCES COMMUNITY,
AND ECONOMIC DEVELOPMENT
DIVISION

B-204290

The Honorable Mike Synar, Chairman
Subcommittee on Environment, Energy,
and Natural Resources
Committee on Government Operations
House of Representatives

Dear Mr. Chairman:

On December 22, 1983, you asked us to answer certain programmatic, technical, and financial questions concerning the Union Oil Company's oil shale program. Specifically, you were interested in knowing whether the U.S. Synthetic Fuels Corporation's plans to award up to \$2.7 billion in assistance to Union for phase II of its program were consistent with the Corporation's programmatic goals. You were also concerned about the propriety of the Corporation's awarding financial assistance to Union for phase II since (1) phase I had already received \$400 million in assistance from the Department of Energy and (2) Union had not been successful in operating phase I even though construction was completed in August 1983. This report provides the answers to the questions you asked.

As requested by your office, we did not obtain official comments on this report either from Corporation or Union officials. We did, however, discuss the contents with officials from both and incorporated their suggested changes where appropriate. Unless you publicly announce its contents earlier, we plan no further distribution of this report until 30 days from the date of its issuance. At that time, we will send copies to the U.S. Synthetic Fuels Corporation, Union Oil Company, and make copies available to others upon request.

Sincerely yours,



J. Dexter Peach
Director

D I G E S T

Union Oil Company of California has a phased approach to convert shale to oil. Union constructed phase I of its program in Garfield County, Colorado, at a cost of about \$650 million. Construction was completed in August 1983, but Union has experienced a number of technical problems and has not yet proven that phase I will work. Union plans to build phase II near its phase I project. Phase II will be constructed in two increments--increment I is estimated to cost \$1.8 billion and is expected to be completed by December 1989. Increment II is estimated to cost \$1.4 billion and is expected to be completed by December 1992.

In July 1981, the Department of Energy (DOE) approved up to \$400 million in price guarantee assistance¹ for Union's 10,400 barrel per day phase I project. In February 1982, all rights and obligations for the phase I contract were transferred to the U.S. Synthetic Fuels Corporation (the Corporation). Under the phase I contract, Union was guaranteed a price of \$42.50 per barrel for the synthetic fuel produced by the project. The \$42.50 price was to be adjusted quarterly based on the Gross National Product and natural gas index and in June 1984 was about \$48 per barrel. As of July 1984, Union had not received any of the \$400 million since phase I had not produced any synthetic fuel. (See p. 1.)

On December 1, 1983, the Corporation signed a letter with Union outlining its intentions to award a maximum of \$2.7 billion in financial assistance for two 21,076 barrel per day phase II increments. Increment I could receive a maximum of \$1.95 billion, and increment II could receive a maximum of \$750 million. The letter states that Union would receive a \$60

¹With a price guarantee, the government agrees to pay the difference between a minimum price per barrel and the market price of the project's product if the market price is lower than the minimum price.

per barrel price guarantee for the project's synthetic fuel, which may be increased by up to \$7 per barrel if Union can successfully build and operate phase II with a modified, more energy efficient technology. (See pp. 1 and 2.)

In a December 22, 1983, letter from the Chairman, Subcommittee on Environment, Energy, and Natural Resources, House Committee on Government Operations, and subsequent discussions with the Chairman's office, GAO was asked to answer several programmatic, technical, and financial questions related to Union's oil shale program. (See pp. 4 and 5.)

WHAT IS THE RELATIONSHIP BETWEEN FUNDING UNION PHASE II AND THE CORPORATION'S PROGRAMMATIC GOALS?

In 1982, the Corporation realized it could not meet the Energy Security Act's production goals of 500,000 barrels per day of crude oil equivalent by 1987 and 2 million barrels per day by 1992. As a result, it decided to trade off "some" production to concentrate on another goal of the act--developing a diversity of projects using various synthetic fuels technologies. To meet this objective, the Corporation established funding levels by resource, such as oil shale. (See pp. 7 and 8.)

The Corporation's current goal is to spend a maximum of \$4.94 billion on oil shale projects. The Corporation plans to award all of the \$4.94 billion to three projects--Union phase II (\$2.7 billion), Cathedral Bluffs (\$2.19 billion), and Seep Ridge (\$0.045 billion). According to Corporation officials, these three projects meet the act's requirements for diversity since they each use different technologies, different mining techniques, and different qualities of shale. However, both Union phase II and Cathedral Bluffs use Union's technologies (although Cathedral Bluffs uses it in combination with another technology). (See pp. 8 and 9.)

The Corporation's ability to follow through with its current plans is in question. For example, since April 1984, the Corporation's Board of Directors has not had a sufficient number of members to act on financial assistance awards. As of July 20, 1984, no new directors had been named. Also, there are a

number of legislative proposals which, if enacted, could sharply curtail the funds and activities of the Corporation. (See p. 9.)

WHY DO THE PHASE II MAXIMUM PRICE GUARANTEE AMOUNTS DIFFER BETWEEN INCREMENT I (\$1.95 BILLION) AND INCREMENT II (\$750 MILLION)?

Price guarantees differ between increments I and II for two reasons. First, construction costs for increment I are higher because they include about \$477 million for facilities which will be used by both increments but whose costs would be paid during construction of increment I. Second, the Corporation assumed that energy prices would increase during the price guarantee period by 7.5 percent per year after 1989--the estimated production date for increment I. For example, the Corporation projects that energy prices would be about \$48 per barrel in 1989 and about \$58 per barrel in 1992--the first year of operation of increment II. As a result of these projected increases, the difference between energy prices and the \$67 per barrel the Corporation guaranteed to pay would be less. The Corporation determined that a lower amount of assistance would still provide Union a "reasonable" return on its investment for increment II. (See p. 10.)

WHY WOULD THE CORPORATION OFFER A \$67 PER BARREL ASSISTANCE LEVEL FOR UNION PHASE II WHEN DOE NEGOTIATED A \$42.50 PER BARREL LEVEL FOR PHASE I?

The \$42.50 per barrel phase I guaranteed price was a composite price derived by DOE from the market price of two petroleum products--jet fuel and diesel fuel. DOE selected these products because Union had agreed to sell to the Department of Defense 33 million barrels of oil of which 30 percent would be jet fuel and 70 percent would be diesel fuel. DOE estimated that the \$42.50 per barrel would provide Union a 20 percent return on its investment. (See pp. 11 and 12.)

The \$67 per barrel guaranteed price in the phase II letter (this assumes the modified, more energy efficient technology is built) is not related to specific petroleum products. Rather, after conducting various analyses, the Corporation determined that \$67 per barrel would provide Union a "reasonable" return on its investment--about 21 percent. These analyses considered inflation and increased

construction, operating, and maintenance costs. (See pp. 11 and 12.)

HOW DOES UNION'S \$67 PER BARREL COMPARE WITH OTHER REQUESTS FOR FINANCIAL ASSISTANCE FOR OIL SHALE PROJECTS?

The three projects competing for the \$4.94 billion targeted by the Corporation for oil shale have been offered price guarantees of up to \$67 (Union phase II), \$60 (Cathedral Bluffs), and \$42.50 (Seep Ridge) per barrel. Both Cathedral Bluffs and Seep Ridge requested a combination loan and price guarantee while Union requested only price guarantees. Further, Union would be guaranteed \$60 per barrel which may be increased by \$7 per barrel if Union builds phase II using its modified, more energy efficient technology and is successful in achieving expected energy efficiencies. (See pp. 12 and 13.)

WILL PHASE II ASSISTANCE SUPPLEMENT PHASE I OPERATIONS?

Neither GAO nor the Corporation identified any phase II costs specifically targeted to supplement phase I operations. According to the Corporation's Project Officer for Union, the phase II letter does not restrict how Union uses the price support payments it receives. Therefore, Union could, according to the Corporation, use phase II funds for phase I. Union cannot, however, use phase I production to collect price guarantee payments from phase II. (See p. 13.)

HOW WILL PHASE I AND PHASE II PRICE GUARANTEES AFFECT UNION'S AFTER-TAX CASH FLOW?

GAO calculated, based on Corporation data, Union's cumulative after-tax cash flow for phase I and phase II using constant dollars. GAO found that it will take Union 16 years from the start of construction of phase I to experience a positive cumulative after-tax cash flow. During these 16 years, the maximum Union would have invested in the project would be about \$585 million. For both increments of phase II, it will take Union 11 years to achieve a positive cumulative after-tax cash flow. Union would have invested about \$1.2 billion of its money during the 11 years. However, in the later years, the projects' economics become more favorable. For

example, Union's cumulative after-tax cash flow could be as much as \$252 million for phase I resulting in an internal average annual rate of return of about 8.5 percent. For phase II (both increments) Union's cumulative after-tax cash flow could be as much as \$2.3 billion, resulting in an internal average annual rate of return of about 14 percent. (See pp. 15 and 16.)

IS THE TECHNOLOGY TO BE USED TO BUILD PHASE II SUBSTANTIALLY DIFFERENT FROM, OR IS IT A REFINEMENT OF, THE TECHNOLOGY USED TO BUILD PHASE I?

The technologies are the same except that the technology to be used to build phase II adds a component which processes the waste product to extract additional energy. Because the component and other pieces of ancillary equipment have not been demonstrated commercially with shale, both Corporation and Union officials believe that the phase II technology is substantially different from that used to build phase I. (See pp. 19 and 20.)

ARE THERE IMPEDIMENTS TO UNION'S ACHIEVING THE EXPECTED ENERGY SAVINGS FROM ITS PHASE II TECHNOLOGY?

Union expects to realize energy savings of about 25 percent, equivalent to a cost reduction of \$6 per barrel from its phase II technology. GAO found that Union may achieve the expected savings if a number of technical factors are resolved and if natural gas prices increase to about \$5.50 per million Btu's (British thermal units). Until Union builds and operates a planned phase II test facility, no one really knows whether the savings could be achieved. (See pp. 20 and 21.)

WILL UNION'S PHASE II TECHNOLOGY BE TRANSFERABLE TO OTHER OIL SHALE PROCESSES?

The Corporation believes that at least four other oil shale processes should be able to use Union's phase II technology. GAO believes that, while there is potential for other oil shale processes to use Union's phase II technology, additional study would be required. In addition, GAO does not know the extent of engineering effort that would be required to adapt Union's technology to oil shale processes with a design different from Union's. (See p. 21.)

WHAT IS THE INCENTIVE ADJUSTMENT PROVISION?

The letter outlining the phase II financial intentions contains an incentive adjustment provision--up to \$7 per barrel (the \$7 is included in the \$67 per barrel guaranteed price)--if Union can successfully build and operate its phase II technology. The incentive is a means to encourage Union to make every effort to develop its phase II technology because of its potential 25 percent energy savings. This is the Corporation's first attempt with an incentive adjustment provision. (See pp. 21 and 22.)

Although negotiations are still on-going for the phase II contract, the Corporation's Project Officer told GAO that tentative agreement has been reached whereby Union must demonstrate at least one half of the expected energy savings before it will be entitled to any of the \$7 per barrel incentive. For example, if one half of the expected energy savings is achieved, Union would receive a \$3.50 per barrel incentive. On the other hand, if the total expected savings are achieved, Union would get the full \$7 incentive. (See p. 22.)

WILL THE CURRENT PROBLEMS ASSOCIATED WITH BRINGING PHASE I ON LINE BE FULLY RECONCILED PRIOR TO PHASE II CONTRACT EXECUTION?

Corporation and Union officials have tentatively agreed to a provision whereby Union cannot proceed with phase II until phase I has operated at least at 50 percent of design capacity for 30 consecutive days. Further, Union plans to build and operate a facility to test the phase II technology before deciding whether to proceed. (See p. 23.)

- - - -

GAO did not obtain official comments either from the Corporation or Union on this report. GAO did, however, discuss the material presented with numerous Corporation officials, including its Project Officer for Union, and with Union's Vice President of Budgets and Planning, Oil Shale Project Coordinator, and Manager of Planning and Marketing. Both the Corporation and Union offered clarifications to the report which were incorporated as appropriate. Corporation officials told GAO that the report contained no proprietary information.

C o n t e n t s

| | | <u>Page</u> |
|---------|--|-------------|
| DIGEST | | i |
| CHAPTER | | |
| 1 | INTRODUCTION | 1 |
| | Description of Union's processes | 2 |
| | Objective, scope, and methodology | 4 |
| 2 | WHAT IS THE RELATIONSHIP BETWEEN FUNDING UNION PHASE II AND THE CORPORATION'S PROGRAMMATIC GOALS? | 7 |
| 3 | QUESTIONS CONCERNING FINANCIAL ASSISTANCE | 10 |
| | Why do the phase II maximum price guarantee amounts differ between increment I (\$1.95 billion) and increment II (\$750 million)? | 10 |
| | Why would the Corporation offer a \$67 per barrel assistance level for Union phase II when DOE negotiated a \$42.50 per barrel level for phase I? | 11 |
| | How does Union's \$67 per barrel compare with other requests for financial assistance for oil shale projects? | 12 |
| | Will phase II assistance supplement phase I operations? | 13 |
| | How will phase I and phase II price guarantees affect Union's after-tax cash flow? | 14 |
| 4 | QUESTIONS CONCERNING UNION'S PHASE I AND PHASE II TECHNOLOGIES | 19 |
| | Is the technology to be used to build phase II substantially different from, or is it a refinement of, the technology used to build phase I? | 19 |
| | Are there impediments to Union's achieving the expected energy savings from its phase II technology? | 20 |
| | Will Union's phase II technology be transferable to other oil shale processes? | 21 |
| | What is the incentive adjustment provision? | 21 |

Will the current problems associated
with bringing phase I on line be fully
reconciled prior to phase II contract
execution? 23

APPENDIX
I

OIL SHALE PROJECTS CONSIDERED BY THE
CORPORATION 25

ABBREVIATIONS

DOE Department of Energy
ETC Energy tax credits
GAO General Accounting Office
ITC Investment tax credits
PTC Production tax credits

CHAPTER 1

INTRODUCTION

Union Oil Company of California has a phased approach to convert shale to oil. Union constructed the first phase of its program (phase I) near the town of Parachute in Garfield County, Colorado. Union built phase I using Unishale B technology (see p. 2 for description) at a cost of about \$650 million. Union now plans to build the second phase of its program (phase II) near its phase I project using a modified version of Unishale B--referred to as Unishale C technology (see p. 3 for description). Phase II will be constructed in two increments at an estimated cost of about \$3.2 billion. The first increment (increment I) is estimated to cost about \$1.8 billion and the second increment (increment II) about \$1.4 billion.

On July 29, 1981, the Department of Energy (DOE) entered into a contract with Union to provide up to \$400 million in assistance for its 10,400 barrel per day phase I project.¹ The contract guarantees a minimum price of \$42.50 per barrel for the project's product. The phase I contract includes a provision whereby Union would share revenues with the government should energy prices exceed certain levels. On February 9, 1982, responsibility for all phase I contract rights and obligations was transferred to the U. S. Synthetic Fuels Corporation (the Corporation). Construction of phase I was completed in August 1983. As of July 1984, Union is in a startup mode and has not yet achieved production.

In response to a Corporation solicitation for synthetic fuels projects, Union submitted a proposal to construct phase II of its program. On December 1, 1983, the Corporation signed a letter of intent² with Union to award a maximum of \$2.7 billion in price guarantee assistance³ for two 21,076 barrel per day increments of its phase II project. Increment I of the phase II project could receive \$1.55 billion which may be increased by up to \$400 million if Union uses its modified, more energy efficient Unishale C technology. Increment II could receive up to \$750 million. The letter of intent also includes a provision whereby Union would share

¹DOE awarded the phase I contract under Title III of the Defense Production Act of 1950, as amended (50 U.S.C. App. 2061 et seq.)

²A nonbinding statement documenting the financial terms negotiated by Corporation and Union staff. The letter also discusses the various conditions which Union must meet before the Corporation's Board of Directors will consider approving financial assistance.

³The Corporation agrees to pay the difference between a minimum price per barrel and the market price if the market price is lower than the minimum price. The Corporation's assistance would be paid for the product that is sold. This differs from the assistance awarded by DOE to Union phase I, which pays assistance whether or not the product is sold. For purposes of this report, we will refer to both phase I and II assistance as price guarantees.

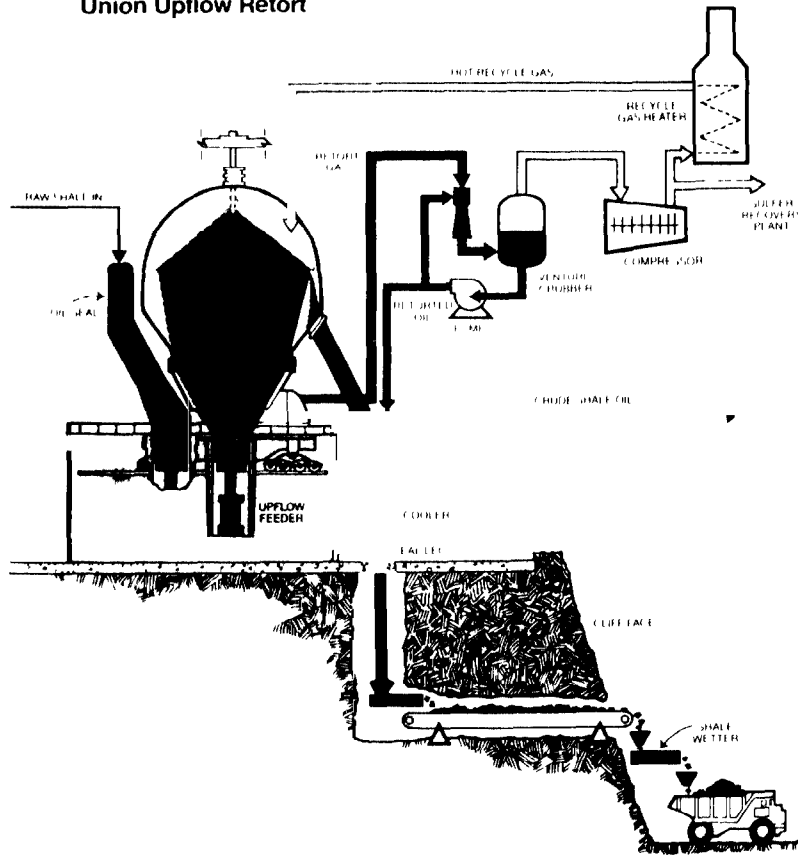
revenues (revenue sharing) with the Corporation should energy prices exceed certain levels (pp. 16 and 17 discusses this provision in detail).

The letter of intent permits Union to build phase II using Unishale B if Unishale C is not technically or economically feasible. If Union builds phase II using Unishale B, it would be guaranteed at least \$60 per barrel for the project's synthetic fuel. The guaranteed price may be increased up to \$67 per barrel if Union uses Unishale C and achieves a specified energy savings (for purposes of this report, we will use \$67 per barrel as the guaranteed amount unless otherwise noted because this is what the Corporation uses in its financial analyses of the project).

DESCRIPTION OF UNION'S PROCESSES

Shale will be mined using conventional mining techniques. Trucks will haul the shale to crushers where it will be crushed in two stages to a size suitable for the retort (equipment which heats the shale to produce raw shale oil and gas). The raw shale enters the retort from the bottom and reacts with heated natural gas (900° Fahrenheit) which enters the top of the retort. As the raw shale moves upward in the retort, raw shale oil and gas are produced and the retorted shale exits at the top of the retort. The gas generated (process gas) is separated from the raw shale oil, cleaned, and some is reheated in a furnace (recycle gas heater) that is fueled by the balance of the gas and flows back to heat the shale in the retort. The raw shale oil is transported by pipeline to an upgrading facility where it is processed into a synthetic crude oil. In Unishale B, the retorted shale is cooled and moved by conveyor belt to an enclosed chute for subsequent disposal. The following schematic shows this process.

Union Upflow Retort



Source Union Oil Company of California

In the Unishale C process, the retort will be the same as Unishale B. Unishale C will also produce raw shale oil and gas. Rather than disposing of the retorted shale, it will be crushed and moved into a fluidized bed combustor⁴ system. The fluidized bed combustor system will burn the carbon retained on the retorted shale to (1) heat the gas coming from the retort which then flows back to the retort and (2) produce steam and electric power for other parts of the facility. The benefits of Unishale C, according to Corporation and Union officials, are operating cost savings because Unishale C would virtually eliminate the need for Union to use process gas to heat the retort thereby making it available for use in the upgrading facility. The process gas replaces about 98 percent of the natural gas which it currently purchases for the upgrading facility.

⁴Equipment in which the retorted shale is burned to heat the recirculating gas and generate steam for the facility.

OBJECTIVE, SCOPE, AND METHODOLOGY

On December 22, 1983, the Chairman, Subcommittee on Environment, Energy, and Natural Resources, House Committee on Government Operations, asked us to answer several programmatic, financial, technical, legal, and environmental questions on Union's oil shale program. Based on discussions with the Chairman's office and an April 23, 1984, briefing document we provided, the Chairman's office stated that the environmental questions could be deleted from this report. In addition, on July 12, 1984, we responded separately to the legal question raised (B-202463). Therefore, this report addresses the programmatic, financial, and technical questions raised. During the course of this review, the Chairman's office asked us to answer several other programmatic, financial, and technical questions. As a result, the questions we agreed to answer in this report are as follows:

- What is the relationship between funding Union phase II and the Corporation's programmatic goals? (See ch. 2.)
- How many oil shale projects have applied to the Corporation for financial assistance and what is their current status? (See ch. 2.)
- Why do the phase II maximum price guarantee amounts differ between increment I (\$1.95 billion) and increment II (\$750 million)? (See ch. 3.)
- Why would the Corporation offer a \$67 per barrel assistance level for Union phase II when DOE negotiated a \$42.50 per barrel level for phase I? (See ch. 3.)
- How does Union's \$67 per barrel compare with other requests for financial assistance for oil shale projects? (See ch. 3.)
- Will phase II assistance supplement phase I operations? (See ch. 3.)
- How will phase I and phase II price guarantees affect Union's after-tax cash flow? (See ch. 3.)
- What rate of return does Union expect and how does this compare to the petroleum industry? (See ch. 3.)
- Is the technology to be used to build phase II substantially different from, or is it a refinement of, the technology used to build phase I? (See ch. 4.)
- Are there impediments to Union's achieving the expected energy savings from its phase II technology? (See ch. 4.)
- Will Union's phase II technology be transferable to other oil shale processes? (See ch. 4.)

--What is the incentive adjustment provision? (See ch. 4.)
and

--Will the current problems associated with bringing phase I on line be fully reconciled prior to phase II contract execution? (See ch. 4.)

To obtain information on the Corporation's programmatic goals and the oil shale projects that have applied to the Corporation - including Union's projects--we interviewed senior officials in the Corporation's Offices of Finance, Projects, and Technology and Engineering and reviewed internal and external correspondence related to Union's projects. These documents included project proposals and staff evaluations which were presented to the Corporation's Board of Directors concerning engineering design, management structure, financing, and environmental acceptability of the phase II project. We also reviewed (1) minutes of Board of Directors' meetings, (2) press releases, (3) testimony provided by the Corporation's Chairman to various congressional committees, (4) Corporation's annual reports, (5) Corporation's solicitations for synthetic fuels projects, and (6) information on the phase I project transferred to the Corporation from DOE, which included project proposals, staff evaluations, and financial analyses.

We discussed various aspects of the projects with, and reviewed documents provided by, senior officials of Union Oil, including the Vice President of Budgets and Planning, the Oil Shale Project Coordinator, the Manager of Planning and Marketing, and the Environmental Coordinator. We also visited Union's phase I project site in Parachute, Colorado.

To assess the phase I and II economics and determine the impact of the Corporation's price guarantees on the economic viability of the project, expected rates of return, and the amount of equity Union would have at risk and/or realize from these projects, we reviewed 45 different computer runs prepared by the Corporation which assessed the projects' financial/economic viability. Of these 45 computer runs, 1 analyzed the phase I economics, 40 analyzed phase II's economic viability using a \$67 per barrel price guarantee, 3 analyzed phase II with no Corporation assistance, and 1 analyzed phase II using a \$75 per barrel price guarantee.

We concentrated our efforts on the 40 phase II analyses which used a \$67 per barrel price guarantee. Of these 40 analyses, 17 dealt with increment I, 7 with increment II, and 16 with both increments. These runs analyzed a variety of factors such as the average costs and revenues, expected costs and revenues, construction cost estimates and production efficiencies provided by Union, and the Corporation's engineering estimates for costs and production efficiencies.

After reviewing the 40 phase II analyses, we identified those which represented the financial terms agreed to by the Corporation

and Union in the letter of intent. We used these analyses to discuss the economic viability of the phase II project. We used the Corporation's single analysis of phase I to discuss that project's economic viability.

We reviewed selected components of the Corporation's computer model to determine how it integrates the data and the specific assumptions used (including tax assumptions). These components were the ones which compute operating revenues, price guarantee amounts, and operating and maintenance costs. For these components, we found that the computer model logically integrates the data and the assumptions used were not unreasonable.

We also wanted to determine the sensitivity of the phase II economics to changing energy prices, cost overruns, and expected plant operating efficiencies. Because of this, the Corporation developed 18 additional computer runs incorporating various assumptions with respect to capital costs, plant performance, and energy prices which we provided. The Corporation conducted these analyses using a \$67 per barrel price guarantee to be consistent with the other analyses of phase II's economic viability. We limited our analysis to phase II since, as mentioned above, the Corporation provided only one analysis of phase I's economics.

We also compared Union's rates of return with returns for the petroleum industry from the Statistical Abstract of the United States. We selected this industry because its output is similar to Union's projects.

To assist us in addressing the technical questions raised and assess certain technical issues such as (1) the differences between Unishale B and Unishale C, (2) Union's claim for certain energy efficiencies of Unishale C, and (3) the transferability of the fluidized bed combustor to other oil shale technologies, we hired a consultant with a background in the design and assessment of major energy systems. The consultant is also familiar with the application of shale in an industrial environment both as an energy source and as a raw material and has studied the potential uses of shale in the United States. The consultant used information from the Corporation, Colorado School of Mines, Office of Technology Assessment, and other publicly available information concerning Union's processes and on oil shale technologies in general.

As requested by the Chairman's office, we did not obtain official comments on this report either from the Corporation or Union officials. We did, however, discuss the material presented with numerous Corporation officials, including the Project Officer for Union's projects, and Union's Vice President of Budgets and Planning, Oil Shale Project Coordinator, and Manager of Planning and Marketing. These officials offered clarifications in specific areas. We incorporated these suggested changes as appropriate. Corporation officials told us that the report contains no proprietary information.

Our review was conducted between January and July 1984 and in accordance with generally accepted government auditing standards, except as noted above.

CHAPTER 2

WHAT IS THE RELATIONSHIP BETWEEN FUNDING

UNION PHASE II AND THE CORPORATION'S PROGRAMMATIC GOALS?

The Energy Security Act of 1980 (Public Law 96-294) created the Corporation to provide financial assistance for synthetic fuels projects. The act set national synthetic fuel production goals of 500,000 barrels of crude oil equivalent per day for 1987 and 2 million barrels per day for 1992. The act also requires the Corporation to use the financial assistance to develop technical diversity of processes, methods, and techniques for each domestic resource which offers (1) significant potential for use as a synthetic fuels feedstock¹ and (2) potential for achieving the national synthetic fuels production goals.

To accomplish these goals, the Department of the Interior and Related Agencies Appropriations Act of 1980 (Public Law 96-126) and the Supplemental Appropriations and Rescissions Act of 1980 (Public Law 96-304) provided a total of \$17.7 billion which could be obligated for commercial synthetic fuels projects. Of these funds, \$12.2 billion was provided for the Corporation's activities, and the remaining \$5.5 billion (\$300 million was rescinded in June 1981) was provided to DOE to finance an interim alternative fuels program. As a result of DOE's funding three projects and transferring its remaining funds to the Corporation, the Corporation was authorized to commit about \$14.8 billion to assist synthetic fuels projects.²

The Corporation has attempted to foster both the production and diversity goals of the act. However, as a result of a decline in world oil prices and after evaluating the status of the synthetic fuels industry and the pessimistic economics of synthetic fuels development, on February 16, 1982, the Corporation's Board of Directors recognized the difficulty of meeting the act's production goals and adopted a strategy to place increased emphasis on diversity. The strategy stated that the Corporation would be prepared to trade off "some" near-term production to enhance technological diversity and improve the synthetic fuels industry's capability for expansion and long-term production. To implement this objective, the Board in July 1982, established funding levels to accomplish the diversity goal adopted in February 1982. Since July 1982, these funding levels have changed several times. The following table shows the dollar amounts that the Board would have been willing to commit to each resource and the date the levels were established.

¹The raw material--coal, oil shale, and tar sands/heavy oil--used in the synthetic fuels project.

²In June 1984, the Deficit Reduction Act (Public Law 98-369), in effect, reduced the Corporation's obligational authority to \$13.9 billion.

| <u>Resource</u> | <u>July 1982</u> | <u>February 1983</u> | <u>February 1984</u> | <u>April 1984</u> |
|-------------------------|----------------------|--------------------------|--------------------------|-----------------------|
| -----billions----- | | | | |
| Coal | \$6.0 | \$6.0 | \$4.95 | \$5.0 |
| Oil shale | 3.0 | 4.8 | 4.94 | 4.94 |
| Tar sands/ heavy oil | 1.0 | 1.0 | .95 | 1.1 |
| Other | a | a | 3.93 ^b | 3.7 ^b |

^aNo decision was made by the Board on the use of the remaining appropriated funds.

^bAdditional projects using coal, shale, and tar sands/heavy oil as a resource and a reserve for contingency.

The Corporation has solicited and received proposals for numerous oil shale projects. Since March 1981, 24 different oil shale projects--including Union phase I and Colony³--have responded to the Corporation's solicitations for financial assistance. However, as of July 1984,⁴ Union phase I is the only oil shale project of the 24 which has been guaranteed financial assistance--up to \$400 million in price guarantees.

As of July 1984, sponsors of eight other oil shale projects were involved in evaluations or negotiations with the Corporation. Of the remaining 15 projects, 2 withdrew primarily for economic reasons and the other 13 were eliminated because their sponsors were unable to meet the Corporation's evaluation criteria for such things as design, management structure, financing, and environmental acceptability. Appendix I lists the 24 projects, their sponsors, the technologies proposed, their status, and, if such status is inactive, the reason they are no longer in competition for Corporation funding.

The 24 projects were sponsored by at least 39 different companies and represent 16 different technologies. These technologies are in varying degrees of development. Union's technologies were planned for use in 4 of the 24 projects. Four other oil shale technologies were planned for two projects each.

The Corporation planned to award all of the \$4.94 billion in financial assistance targeted as of April 1984 for oil shale

³The Colony Oil Shale project also had a contract with DOE--a \$1.2 billion loan guarantee. On February 9, 1982, responsibility for this contract was transferred to the Corporation. However, in June 1982, the sponsors abandoned the project and repaid the monies borrowed.

⁴On April 27, 1984, one member of the Corporation's Board of Directors resigned, leaving the Board without a quorum. As a result, no action has been taken on financial assistance awards since that time.

development to the Union phase II (\$2.7 billion), Cathedral Bluffs (\$2.19 billion), and Seep Ridge (\$0.045 billion) projects. Some of the other five oil shale projects could receive assistance from the \$3.7 billion not currently targeted for any specific resource. However, these plans may be affected by various congressional proposals to rescind up to \$11 billion of the Corporation's remaining unobligated funds.⁵ As of July 20, 1984, the Congress had not acted on these legislative proposals.

The Corporation believes that its program to fund Union, Cathedral Bluffs, and Seep Ridge meets the act's diversity and production goals. Corporation officials stated that these three projects use different technologies, different mining techniques, and different grades of shale. They also pointed out that Union is the largest contributor to the act's production goals of any project being considered for financial assistance.

Both Union phase II and Cathedral Bluffs use Union's technologies (although Cathedral Bluffs uses it in combination with another technology). These two projects could receive about \$4.9 billion of the \$4.94 billion targeted for oil shale development. However, the five other projects being considered by the Corporation for financial assistance use technologies different from Union's. According to Corporation officials, these projects could provide the the Corporation a wider range of diversity if it were feasible to award financial assistance to some of them.

⁵This would be in addition to the legislation already passed to reduce the Corporation's obligational authority to \$13.9 billion.

CHAPTER 3

QUESTIONS CONCERNING FINANCIAL ASSISTANCE

The Chairman asked several questions concerning the financial assistance offered Union by the Corporation for phase II and the assistance provided by the phase I contract. The Chairman also wanted to know the effect of both assistance packages on the money Union would have at risk and the money it could expect to realize after taxes; the rates of return Union could expect from its investment; the net effect to the government of price support payments and revenue sharing; and the sensitivity of phase II's economics to changing energy prices, cost overruns, and different plant operating efficiencies. A discussion of these questions and our findings follow.

WHY DO THE PHASE II MAXIMUM PRICE GUARANTEE AMOUNTS DIFFER BETWEEN INCREMENT I (\$1.95 BILLION) AND INCREMENT II (\$750 MILLION)?

Phase II will be built in two increments. The phase II letter of intent states that the price guarantee for increment I is \$1.55 billion, which may be increased by up to \$400 million if Union uses Unishale C. Increment II could receive a maximum of \$750 million.

According to the Corporation's Project Officer for Union, there are two reasons for a larger price guarantee for increment I. First, estimated construction costs are higher for increment I--\$1.8 billion versus \$1.4 billion for increment II--because certain facilities will be shared by both; for example, roads, shale disposal facilities, and electric power lines. The costs for these shared facilities--about \$477 million--will be paid during construction of increment I. The Project Officer also told us that the Corporation conducted a line-by-line analysis of Union's data and found that Union did not include these costs in the costs for increment II.

Secondly, oil production for increments I and II is projected to start in December 1989 and December 1992, respectively. The Corporation, considering both the effect of inflation and the real change in petroleum prices, assumed that energy prices would increase during the price guarantee period by 7.5 percent per year after 1989. For example, the projected price in 1989 would be about \$48 per barrel but in 1992--the first year of increment II's operation--the projected price would be about \$58 per barrel. As a result of these estimated increases, the difference between energy prices and the Corporation's guaranteed price of \$67 per barrel would be less. Therefore, the Corporation determined that the lower amount of assistance for increment II would provide Union with approximately the same rate of return as the return for increment I.

WHY WOULD THE CORPORATION OFFER A \$67 PER BARREL ASSISTANCE LEVEL FOR UNION PHASE II WHEN DOE NEGOTIATED A \$42.50 PER BARREL LEVEL FOR PHASE I?

According to DOE documentation, the \$42.50 per barrel was a composite price derived from the market price of 30 percent jet fuel (JP-4) and 70 percent diesel fuel. DOE selected these two products in deriving the \$42.50 per barrel level because the phase I contract provides that Union would sell to the Department of Defense 33 million barrels of oil of which 30 percent would be JP-4 and 70 percent would be diesel fuel. The \$42.50 per barrel is adjusted quarterly based on a combination of two factors: 75 percent of the Gross National Product price deflator and 25 percent of the national average price that electric utilities pay for natural gas (natural gas index). As a result of these adjustments, the \$42.50 per barrel price support amount in June 1984 is about \$48 per barrel. Since the June 1984 weighted average price of JP-4 and diesel fuel is about \$34 per barrel, Union would have been entitled to a support payment of around \$14 per barrel at that time.

Unlike the phase I contract, the phase II price support level does not relate the price support amount to refined products. Corporation officials told us that the phase II support is based on its assessment of the minimal subsidy which the Corporation believes is necessary to induce Union to initiate the project.

In response to a Corporation solicitation for synthetic fuels projects, Union submitted a proposal for one 21,076 barrel per day phase II facility and requested \$2.6 billion in assistance with a \$65 per barrel price guarantee. The Corporation evaluated Union's proposal and subsequently negotiated a \$60 per barrel price guarantee plus a \$7 per barrel incentive for two 21,076 barrel per day facilities. The Project Officer told us that the Corporation, when evaluating Union's phase II proposal, conducted sensitivity analyses and developed an assistance structure which the Corporation believed would provide Union a "reasonable" return on its investment while providing the Corporation with protection to recover a "significant" amount of the outlays through the revenue sharing provisions negotiated.

In addition, the index used to adjust the \$67 per barrel price guarantee for phase II differs from that used in the phase I contract. The phase II letter states that the \$67 per barrel will be adjusted monthly by the Producer Price Index for Finished Consumer Goods, Excluding Food (nonseasonally adjusted). If the producer price index increases at a 5.5 percent rate (the rate the Corporation expects the Producer Price to increase), the \$67 per barrel could be about \$92 per barrel in December 1989 when increment I is scheduled to begin production. Since the Corporation estimated that the market price for the phase II product would be about \$48 per barrel in December 1989, Union would receive a support payment of about \$44 per barrel at that time.

Union officials told us that the \$67 per barrel price guarantee provides approximately the same financial return as the \$42.50

per barrel price guarantee for phase I when considering the time value of money, inflation, and increased construction, operating, and maintenance costs. While Corporation documentation shows that Union had expected about a 20 percent average annual rate of return for phase I in July 1981, the Corporation's April 1983 (more recent data on phase I is not available) analysis of the phase I economics showed that the average annual, after-tax rate of return could be 13.9 percent. The Corporation's January 1984 analyses of the phase II economics showed that the projected average annual after-tax rate of return for phase II increment I and for increments I and II combined is 20.6 percent.¹

HOW DOES UNION'S \$67 PER BARREL COMPARE WITH OTHER REQUESTS FOR FINANCIAL ASSISTANCE FOR OIL SHALE PROJECTS?

As noted earlier, there are three oil shale projects which could receive the \$4.94 billion targeted by the Corporation for oil shale development. Information on the financial terms of the other five projects under consideration is not available until the Corporation completes negotiations with the projects' sponsors. The following table compares the per barrel amounts proposed for the three projects.

| <u>Project</u> | <u>Estimated production (Barrels per day)</u> | <u>Proposed guarantee price</u> | <u>Type of assistance requested</u> |
|------------------|---|---------------------------------|-------------------------------------|
| Union phase II | 42,152 | \$67.00 | Price guarantee |
| Cathedral Bluffs | 14,100 | \$60.00 | Loan and price guarantee |
| Seep Ridge | 1,000 | \$42.50 | Loan and price guarantee |

According to the Corporation's Project Officer for Union, the differences in price per barrel resulted from negotiations related to the specific characteristics of each project and the amount needed to assure the sponsors a "reasonable" rate of return. These characteristics include construction costs, plant size, quantity of output expected, operating economies, degree of maturity of the technology, financial structure of the project, the type of assistance requested, and profit or revenue sharing negotiated.

For these reasons, this official stated that price guarantee amounts will differ among projects. For example, the Corporation offered Cathedral Bluffs a lower price per barrel than Union as a result of the above factors. Seep Ridge was offered a lower price per barrel than Union because, in addition to these factors, it

¹Analyses use nominal rates of return which are based on current year dollars and consider the impact of inflation.

does not plan to have a facility to upgrade the oil it produces. As a result, Seep Ridge's product will be of a lesser value than that produced by Union.

WILL PHASE II ASSISTANCE SUPPLEMENT
PHASE I OPERATIONS?

In the phase II financial information, there were no dollar amounts specifically targeted to supplement phase I operations. In addition, the Corporation's Project Officer for Union told us that the Corporation did not identify any funds targeted for phase I operations in its review of phase II costs. However, neither the phase I contract nor the phase II letter of intent restrict how Union uses the price support payments it receives.

The phase I contract limits the amount of assistance Union could receive to \$400 million. The payment is limited to the period beginning in July 1983 and ending on the earlier of (1) June 30, 1990 or (2) the date Union reaches 20 million barrels of synthetic fuels production. However, price support payments are not made until Union has produced a synthetic fuel which, as of July 20, 1984, has not occurred. Union is currently in its startup mode and neither Union nor Corporation officials could estimate when phase I would achieve sustained operations.

Since Union did not begin production in July 1983, it may not reach the 20 million barrels by June 30, 1990, and, therefore, may not receive the full \$400 million in assistance. It may also not receive the full \$400 million if the price differential remains at about \$14 per barrel of oil (see p. 11). For example, if Union produces 20 million barrels by June 1990 but the differential payment remains around \$14, Union would collect \$280 million (20 million barrels @ \$14 per barrel) of the \$400 million agreed upon price support. If Union needs additional funds to supplement phase I, it could use, according to Corporation officials, any funds it has available.

However, according to the phase II letter of intent, Union cannot use phase I production to claim reimbursement for phase II. According to Corporation officials, the two phases of the Union project are viewed separately. They also said that the design of the two projects--different mine, mountain, pipeline, and metering system--should provide for adequate monitoring and assurances that phase I production cannot be comingled with phase II production for purposes of calculating the price support payments. They further stated that provisions in the phase I contract and the proposed phase II contract² allow the Corporation to conduct onsite visits, reviews, audits, and testing to verify the amount and source of the oil on which Union would claim price support payments.

²Since December 1, 1983, the Corporation and Union have been working on a draft contract for phase II. Since the contract is in draft, the Corporation did not provide it for our review.

HOW WILL PHASE I AND PHASE II PRICE GUARANTEES
AFFECT UNION'S AFTER-TAX CASH FLOW?

The Chairman's office asked us to concentrate our review of the economic viability of the phase I and phase II projects to five factors: the potential tax effects; the investment that Union would have at risk and/or expect to realize after taxes; rate of return Union could expect from its investment and how such rates compare to returns for the petroleum industry; the effect on the government of the payment of price supports and possible revenue sharing; and the sensitivity of phase II's economics to changing energy prices, cost overruns, and different plant operating efficiencies. The following sections discuss each of these five factors.

Tax effects

Tax credits and benefits are available to the phase I and II projects. According to Union's Vice President of Budgets and Planning, Union expects to take all such credits and benefits in the year they are available. The types of tax credits and benefits available are investment tax credits (ITC), energy tax credits (ETC), production tax credits (PTC)³ and a depletion allowance for extracting a nonrenewable resource--shale.

The Corporation's analyses of Union's phase I and II projects estimated the value of tax effects as follows.

| <u>Phase</u> | <u>Tax effects^a</u> | | | |
|--------------------------------|---------------------------------------|------------|------------|----------------------------|
| | <u>ITC</u> | <u>ETC</u> | <u>PTC</u> | <u>Depletion allowance</u> |
| | -----millions of current dollars----- | | | |
| Phase I ^b | \$ 58.7 | \$ 31.3 | \$ 93.0 | \$ 328.1 |
| Phase II | | | | |
| increment I only | 211.7 | 125.9 | 98.2 | 1635.9 |
| increment I and II combined | 401.8 | 175.8 | 147.0 | 3393.9 |

^aITC and ETC accrue during construction and PTC during the period 1993 through 2000. Depletion allowance can be taken over the life of the project.

^bBased on data Union provided DOE in 1981 and incorporated into the Corporation's computer model in April 1983. The Corporation could not provide a more recent analysis of the phase I economics.

³Both phase I and phase II are eligible for production tax credits after energy tax credits have been offset if Union can meet certain milestones necessary to take advantage of these credits; for example, start of production by January 1, 1990.

Investment

After taking the above tax effects into consideration, Corporation documents showed that the phase I and phase II economics would be favorable after the year 2000. However, Union would be in a negative cash flow position during the early years of both projects.⁴

For phase I, the discounted present value⁵ of Union's cumulative after-tax cash flow through the year 2010 could be as high as \$252 million.⁶ However, it will take Union 16 years from the start of construction to experience a positive cumulative cash flow from phase I. During the lowest point of these 16 years, Union would have about \$585 million invested in the project.

For phase II increment I, the discounted present value of Union's cumulative after-tax cash flow through the year 2020 could be as much as \$1.3 billion.⁷ However, it will take Union 10 years from the start of construction to achieve a positive cumulative cash flow from increment I. At the lowest point during these 10 years, the maximum cumulative amount Union would have invested would be about \$1.1 billion. For increments I and II combined, the discounted present value of Union's cumulative after-tax cash flow could be as much as \$2.3 billion through the year 2020. However, it would take Union 11 years from the start of construction to achieve a positive cumulative cash flow. At the lowest point during these 11 years, the maximum cumulative amount Union would have invested would be about \$1.2 billion.

Internal rates of return

The after-tax internal rate of return Union could expect from the cash flows described above are shown in the following table.

⁴The Corporation's analyses of the projects' economics use current year dollars which do not correct for inflation. Since GAO normally analyzes long-term economic impacts based on constant dollars, we calculated, based on the Corporation's data, the economic impacts based on constant dollars. The investment discussion is based on a constant year dollar analysis.

⁵The technique to determine the amount of money which, if invested today at a selected interest rate, would be sufficient to meet expected future costs. We used a 10 percent discount rate which approximated the government's long-term cost of borrowing at the time these analyses were conducted.

⁶The Corporation's year-by-year and cumulative analyses of the phase I economics stop with the year 2010.

⁷As with the phase I economics, the Corporation's year-by-year and cumulative analyses of the phase II economics stop with the year 2010. However, for phase II the Corporation provided us additional information which allowed us to calculate the cumulative after-tax cash flow through the year 2020.

| <u>Phase</u> | <u>Internal rate of return</u> (current dollars) |
|--------------------------------|---|
| | ----percent--- |
| Phase I | 13.9 |
| Phase II | |
| increment I only | 20.6 |
| increment I and II combined | 20.6 |

The above internal rates of return are nominal rates based on a current year dollar analysis. If constant dollars are used, the internal rates of return for phase I would be 8.5 percent and for both phase II increment I, and increments I and II combined about 14 percent. The constant dollar results are, in effect the real (adjusted for inflation) after-tax internal rates of return.

We also compared Union's internal rates of return with the average return on investment for major petroleum companies for five sample years. The following table shows these returns.

| <u>Year</u> | <u>Rates of return</u> (current dollars) |
|-------------|---|
| | ----percent---- |
| 1970 | 8.3 |
| 1975 | 10.0 |
| 1980 | 17.0 |
| 1981 | 10.4 |
| 1982 | 8.6 |

The effects of revenue sharing
on price guarantee payments

Both the phase I contract and the phase II letter of intent include provisions whereby Union would share revenues with the Corporation should energy prices exceed certain limits (revenue sharing). In the phase I contract, Union's obligation to share revenues with the Corporation begins and ends at the same time as the Corporation's obligation for price support payments--July 1983 through June 1990. The revenue sharing provision does not become applicable until the weighted average price of JP-4 and diesel fuel exceeds by 25 percent the \$42.50 per barrel adjusted. The Corporation's analysis does not anticipate any revenue sharing under the phase I contract.

Unlike the phase I contract where the revenue sharing period is the same as the price guarantee period, the phase II letter of intent states that the revenue sharing period would extend beyond the price guarantee period. Union could be obligated to share revenues with the Corporation for a period of 16 years after the

date of initial production for increment I (estimated to be December 1989) if the market price of phase II's synthetic fuel product exceeds the following levels:

| | Market price per barrel (1983 dollars) | Revenue sharing | |
|----------------------------------|--|--------------------|--------------|
| | | <u>Corporation</u> | <u>Union</u> |
| | | -----percent----- | |
| During price guarantee period | \$67.01 and over | 70 | 30 |
| After price guarantee period | \$31.00 - \$32.55 | 0 | 100 |
| | \$32.56 - \$45.00 | 50 | 50 |
| | \$45.01 and over | 70 | 30 |

For example, for every dollar that the market price of phase II's synthetic fuel product exceeds \$67.01 during the price guarantee period, the Corporation would receive \$.70 and Union, \$.30. After the price guarantee period, if the price is between \$31 and \$32.55, the Corporation would receive nothing. For every dollar above the \$45.01 level, the Corporation would receive \$.70.

Although revenue sharing could start in December 1989, the Corporation's analysis for phase II increment I estimates that the \$1.95 billion in price guarantee assistance would be paid during a 7-year period and, for the next 9 years, the revenue sharing provisions would become applicable. For increment I, Union would not pay back the entire \$1.95 billion. It would pay the Corporation about \$1.55 billion. For both phase II increments, the Corporation estimates that Union would receive the entire \$2.7 billion guaranteed between 1989 and 1995. Then, revenue sharing would begin, and over the remaining 9 years of the revenue sharing period, the Corporation would receive \$445 million more than the \$2.7 billion it paid out. The Corporation's analyses of revenue payments made or received are not discounted to reflect the fact that these payments occur at different periods of time. The payments made and received should not be compared to each other without some adjustments to reflect timing differences.

Sensitivity of phase II economics

We found that phase II's economic viability varies somewhat when energy prices, plant operating efficiencies, and costs are changed from those used by the Corporation. The following table compares the after-tax nominal internal rates of return projected for increment I and for increments I and II combined shown in the table on page 16 to the internal rates of return that could be expected if the plant operates below the efficiency that the Corporation expects (92 percent), if costs exceed projections by

50 percent, and if energy prices are lower or higher than those used by the Corporation.⁸

| | <u>Increment I</u> | <u>Increments I and II</u> |
|----------------------|--------------------|----------------------------|
| | (current dollars) | |
| | -----percent----- | |
| Base Case | 20.6 | 20.6 |
| 60% plant efficiency | 15.2 | 15.7 |
| 80% plant efficiency | 18.5 | 18.9 |
| 50% cost overrun | 15.2 | 15.7 |
| low energy prices | 18.9 | 18.8 |
| high energy prices | 21.3 | 22.0 |

Even varying these factors, however, phase II's internal rate of return is within the range that the Corporation believes to be reasonable to encourage sponsors to initiate a synthetic fuels project.

⁸The Corporation estimated that energy prices between 1981 and 2010 would range from \$36 per barrel to \$219 per barrel. The low energy prices we used ranged from \$37 per barrel to \$143 per barrel and the high, from \$37 per barrel to \$301 per barrel. The year-by-year prices we used were based on the pessimistic and optimistic forecasts of an econometric forecasting firm--Data Resources Incorporated.

CHAPTER 4

QUESTIONS CONCERNING UNION'S PHASE I AND

PHASE II TECHNOLOGIES

The Chairman asked several questions concerning Union's phase I and phase II technologies and the effect of phase I's technical problems on contract execution for phase II. A discussion of these questions and our findings follow.

IS THE TECHNOLOGY TO BE USED TO BUILD PHASE II SUBSTANTIALLY DIFFERENT FROM, OR IS IT A REFINEMENT OF, THE TECHNOLOGY TO BE USED TO BUILD PHASE I?

Union built its phase I oil shale project using Unishale B technology and plans to use Unishale C for its phase II project. Unishale B and C are the same from mining through the retort. The equipment beyond the retort for phase II, according to Corporation officials, is substantially different and allows Union to extract energy--in the form of carbon--from the retorted shale (see pp. 2 and 3 for a description of these processes).

This energy extraction would take place in a fluidized bed combustor. The energy obtained from the retorted shale in the fluidized bed combustor will be used to heat the recirculating retort gas and to produce steam and electric power for other parts of the facility. Since the process gas is no longer required to heat the recirculating gas, it will be transported by pipeline to the upgrading facility where it replaces about 98 percent of the natural gas which is currently purchased for the upgrading facility. Union claims that the Unishale C process would result in operating cost savings of about 25 percent or \$6 per barrel over Unishale B. The Corporation's Senior Vice President for Projects told us that, if Union is successful in demonstrating these savings, this could encourage further oil shale development in the United States.

In the United States, coal traditionally has been used in fluidized bed combustors. Corporation officials told us that the commercial viability of the fluidized bed combustor and other equipment associated with it have not been demonstrated with shale. This equipment includes a high temperature, pressurized crusher, a "dusty" gas heat exchanger (equipment which extracts heat from "dirty" gas), and fluidized bed coolers (equipment which cools the spent shale leaving the fluidized bed combustor and produces steam).

Because this equipment has not been demonstrated commercially with shale, Union plans to test the fluidized bed combustor system in a test facility, costing between \$25 million and \$50 million, that will process about 400 tons per day of retorted shale. Union plans to build the test facility adjacent to the phase I retort. According to Corporation officials, the current draft of the phase II contract states that Union will not start constructing the test facility until after phase I operates at 50

percent of design capacity for 30 consecutive days. Union officials estimate it will then take at least 18 months to complete, operate, and evaluate the test data. After that time, Union officials stated that it will have the information necessary to decide to build phase II using Unishale C, to build it using Unishale B, or not build it at all.

Because the Unishale C system has not been demonstrated commercially, both Corporation and Union officials stated that they view Unishale C as a substantially different technology. Corporation officials also pointed out that the equipment to process the retorted shale is almost totally different from Unishale B, has never been used with shale before, and represents significant technical risk.

ARE THERE IMPEDIMENTS TO UNION'S ACHIEVING
THE EXPECTED ENERGY SAVINGS FROM
ITS PHASE II TECHNOLOGY?

Using Corporation data for the projected energy consumption for Unishale B and C, we found that the \$6 per barrel savings are possible if:

- the fluidized bed combustor can (1) reach the same heat transfer efficiencies as the gas-fired heat exchanger and (2) maintain combustion of the retorted shale without adding other fuel,
- the carbon content in the retorted shale is at least 3 percent, and
- natural gas prices increase beyond their present levels (about \$4.29¹ per million Btu's² in 1983 for industrial users).

We found, for example, that if the carbon content on the retorted shale is 3 percent, gas prices would have to be about \$6.40 per million Btu's for Union to realize the \$6 per barrel savings. If the carbon content is 4 percent, gas prices would have to be about \$4.80 per million Btu's for Union to achieve the savings.

Union officials maintain that the carbon content on the retorted shale is at least 4 percent. In addition, the Energy Information Administration estimates that natural gas prices in 1989--the estimated start of production for phase II--will be about \$5.50 per million Btu's. Therefore, if the carbon content is 4 percent and if natural gas prices reach \$5.50 as projected, Union could realize the expected energy savings from Unishale C if

¹From Energy Information Administration's Annual Energy Outlook, 1983.

²A British thermal unit (Btu) is the amount of energy necessary to raise the temperature of 1 pound of water 1 degree Fahrenheit at or near its point of maximum density.

the technology works as planned. However, the equipment efficiency and stability of combustion of the fluidized bed combustor system will not be known until Union tests it. Further, it is difficult to know whether the appropriate combination of factors cited above (equipment efficiency, stability of combustion, carbon content on the retorted shale, and price of natural gas) will occur. As a result, the savings expected may not be achieved, may be marginal, or may exceed Union's expectations.

Corporation officials are confident, based on their review of Union's engineering plans for the fluidized bed combustor system, that Unishale C could achieve the expected energy savings. They pointed out, however, that no one will really know until Union builds and operates the Unishale C test facility.

WILL UNION'S PHASE II TECHNOLOGY BE TRANSFERABLE TO OTHER OIL SHALE PROCESSES?

Corporation officials believe that, if Union is successful in demonstrating the energy efficiencies of its Unishale C technology, it could encourage greater development of a domestic oil shale industry. This assumes that Union's fluidized bed technology is transferable to other retort technologies.

According to the Project Officer for Union, the Corporation has not made a study to determine the transferability of Union's fluidized bed technology to other retorts. He did, however, identify four surface retorts--Paraho (indirect), Dravo, Petrosix, and Tosco³--which should be able to use it, although some modifications could be necessary. The assumptions he used in making this determination were that all these retorts (1) must purchase energy to operate their facilities, (2) have a heat exchanger in one form or another, and (3) produce a retorted shale which has sufficient carbon content remaining to produce a useful energy product such as electricity or steam.

Our review showed that there is potential for other surface retorts to use Union's fluidized bed combustion system although further study would be required. For other retorts to use Union's technology, they must produce a retorted shale with at least 3 percent carbon content and must have other technical factors similar to those expected from Union's process. These factors include (1) the rate at which gas flows into the retort, (2) the temperature of the gas when it enters the retort, and (3) the heating value of the retorted shale. We do not know, however, the extent of engineering effort that would be required to adapt Union's fluidized bed combustor system to retorts with a design different than Union's.

WHAT IS THE INCENTIVE ADJUSTMENT PROVISION?

The Corporation's letter of intent with Union contains a \$7 per barrel incentive adjustment provision in the \$67 per barrel

³Various oil shale processes named for the companies which developed them.

guaranteed price if Union can successfully demonstrate, build, and efficiently operate its Unishale C technology. Union would receive \$60 per barrel if it builds phase II with its Unishale B design or if specified economics will not be realized with Unishale C.

According to the Corporation's Project Officer for Union, the draft of the phase II contract includes a provision whereby Union must demonstrate during an "acceptance test" period that the project will realize at least one half (equivalent to \$3 per barrel) of the energy savings expected from the fluidized bed combustor. The acceptance test period will be for a "number of months" and "many millions" of barrels of oil. He did not, however, specify the exact time or number of barrels since the Corporation and Union are still involved in negotiations. If Union cannot demonstrate at least one half of the projected energy savings during the acceptance test period, it will not be entitled to any of the \$7 per barrel incentive. If, on the other hand, Union can demonstrate at least one half of the savings, it would be entitled to a \$3.50 per barrel incentive which could eventually be increased by a formula to \$7 per barrel depending on the additional energy savings achieved.⁴ The Corporation will have access, according to the Project Officer, to all phase II records in order to verify that Union met the prescribed objectives during the acceptance test period.

According to the Corporation's Project Officer for Union, the \$7 per barrel incentive is a means to encourage Union to make every effort to develop Unishale C as a commercial technology because of its potential energy savings. While Union is the Corporation's first attempt with such an incentive provision, the Project Officer pointed out that this type of financial incentive could conceivably be used again with future financial assistance awards.

Union officials told us that they do not view the \$7 per barrel as an incentive. Documentation from the Corporation shows that in December 1982 Union had proposed to build phase II using its Unishale B technology. According to the Project Officer, it was not until May 1983 that Union introduced its Unishale C technology into negotiations for the phase II project. Also during negotiations, the Corporation introduced, and Union accepted, a provision which states that if Union builds phase II with Unishale B technology, Union would receive a \$60 per barrel price support rather than \$67 per barrel. Union officials, therefore, view the \$7 per barrel as a penalty. However, if Union is successful in achieving the full \$6 per barrel energy savings, thereby enabling it to receive the additional \$7 per barrel incentive, the net effect would be a \$13 per barrel benefit to Union.

⁴Since the Corporation and Union are still negotiating the phase II contract, the Corporation would not provide specifics on the formula to be used to derive the additional incentive.

WILL THE CURRENT PROBLEMS ASSOCIATED WITH
BRINGING PHASE I ON LINE BE FULLY RECONCILED
PRIOR TO PHASE II CONTRACT EXECUTION?

Construction of phase I was completed on August 15, 1983. However, various components of the plant were completed prior to that time. For example, the mine was completed in February 1983, the upgrading facilities in April 1983, and the retort in August 1983. On October 20, 1983, Union made its first attempt to start the retort. Union officials stated that they had anticipated that phase I would operate at 50 percent of capacity by December 1983.

This, however, did not happen. Since October 20, 1983, Union has made about 20 unsuccessful attempts to operate the plant. While there were several problems in the earlier attempts, such as a faulty conveyor belt on the shale disposal equipment, the major problem, according to Union and the Corporation, was with a component called a "scraper" which removes the retorted shale from the top of the retort. Union redesigned the scraper and, in April 1984, tested the retort with it. According to a Corporation official, the scraper and retort worked "very well" and there was some confidence that the problem had been resolved. However, as of July 1984, Union continued to experience technical problems with equipment which processes the retorted shale and has not yet proven that phase I will work.

To provide assurances that Union will not proceed with phase II until the phase I problems have been resolved, the draft phase II contract includes provisions, according to Corporation and Union officials, requiring Union to demonstrate the "successful startup" of phase I. Although the definition of successful startup is still under negotiation, the draft contract states that Union will operate phase I at least at 50 percent of design capacity for 30 consecutive days.

The draft contract, according to Corporation officials, also contains a renegotiated "contract administration fee"⁵ whereby the portion of the fee Union would be required to pay prior to successful startup for phase I would be reduced. The total contract administration fee set out in the December 1, 1983, letter of intent was about \$6.8 million. Three payments were designated: \$3.4 million at the time of contract execution; \$2.4 million at the time Union decided to construct increment I or December 31, 1986, whichever was earlier; and about \$1 million at the time Union decided to construct increment II or December 31, 1990, whichever was earlier.

According to the Corporation's Project Officer for Union, the total contract administration fee of \$6.8 million has not

⁵The Energy Security Act states that the Corporation may require a fee--up to 1 percent of the financial assistance to be provided. Such fees may be used by the Corporation for administrative costs associated with the contract. According to the Project Officer for Union, should a sponsor abandon the project, the fee is not refunded.

changed in the draft contract, but the number of installments have. Rather than the three installments in the letter of intent, Union would make four: (1) \$750,000 at the time of contract execution, (2) after Union successfully operates phase I at 50 percent of design capacity for 30 days, (3) when Union decides to construct increment I, and (4) when Union decides to construct increment II. This official would not, however, specify the amounts for the other three installments.

OIL SHALE PROJECTS CONSIDERED BY THE CORPORATION

| <u>Project Name and Location</u> | <u>Project Sponsors</u> | <u>Technology Proposed</u> | <u>Status or Reason for Withdrawal</u> |
|---|--|---|---|
| ACTIVE PROJECTS | | | |
| Parachute Creek Phase I Colorado | Union Oil Company of California | Union surface retort - Unishale B | Contract awarded by DOE on July 29, 1981 |
| Parachute Creek Phase II Colorado | Union Oil Company of California | Union surface retort - Unishale C | Letter of intent signed December 1, 1983 |
| Cathedral Bluffs Colorado | Occidental Oil Shale, Inc.; Tenneco Shale Oil Company; Peter Kiewit Sons, Inc. | Occidental modified in situ and Union Unishale B surface retort | Letter of intent signed July 28, 1983 |
| Seep Ridge Utah | Geokinetics, Inc.; Peter Kiewit Sons, Inc. | Geokinetics' "LOPRECO" in situ extraction | Letter of intent signed on June 22, 1984 |
| Paraho-Ute Utah | Paraho Development Corp.; Raymond International Corp.; Signal Cos., Inc.; Texas Eastern Corp. | Paraho surface retort - direct heating | Still in third solicitation, reached key financial terms, has until 9/1/84 to meet the Corporation's conditions |
| American Sym-Crude Indiana | American Sym-Crude Corp.; Stone & Webster | "Petrolix" surface retort | Reapplied in June 1984 |
| Cottonwood Wash Utah | American Mine Services Corp.; Desert Generation & Transmission Corp.; Foster Wheeler Energy Corp.; Magic Circle Energy Corp. | Paraho surface retort | Reapplied in June 1984 |
| Edwards Engineering (Site Undetermined) | Edwards Engineering Corp. | Edwards anaerobic metal surface retort | Reapplied in June 1984 |
| Means Oil Shale Kentucky | Central Pacific Minerals, N.L.; Dravo Corp.; Southern Pacific Petroleum, N.L. | Dravo traveling grate retort | Reapplied in June 1984 |
| INACTIVE PROJECTS | | | |
| Agency Draw Utah | Geokinetics, Inc. | Tosco II surface retort | Corporation dropped in July 1982 because the project did not meet its evaluation criteria |
| Colony Colorado | Exxon Corp.; Tosco (The Oil Shale Co.) | Tosco II surface retort | Contract awarded by DOE, Exxon withdrew for economic reasons |
| Montex Oil Shale (Site Undetermined) | Montex International, Inc. | Montex fuel alloys acetal process | Corporation dropped in April 1983 because Montex was not a qualified bidder |
| Multi-Mineral Colorado | Charter Oil Co. | Its own integrated in-situ process | Corporation dropped because it failed to meet the January 1982 deadline for further information |
| Pacific Colorado | Cleveland Cliffs Iron Co.; Standard Oil Co. of Ohio; Superior Oil Co. | Superior Oil/Davy McKee circular grate retort | Sponsor withdrew because it could not pass evaluation criteria |
| Parachute Colorado | Mobil Oil Co. | Retort process not specified | Corporation dropped in January 1982 because it did not meet evaluation criteria |
| Plateau Utah | Suburban Propane Gas Corp. | Raw shale oil upgrading and refining | Corporation dropped because it failed to meet January 1982 deadline for submitting information |
| Rio Blanco Colorado | Gulf Oil Corp.; Standard Oil Co of Indiana | Lurgi surface retort | Corporation dropped because it failed to meet January 1982 deadline for submitting information |
| Shale Development Utah | Shale Development Corp. | ENDECO I direct combustion and surface retort | Corporation dropped because it failed to meet January 1982 deadline for submitting information |
| Shaleglass Colorado | Nielson Resources Corp.; Sorg Engineering | Sorg cellular glass process to produce glass | Corporation dropped in January 1982 because it failed to meet evaluation criteria |
| Silmon Smith Colorado | Shale Energy Corp. of America | Surface retort | Corporation dropped in February 1983 because it failed to meet evaluation criteria |
| Syntana-Utah Utah | Magic Circle Energy Corp.; Quintana Mineral Corp.; Synthetic Oil Corp. | Superior circular grate retort | Sponsor withdrew because it did not submit technical proposal and competitive bid by June 1, 1983 deadline |
| U.S. Shale Oil Tennessee | U.S. Shale Oil, Inc. | Everman hot oil retort | Corporation dropped in January 1983 because it failed to meet evaluation criteria |
| White River Utah | Phillips Petroleum Corp.; Standard Oil Co. of Ohio; Sunoco Energy Development Corp. | Union's Unishale B surface retort | Project sponsor—SOHIO—dropped out in January 1984 for economic concerns, did not elaborate |
| Wolf Den Utah | Geokinetics, Inc. | Geokinetics "LOPRECO" in situ process | Corporation dropped in March 1983 because it failed to meet evaluation criteria |

AN EQUAL OPPORTUNITY EMPLOYER

UNITED STATES
GENERAL ACCOUNTING OFFICE
WASHINGTON, D C 20548

OFFICIAL BUSINESS
PENALTY FOR PRIVATE USE \$300

POSTAGE AND FEES PAID
U S GENERAL ACCOUNTING OFFICE



THIRD CLASS

NOV 19 1974 PM

17