DOE/FE-0194P

Comprehensive Report to Congress Clean Coal Technology Program

ENCOAL Mild Coal Gasification Project

A Project Proposed By: ENCOAL Corporation

U.S. Department of Energy
Assistant Secretary for Fossil Energy
Office of Clean Coal Technology
Washington, D.C. 20585

June 1990

TABLE OF CONTENTS

TABLE OF CONTENTS
(Continued)

PAGE

1.0 EXECUTIVE SUMMARY

In September 1988, Congress provided $575 million to conduct cost-shared Clean Coal Technology (CCT) projects to demonstrate technologies that are capable of retrofitting or Repowering existing facilities. To that end, a Program Opportunity Notice (PON) was issued by the Department of Energy (DOE) in May 1989, soliciting proposals to demonstrate innovative energy efficient technologies that were capable of being commercialized in the 1990's, and were capable of (1) achieving significant reductions in the emissions of sulfur dioxide and/or the oxides of nitrogen from existing facilities to minimize environmental impacts such as transboundary and interstate pollution and/or (2) providing for future energy needs in an environmentally acceptable manner.

In response to the PON, 48 proposals were received in August 1989. After evaluation, 13 projects were selected in December 1989 as best furthering the goals and objectives of the PON. The projects were located in 10 different states and represented a variety of technologies. A proposal by ENCOAL Corporation was one of those selected for negotiation.

ENCOAL Corporation (ENCOAL), a wholly-owned subsidiary of Shell Mining Company of Houston, Texas, has requested financial assistance from DOE for the design, construction, and operation of a 1,000 ton per day mild gasification demonstration plant at the Buckskin Mine near Gillette, Wyoming. The demonstration plant would utilize the Liquids from Coal (LFC) technology developed by Shell Mining Company and SGI International of La Jolla, California. The demonstration project would last approximately 48 months at a total cost of $72,564,000. DOE's share of the project cost would be 50 percent, or $36,282,000.

LFC Technology involves the mild gasification of coal at moderate temperatures and near atmospheric pressure to produce two marketable products. Both products are new low-sulfur fuel forms. The high heating value, low-sulfur solid is called Process Derived Fuel (PDF). The low-sulfur, heavy-hydrocarbon liquid is called Coal Derived Liquid (CDL). The process chemically modifies the feed coal to create the two new fuel forms and also removes most of the moisture and some of the sulfur, depending on the sulfur form in the feed coal. A key to the process is SGI International's proprietary control system that optimizes the product specifications based on market needs and the feed coal composition.

The proposed demonstration plant would be put in service by the first quarter of 1992. The plant would be designed and operated as a small commercial facility and would be expected to produce sufficient quantities of PDF and CDL to conduct full-scale test burns of the products in industrial and utility boilers. Feed coal for the plant would be purchased from the Buckskin Mine which is owned and operated by Triton Coal Company (a wholly-owned subsidiary of Shell Mining Company). Other United States coals could be shipped to the demonstration plant from time to time for test processing.

ENCOAL has received a permit to construct the demonstration plant from the Wyoming Department of Environmental Quality, Air Quality Division. It was approved on the basis of the use of best available technology for the control of sulfur dioxide, nitrogen dioxide, carbon monoxide, hydrocarbons, and particulate. There will be no waste water or toxic solid wastes generated by the demonstration plant. Source water requirements will have a very minimal environmental impact at the site.

The demonstration plant could ultimately have a very favorable impact on sulfur dioxide ($S0_2$) emissions in the United States if the project is successful. ENCOAL has estimated that the new fuel forms, PDF and CDL, from one commercial plant using the LFC Technology would reduce SO emissions by about 160,000 tons per year when burned at utility customers' plants.

In addition to ENCOAL, which will be the signatory to the Cooperative Agreement and will own and operate the demonstration plant, the project team will include TEK-KOL (a partnership between Shell Mining Company (SMC) and SGI International) , the owner, developer, licenser, and commercializer of the LFC Technology; The M. W. Kellogg Company, which will be the engineering, procurement, and construction contractor; Triton Coal Company, a wholly-owned subsidiary of SMC, which will provide the project site, existing facilities, and raw feed coal; and Shell Mining Company, which will provide equity to ENCOAL for all non-DOE funds.

2.0 INTRODUCTION AND BACKGROUND

The domestic coal resources of the United States play an important role in meeting current and future energy needs. During the past 20 years considerable effort has been directed to developing improved coal combustion, conversion, and utilization processes to provide efficient and economic energy options. These technology developments permit the efficient use of coal in a cost-effective and environmentally acceptable manner.

2.1 REQUIREMENT FOR A REPORT TO CONGRESS

On September 27, 1988, Congress made available funds for the third clean coal demonstration program (CCT-III) in Public Law 100-446, “An Act Making Appropriations for the Department of the Interior and Related Agencies for the Fiscal Year Ending September 30, 1989, and for Other Purposes” (the “Act”). Among other things, this Act appropriates funds for the design, construction, and operation of cost-shared, clean coal projects to demonstrate the feasibility of future commercial applications of such “... technologies capable of retrofitting or Repowering existing facilities . ...” On June 30, 1989, Public Law 101-45 was signed into law, requiring that CCT-III projects be selected no later than January 1, 1990.

Public Law 100-446 appropriated a total of $575 million for executing CCT-III. Of this total, $6.906 million are required to be reprogrammed for the Small Business and Innovative Research Program (SBIR) and $22.548 million are designated for Program Direction Funds for costs incurred by DOE in implementing the CCT-III program. The remaining, $545.546 million, was available for award under the PON.

The purpose of this Comprehensive Report is to comply with Public Law 100-446, which directs the Department to prepare a full and comprehensive report to Congress on each project selected for award under the CCT-III Program.

2.2 EVALUATION AND SELECTION PROCESS

DOE issued a draft PON for public comment on March 15, 1989, receiving a total of 26 responses from the public. The final PON was issued on May 1, 1989, and took into consideration the public comments on the draft PON. Notification of its availability was published by DOE in the Federal Register and the Commerce Business Daily on March 8, 1989. DOE received 48 proposals in response to the CCT-III solicitation by the deadline, August 29, 1989.

2.2.1 PON Objective

As stated in PON Section 1.2, the objective of the CCT-III solicitation was to obtain "proposals to conduct cost shared Clean Coal Technology projects to demonstrate innovative, energy efficient technologies that are capable of being commercialized in the 1990's. These technologies must be capable of (1) achieving significant reductions in the emissions of sulfur dioxide and/or the oxides of nitrogen from existing facilities to minimize environmental impacts such as transboundary and interstate pollution and/or (2) providing for future energy needs in an environmentally acceptable manner."

2.2.2 Qualification Review

The PON established seven Qualification Criteria and provided that, "In order to be considered in the Preliminary Evaluation phase, a proposal must successfully pass Qualification." The Qualification Criteria were as follows:

(a) The proposed demonstration project or facility must be located in the United States.

(b) The proposed demonstration project must be designed for and operated with coal(s) from mines located in the United States.

(c) The proposer must agree to provide a cost share of at least 50 percent of total allowable project cost, with at least 50 percent in each of the three project phases.

(d) The proposer must have access to, and,use of, the proposed site and any proposed alternate site(s) for the duration of the project.

(e) The proposed project team must be identified and firmly committed to fulfilling its proposed role in the project.

(f) The proposer agrees that, if selected, it will submit a "Repayment Plan" consistent with PON Section 7.4.

(g) The proposal must be signed by a responsible official of the proposing organization authorized to contractually bind the organization to the performance of the Cooperative Agreement in its entirety.

2.2.3 Preliminary Evaluation

The PON provided that a Preliminary Evaluation would be performed on all proposals that successfully passed the Qualification Review. In order to be considered in the Comprehensive Evaluation phase, a proposal must be consistent with the stated objective of the PON, and must contain sufficient business and management, technical, cost, and other information to permit the Comprehensive Evaluation described in the solicitation to be performed.

2.2.4 Comprehensive Evaluation

The Technical Evaluation Criteria were divided into two major categories: (1) Demonstration Project Factors used to assess the technical feasibility and likelihood of success of the project, and (2) Commercialization Factors used to assess the potential of the proposed technology to reduce emissions from existing facilities, as well as to meet future energy needs through the environmentally acceptable use of coal, and the cost effectiveness of the proposed technology in comparison to existing technologies.

The Business and Management Criteria required a funding plan and an indication of financial commitment. These were used to determine the business performance potential and commitment of the proposer.

The PON provided that the cost estimate would be evaluated to determine the reasonableness of the proposed cost. Proposers were advised that this determination "will be of minimal importance to the selection, " and that a detailed cost estimate would be requested after selection. Proposers were cautioned that if the total project cost estimated after selection is greater than the amount specified in the proposal, DOE would be under no obligation to provide more funding than had been requested in the proposer's cost sharing plan.

2.2.5 Program Policy Factors

The PON advised proposers that the following program policy factors could be used by the Source Selection Official to select a range of projects that would best serve program objectives:

(a) The desirability of selecting projects that collectively represent a diversity of methods, technical approaches, and applications.

(b) The desirability of selecting projects in this solicitation that contribute to near term reductions in transboundary transport of pollutants by producing an aggregate net reduction in emissions of sulfur dioxide and/or the oxides of nitrogen.

(c) The desirability of selecting projects that collectively utilize a broad range of U.S. coals and are in locations which represent a diversity of EHSS, regulatory, and climatic conditions.

(d) The desirability of selecting projects in this solicitation that achieve a balance between (1) reducing emissions and transboundary pollution and (2) providing for future energy needs by the environmentally acceptable use of coal or coal-based fuels.

The word "collectively" as used in the foregoing program policy factors, was defined to include projects selected in this solicitation and prior Clean Coal solicitations, as well as other ongoing demonstrations in the United States.

2.2.6 Other Considerations

The PON provided that in making selections, DOE would consider giving preference to projects located in states for which the rate-making bodies of those states treat the Clean Coal Technologies the same as pollution control projects or technologies, This consideration could be used as a tie breaker if, after application of the evaluation criteria and the program policy factors, two projects receive identical evaluation scores and remain essentially equal in value. This consideration would not be applied if, in doing so, the regional geographic distribution of the projects selected would be altered significantly.

2.2.7 National Environmental Policy Act (NEPA) Compliance

As part of the evaluation and selection process, the Clean Coal Technology Program developed a procedure for compliance with the National Environmental Policy Act of 1969, the Council on Environmental Quality (CEQ) NEPA regulations (40 CFR Parts 1500-1508) and the DOE guidelines for compliance with NEPA (52 F.R. 47662, December 15, 1987).

This procedure included the publication and consideration of a publicly available Final Programmatic Environmental Impact Statement (DOE/EIS-0146) issued in November 1989, and the preparation of confidential preelection project-specific environmental reviews for internal DOE use. DOE also prepares publicly available site-specific documents for each selected demonstration project as appropriate under NEPA.

2.2.8 Selection

After considering the evaluation criteria, the program policy factors, and the NEPA strategy as stated in the PON, the Source Selection Official selected 13 projects as best furthering the objectives of the CCT-III PON.

Secretary of Energy, Admiral James D. Watkins, U.S. Navy (Retired), announced the selection of 13 projects on December 21, 1989. In his press briefing, the Secretary stated he had recently signed a DOE directive setting a 12-month deadline for the negotiation and approval of the 13 cooperative agreements to be awarded under the CCT-III solicitation.

3.0 TECHNICAL FEATURES

3.1 PROJECT DESCRIPTION

ENCOAL proposes to construct and operate a demonstration plant to produce two new low-sulfur fuels; a solid, PDF, and a liquid, CDL. The plant will process 1,000 tons per day of Powder River Basin sub-bituminous coal to produce PDF and CDL at an overall yield of 60 percent by weight; however, 90 percent of the heating value will be recovered. The PDF is a stable, high-Btu fuel similar in composition and handling properties to eastern bituminous coals. CDL is a liquid fuel similar in properties to a low-sulfur No. 6 fuel oil,

The demonstration project uses a mild gasification process based on LFC Technology developed by SGI International and the Shell Mining Company. A simplified process diagram of the proposed process is illustrated in Figure 1. The process causes chemical changes in the feed coal by drying and heating it under carefully controlled conditions. This devolatilizes and decomposes the coal, producing gases and a solid residue. The gases are cooled and partially condensed to form CDL, while the solids are cooled and further processed to make PDF. The remaining gases are burned in the process for heat.

The project will demonstrate the integrated operation of several process steps:

- Coal drying on a rotary grate using convective heating.
- Coal devolatilization on a rotary grate using convective heating.
- Hot particulate removal with cyclones.
- Integral solids cooling and deactivation/passivation.
- Combustors operating on low-Btu gas from internal streams.
- Solids stabilization for storage and shipment.

The site of the ENCOAL project is located within Campbell County, Wyoming, at Triton Coal Company's Buckskin Mine, 10 miles north of Gillette (Figure 2), The plant will be built to make use of the present coal handling facilities at the mine. The product fuels are expected to be used economically in commercial boilers and furnaces and to significantly reduce sulfur emissions at industrial and utility facilities currently burning high sulfur bituminous fuels or fuel oils, thereby reducing acid rain-causing pollutants.

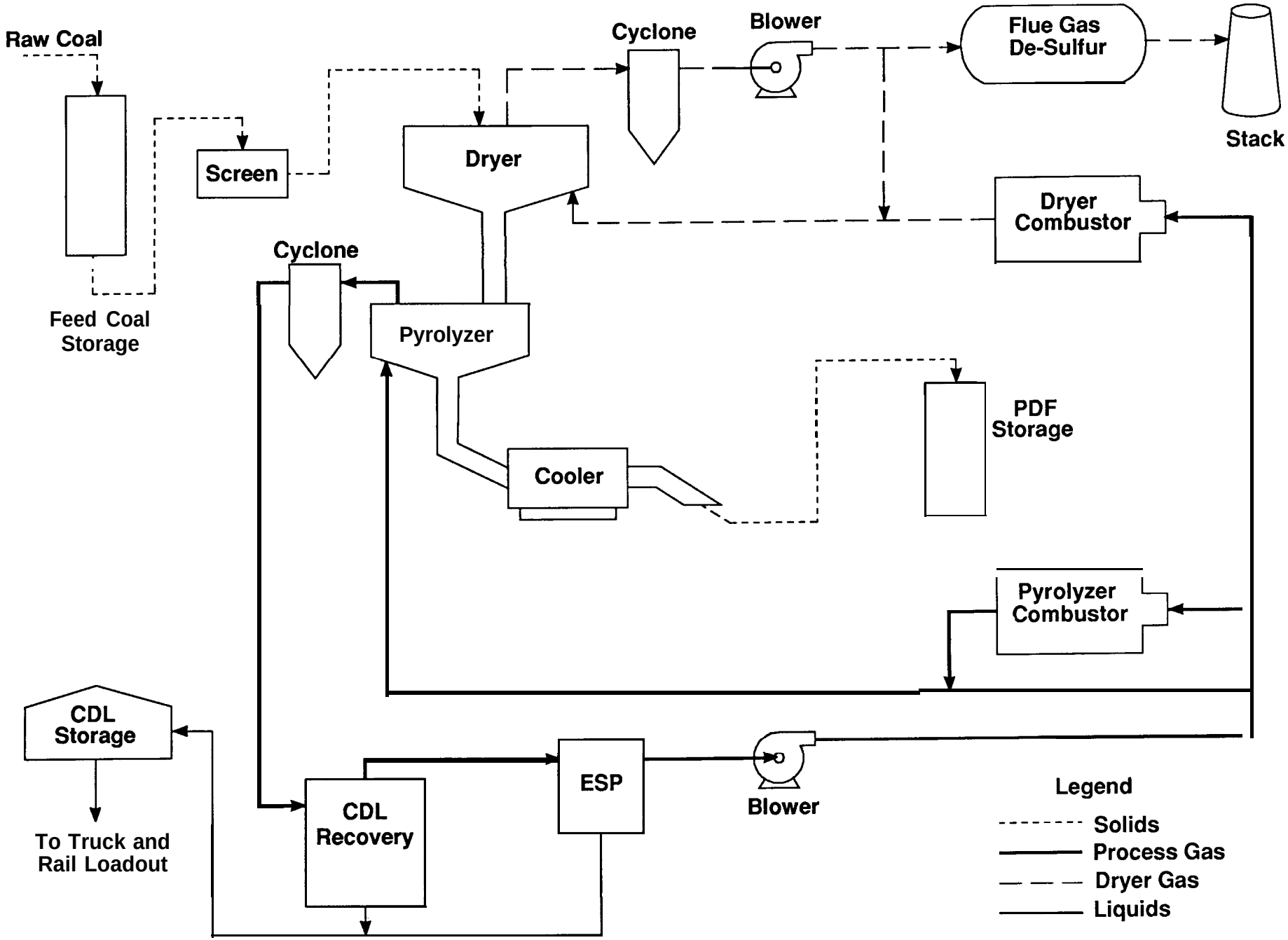
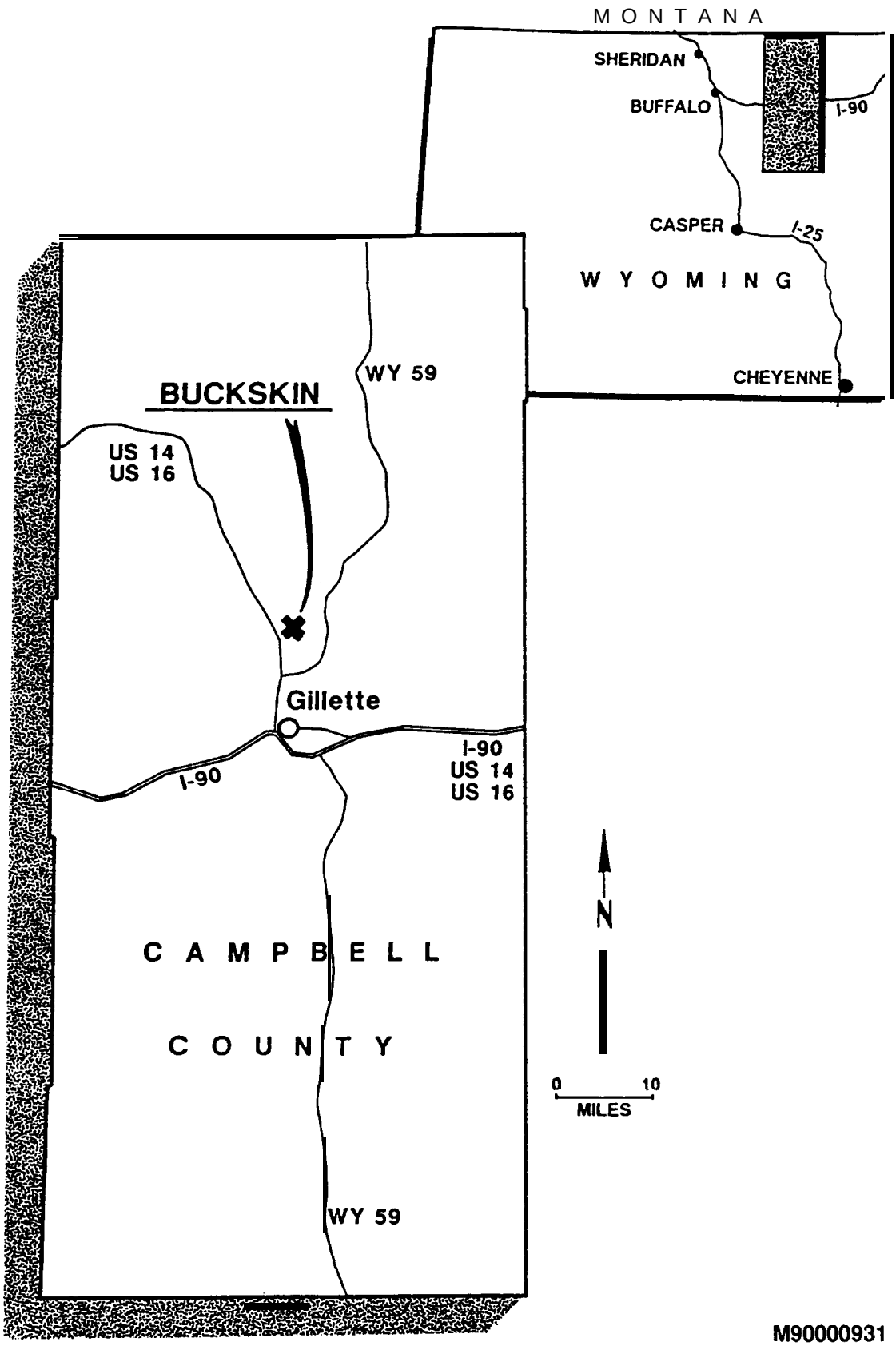


Figure 1. Simplified Flow Diagram

M90002922

Figure 2. ENCOAL Project Location



3.1.1 Project Summary

Title:	ENCOAL Mild Coal Gasification Project.
Proposer:	ENCOAL, a wholly-owned subsidiary of Shell Mining Company.
Team Members:	ENCOAL Corporation, Triton Coal Company, Shell Mining Company, TEK-KOL, SGI International, The M. W. Kellogg Company.
Location:	Buckskin Mine, Campbell County, Wyoming.
Technology:	Mild gasification based on SGI International's LFC Technology.
Application:	Produce solid and liquid new fuel forms suitable for utility and commercial boilers and furnaces.
Type of Coal Used:	Powder River Basin sub-bituminous coal.
Products:	Solid and liquid fuels.
Project Size:	1,000 tons of coal per day throughput.
Project Start Date:	August 1990.
Project End Date:	August 1994.

3.1.2 Project Sponsorship and Cost

Project Sponsor:	ENCOAL Corporation,
Co-Funders:	ENCOAL and U.S. Department of Energy.
Estimated Project Cost:	$72,564,000
Cost Distribution:	Participant Share, 50 percent. DOE Share, 50 percent.

3.2 MILD GASIFICATION PROCESS

3.2.1 Overview of Process Development

The ENCOAL project uses mild coal gasification based on LFC Technology, a process originally developed by SGI International of La Jolla, California, to produce from sub-bituminous coal two new low-sulfur fuels, PDF and CDL. There are two elements in the LFC Technology that differentiate it from other coal gasification technologies. First, the technology takes into consideration the

coal heating rate and temperature level, which affect the governing kinetics of gasification reactions. Second, for the purpose of controlling the gasification condition to get the desired end product, SGI International has developed working computer models of reaction kinetics and control methods,

The LFC Technology was developed using a program of laboratory tests in retorts of increasing size. The scale-up involved bench-scale development units whose batch processing capacity was 4 pounds and a 44-pound batch process test unit. Throughout the bench-scale test program, computer models were developed to assist with the ultimate process design and commercialization of the LFC Technology. Data from the tests were used to calibrate and verify the computer models.

The successful bench-scale tests and computer modeling led to the construction of a process development unit (PDU) in 1986 to produce design information and products for analysis. The PDU is located at Salem Furnace Company's development laboratory in Pittsburgh, Pennsylvania. The PDU underwent extensive changes as development of the LFC Technology evolved. Originally a batch system, the PDU was upgraded in late 1987 to operate in a semi-continuous manner at an equivalent input rate of 200-pounds per hour of wet coal. Shell Mining Company conducted a number of campaigns at the PDU in 1987 and 1988 to generate products from Buckskin coal for product yield analyses and property evaluations in support of the project. The PDU was approximately 1/500 of the demonstration plant scale for the dryer and 1/350 for the pyrolyzer.

The dryer and pyrolyzer to be used in the demonstration project are engineered equipment that are currently in commercial use and require only a few small modifications, Planned processing steps and plant equipment other than the dryer and pyrolyzer are essentially "off-the-shelf" items and have been individually proven in the industry, although operating the processing steps and plant equipment in an integrated manner is yet to be demonstrated.

ENCOAL has developed a data base sufficient for process design through extensive laboratory and PDU research programs by process modeling, by reference to literature and by the use of experts in the field including personnel from SGI International, Shell Mining Company, The M. W. Kellogg Company, vendors, and consultants.

3.2.2 Process Description

The ENCOAL mild coal gasification process as shown in Figure 1 involves heating coal under carefully controlled conditions. Nominal 3-inch by O-inch run-of-mine coal is conveyed from the existing Buckskin Mine to a storage silo. The coal from this silo is screened to remove oversize and undersize materials. The specification coal feed, 2-inch x l/8-inch size, is then fed into a rotary grate dryer where it is heated by a hot gas stream. The residence time and temperature of the inlet gas have been selected to reduce the moisture content of the coal without initiating chemical changes. The solid bulk temperature is controlled so that no significant amounts of methane, carbon monoxide, or carbon dioxide are released from the coal.

The solids from the dryer are then conveyed to the pyrolyzer where the temperature is further raised to about l,000°F on another rotary grate by a hot recycle gas stream. The rate of heating of the solids and their residence time are carefully controlled, since these parameters affect the properties of both solid and liquid products. During processing in the pyrolyzer, all remaining free water is removed, and a chemical reaction occurs which results in the release of volatile gaseous material. Solids exiting the pyrolyzer are quickly quenched to stop the pyrolysis reaction, then are cooled and transferred to a surge bin. Since the solids have no surface moisture and, therefore, are likely to be dusty, a dust suppressant is added as they leave the PDF product surge bin.

The gas produced in the pyrolyzer is sent through a cyclone for removal of the particulate and then cooled to stop any additional pyrolysis reactions and to condense the desired liquids. Only the CDL is condensed in this step; the condensation of water is avoided.

Most of the residual gas from the condensation unit is recycled directly to the pyrolyzer, while some is first burned in the pyrolyzer combustor before being blended with the recycled gas to provide heat for the mild gasification reaction. The remaining gas is burned in the dryer combustor, which converts sulfur compounds to sulfur oxides (SOX). Nitrogen oxide emissions are controlled via staged air injection by appropriate design of the combustor. The hot flue gas from the dryer combustor is blended with the recycled gas from the dryer to provide the heat and gas flow necessary for drying.

The off-gas from the dryer is treated in a venturi scrubber and a horizontal scrubber, both using a water-based sodium carbonate solution. The venturi recovers the fine particulate that escape the dryer cyclone, and the horizontal scrubber removes most sulfur oxides from the flue gas. The treated gas is vented to a stack. The spent solution is discharged into a pond for evaporation.

3.3 GENERAL FEATURES OF PROJECT

3.3.1 Evaluation of Developmental Risk

Subsequent to selection and as a part of the fact-finding process, DOE performed a detailed evaluation of the ENCOAL Project and determined it to be reasonable and appropriate. The evaluation focused on the project's technical, schedule, and cost risks. A team of experts from within DOE and available under contract contributed to the evaluation. The data base for the evaluation included ENCOAL-furnished documentation and DOE fact-finding discussions with ENCOAL.

The ENCOAL mild gasification process contains several features which have been tested to various degrees at laboratory scale or have been commercially used in similar applications. However, they have not been previously combined in a single system operated at a credible scale. As with any new or emerging technology, there is an element of risk involved with its continued development and scale-up. Since most elements of the ENCOAL mild gasification process

have been demonstrated at commercial scale and the major plant equipment is essentially of an off-the-shelf type, this process is for the most part comprised of proven features.

The 48-month schedule allows sufficient time for the detailed design, construction, start-up and operation of the grassroots demonstration plant. The schedule presented in Section 6.2 shows a rather short detailed design and permitting period. This reflects the high degree of completion already achieved by the Participant in these areas. Since all needed equipment is essentially commercially available, little risk to the planned schedule is expected by DOE". A short overlap of Phase I with Phase II also anticipates timely completion of the NEPA process and reflects the Participant's need to complete certain critical civil engineering activities prior to the winter season. Both NEPA completion and permitting activities should be facilitated by the on-going operation of the Buckskin Mine at the site. The Phase II schedule has allotted sufficient time for full component and integrated system evaluation at full load prior to moving into the operation phase. Finally, recognizing the need to produce large quantities of the two new low-sulfur fuel forms for commercial or utility evaluation, a 24-month period of operation in Phase III is planned.

The cost estimate, evaluated during the fact-finding process, was based to a large extent upon firm vendor bids and budget quotations. Where quotations were not available, costs were estimated by consultants using an extensive data base of similar, commercially available equipment and applying appropriate scaling factors. Major systems were estimated on an installed cost basis which included not only equipment items, but also related bulk materials and all subcontractors' costs. A financial risk analysis program was used by DOE to evaluate the risk in the estimate. This analysis indicated that there was a very low risk that the proposed cost would be exceeded.

3.3.1.1 Similarity of Project to Other Demonstration and Commercial Efforts

The LFC Technology, which is the technical basis for the ENCOAL Project, is similar to long-standing coal devolatilization processes which produced smokeless fuels and a variety of chemicals from coal. The ENCOAL Project, however, is expected by the Participant to demonstrate superior equipment design, control systems, and environmental performance.

More recent coal conversion studies in the United States have embarked on low-temperature, low-pressure coal upgrading techniques. These techniques are exemplified in a number of commercial coal drying processes using various dryer configurations. However, the products from these processes usually include only solid fuels, the solid product being dry but typically having the same chemical and elemental composition as the feed coal, The ENCOAL process is similar to these coal upgrading techniques in that a feed coal drying step using a rotary kiln type dryer is included. However, the ENCOAL process produces gaseous, liquid and solid products with the gaseous fuel used internally within the process. The solid product does not resemble the feed coal, but has lower sulfur content and higher heating value due to the chemical changes carried out in the process. The liquid product is similar to a low-sulfur No. 6 fuel oil.

Compared to conventional coal gasification processes, the Participant believes that the mild gasification route is more economic because of the mild operating conditions and a much simpler processing scheme. Low cost alloys can be used for construction, contributing to a lower plant cost. The simpler processing scheme also results in lower operating costs. The operating conditions of the mild gasification process can be varied to obtain a different mix of products with desirable qualities to maximize the net income considering all feedstock, operating, distribution, and capital costs.

3.3.1.2 Technical Feasibility

The ENCOAL mild coal gasification process is based on coal conversion technologies which are similar, in large degree, to both long-standing and contemporary coal upgrading techniques. Its process steps have been individually well-documented and applied on a commercial scale. Plant equipment in the ENCOAL project is predominantly commercially available with minor modifications. The project is backed by a comprehensive database obtained from extensive laboratory and developmental work. Sophisticated computer models can be used for process control and for demonstrating plant performance in an integral fashion,

Technical risks associated with the project include performance of the dryer combustor and the pyrolyzer cyclone, integration of the various innovative features into a single process, and overall system performance. However, all of these risks can be readily addressed through normal engineering practices associated with the design, construction, and operation of a large integrated plant. The successful operation of the individual features at commercial scale indicates that with a proper system engineering design they can be successfully operated in an integrated fashion. Further, all components are typical of those in use in the industry today; therefore, no unusual design or fabrication techniques will be required.

3.3.1.3 Resource Availability

All of the resources required for the project are available. ENCOAL will provide the Participant share of the project financing by way of equity contributions from SMC.

The 10.5-acre site for the ENCOAL project is located within the boundaries of the existing, operating Buckskin Mine. The property is owned by SMC and leased to the Triton Coal Company, a subsidiary of SMC. The site has been subleased to ENCOAL for the duration of the demonstration project. Essential infrastructure services are available including water, natural gas, rail and highway access, electric service, and sanitary waste disposal.

Resources for lifetime operation of the ENCOAL project (including manpower, coal, water, and transportation) are available in the region. Within the Gillette area, ENCOAL anticipates that abundant skilled and unskilled labor will be readily available.

3.3.2 Relationship Between Project Size and Protected Scale of Commercial Facility

The demonstration plant has been designed to be as simple as possible and does not require first-of-a-kind equipment. Even in a large commercial operation where the equipment size conceivably could be 10 times the size of the demonstration equipment, still only off-the-shelf type, commercially available equipment will be required. Discussions have been held between ENCOAL and prospective utility and industrial customers, and test burn contracts to evaluate the use of the plant product have been drafted. ENCOAL believes that the size of the demonstration plant has been chosen not only to prove the LFC Technology, but to provide a sufficient volume of product for full-scale customer testing, The Participant believes that scale-up from the demonstration scale to a commercial scale should be a smooth transition.

3.3.3 Role of Project in Achieving Commercial Feasibility of Technology

This project will demonstrate the integrated operation of a number of novel operating steps to produce two new low sulfur fuel forms from mild gasification of low sulfur sub-bituminous coal.

The project will provide:

- The final technical demonstration needed for the process.
- Needed data on the process effects upon the environment and plant equipment.
- Sufficient products for large-scale commercial plant test burns.
- Applicable economics, technical, and environmental experience necessary to support commercialization decisions.

Successful demonstration of the project will prove the feasibility of the process to produce viable products, thus enabling potential end-users to make informed business decisions concerning use of the novel fuel products.

4.0 ENVIRONMENTAL CONSIDERATIONS

The NEPA compliance procedure, cited in Section 2.2, contains three major elements: a Programmatic Environmental Impact Statement (PEIS); a pre-election, project-specific environmental analysis; and a post-selection, site-specific environmental analysis. DOE issued the final PEIS to the public in November 1989 (DOE/EIS-0146}. In the PEIS, results derived from the Regional Emissions Database and Evaluation System (REDES) were used to estimate the environmental impacts that. might occur in 2010 if each technology were to reach full commercialization, capturing 100 percent of its applicable

market. These impacts were compared to the no-action alternative, which assumed continued use of conventional coal technologies through 2010 with new plants using conventional flue gas desulfurization to meet New Source Performance Standards,

Next, the pre-selection, project-specific environmental review focusing on environmental issues pertinent to decision-making was completed for internal DOE use. The review summarized the strengths and weaknesses of each proposal against the environmental evaluation criteria. It included, to the extent possible, a discussion of alternative sites and/or processes reasonably available to the offeror, practical mitigating measures, and a list of required permits. This analysis was provided for the Source Selection Official's use before the selection of proposals.

As the final element of the NEPA strategy, the Participant (ENCOAL Corporation) submitted the environmental information specified in the PON. This detailed site- and project-specific information formed the basis for the NEPA documents prepared by DOE. These documents, prepared in compliance with 40 CFR Parts 1500-1508, must be approved before Federal funds can be provided for any activity that would limit the choice of reasonable alternatives to the proposed action.

In addition to the NEPA requirements outlined above, the Participant must prepare and submit an Environmental Monitoring Plan (EMP) for the project. The purpose of the EMP is to ensure that sufficient technology, project, and site environmental data are collected to provide health, safety, and environmental information for use in subsequent commercial applications of the technology.

The expected performance characteristics and applicable market for the mild gasification technology were used to estimate the environmental impacts in 2010 which would result from full commercialization of mild gasification. The REDES model was used to compare mild gasification technology impacts to the no-action alternative.

From a programmatic viewpoint, Table 1 shows the projected environmental. impacts from maximum commercialization of the mild gasification technology, both nationally and regionally, in 2010. Negative percentages indicate decreases in emissions or wastes, while positive percentages indicate increases in emissions or wastes as compared to the no-action alternative. These results should be regarded as approximations of actual impacts. They include emissions from the mild gasification plant and further assume that the mild gasification products replace all residual oil use in utility and industrial boilers.

Table 1. Projected Environmental Impacts in 2010, Mild Gasification (Percent Change over No-Action Alternative)

Region	Sulfur Dioxides	Nitrogen Oxides	Carbon Dioxide	Solid Wastes
National	- 5%	- 2%	+1%	+14%
Northeast	- 7%	- 4%	+1%	+17%
Southeast	- 9%	- 2%	+1%	+16%
Northwest	- 2%	- 2%	0	+8%
Southwest	<-1%	<-1%	0	+19%

Source: Programmatic Environmental Impact Statement (DOE/EIS-0146) November 1989.

As shown in Table 1, the overall trend presented by the analysis for commercialization of the mild gasification technology shows decreases in both sulfur dioxide and nitrogen oxides emissions, a slight increase in carbon dioxide emissions, and a small increase in solid waste production (<20% in all sectors). The largest reductions of sulfur dioxide and nitrogen oxides emissions occur in the eastern regions. The quadrants and Federal regions used in the PEIS are depicted in Figure 3.

For the ENCOAL project, the solid waste production is expected to be minimal, resulting primarily from the flue gas desulfurizer. The solids resulting from the process comprise the process derived fuel, which is marketed as a value--added product. The flue gas desulfurization wastes will be contained on-site in a disposal facility constructed to meet industrial waste disposal standards and applicable environmental regulations.

5.0 PROJECT MANAGEMENT

5.1 OVERVIEW OF MANAGEMENT ORGANIZATION

The ENCOAL Corporation, a wholly-owned subsidiary of the Shell Mining Company, has aqreed to execute the ENCOAL Mild Coal Gasification Project. Figure 4 depicts the organization of the project team. ENCOAL will be the signatory to the Cooperative Agreement and will be the owner, manager, and operator of the demonstration plant. ENCOAL will manage the project through a Project Manager, who will be assisted by a team of technical and managerial personnel. The engineering, procurement, and construction of the plant has been contracted to The M. W. Kellogg Company. Coal will be purchased from the site host, Triton Coal Company. Triton will also provide access to the site, associated facilities, and administrative services. Equity and product marketing services for the project will be provided by the Shell Mining

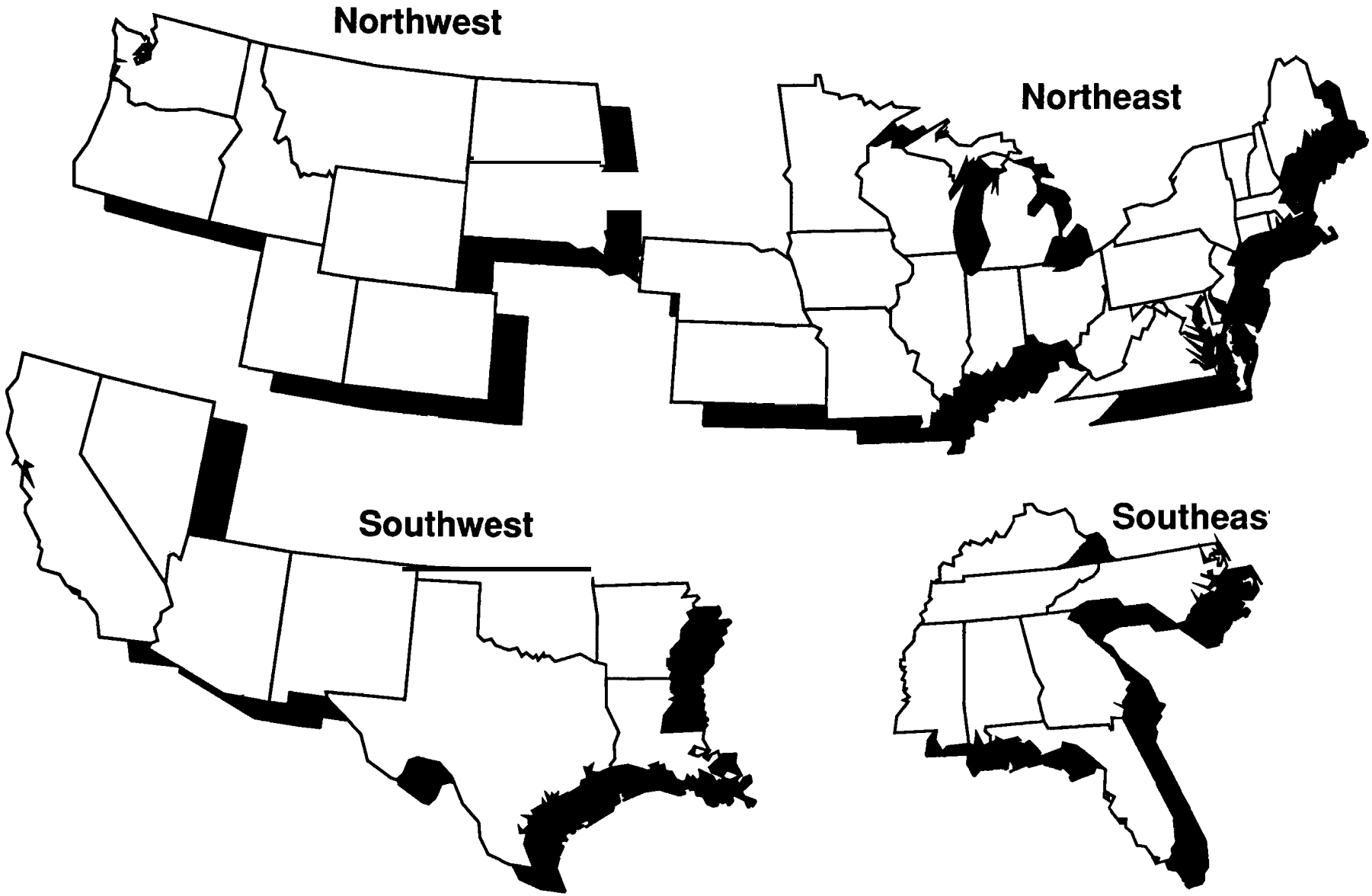
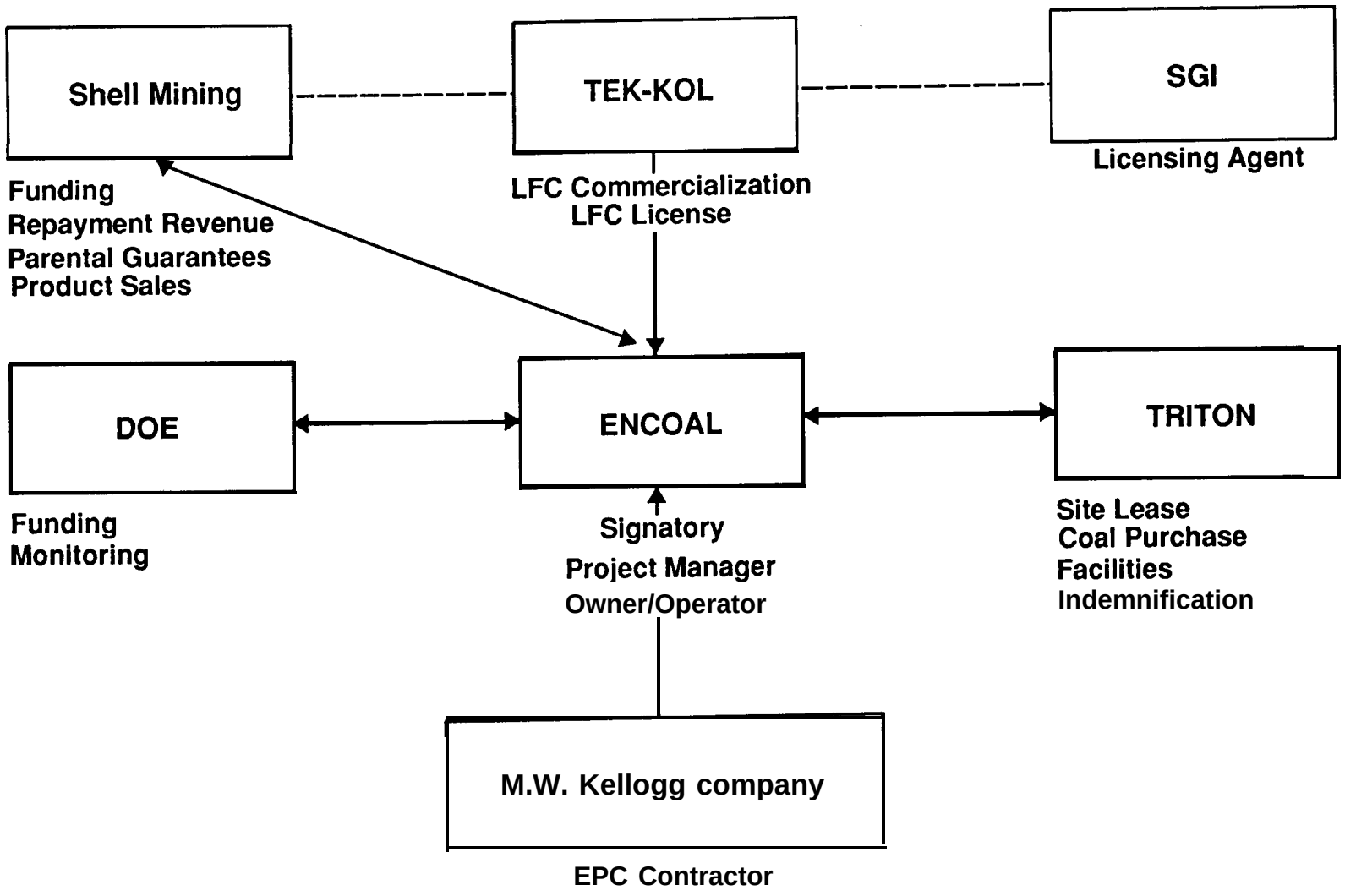


Figure 3. Quadrants for the Conterminous United States

M90002468

Figure 4. ENCOAL Project Organization



M90001 363

Company. Additional technical development support will be provided by TEK-KOL, which will also have the primary responsibility for commercialization, All assets will be assigned to ENCOAL Corporation and all technology rights for future commercialization will be provided to TEK-KOL by ENCOAL.

5.2 IDENTIFICATION OF RESPECTIVE ROLES AND RESPONSIBILITIES

5.2.1 DOE

DOE will be responsible for monitoring all aspects of the project and for granting or denying approvals required by the Cooperative Agreement. A DOE Project Manager will be designated by the DOE Contracting Officer. The Project Manager will be the primary point of contact for the project and will be responsible for DOE management of the project.

5.2.2 Participant

ENCOAL, as the Participant, will be responsible for all aspects of the project, including design, permitting, construction, operation, data collection, and reporting. The Participant will utilize the services of (a) The M. W. Kellogg Company who will design and construct the plant; (b) the Triton Coal Company who will provide the site and certain facilities and infrastructure vital to the project; (c) TEK-KOL who will provide all necessary rights to the LFC Technology being demonstrated; and (d) the Shell Mining Company who is providing financing, technical and marketing services, and other support functions. The Participant will designate a full-time Project Manager, who will be responsible for all technical and administrative activities to be performed under the Cooperative Agreement. This full-time Project Manager will report to the Program Manager of Coal Ventures who, in turn, reports to the President of ENCOAL and the President of Shell Mining Company.

5.3 PROJECT IMPLEMENTATION AND CONTROL PROCEDURES

ENCOAL will prepare and maintain a project management plan that presents project procedures, controls, schedules, budgets, and other activities required to adequately manage the project. This document, which will be finalized shortly after execution of the Cooperative Agreement, will be used to implement and control project activities. Throughout the course of the project, reports dealing with the technical, management, cost, and environmental monitoring aspects of the project will be prepared and provided to DOE. The project will be divided into two budget periods of 24 months duration each, corresponding to the design and construction activities (Phases I and II) and plant operations (Phase III), respectively.

5.4 KEY AGREEMENTS IMPACTING DATA RIGHTS, PATENT WAIVERS, AND INFORMATION REPORTING

With respect to data rights, DOE has negotiated terms and conditions that will generally provide for rights of access by DOE to all data generated or used in the course of or under the Cooperative Agreement by ENCOAL and its subcontractors. DOE will have unlimited rights to nonproprietary data first produced in the performance of the Cooperative Agreement and limited rights of access to

proprietary data utilized in the course of the demonstration. DOE will have the right to have relevant proprietary information delivered to it under suitable conditions of confidentiality.

With regard to patents, data, and other intellectual property, ENCOAL has made an express contractual commitment to exercise its best efforts to commercialize, in the United States, the mild coal gasification technology demonstrated in this project. This will be accomplished through an agreement between ENCOAL and TEK-KOL which commits TEK-KOL to promote commercial-size facilities worldwide for responsible applicants and to provide appropriate technical assistance, training, and licensing of patents and proprietary technology.

5.5 PROCEDURES FOR COMMERCIALIZATION OF TECHNOLOGY

Design, construction, and operation of the ENCOAL Project plant to demonstrate the novel mild coal gasification concept is a vital step in the commercialization of the LFC Technology. To earn the confidence of potential users, it is essential that a demonstration of the technology at a fully commercial scale be conducted to produce sufficient quantities of the low-sulfur, high heat content new fuel forms for combustion testing. Demonstration of the technology with commercially available and large-scale equipment will provide valuable information for the private sector to use in making future commercialization decisions. The fact that the demonstration plant can be used for continued commercial operation at the conclusion of this project will serve to further confirm and encourage its acceptability as an entry-size commercial plant and will serve to provide a valuable benchmark for future larger designs.

Once the LFC Technology is successfully demonstrated at the 1000-tons-per-day scale, the availability of this technology to the coal industry, and its products to the utility industry, should result in substantial penetration into the commercial market. Commercialization will likely be driven by the industry's need to provide ever-increasing quantities of high-energy, low-sulfur solid and liquid fuels for meeting the country's electric and thermal requirements. Important commercialization data from this project will include the results of several utilities' actual experience using these new fuel forms in their commercial-sized burners. The expected compatibility and acceptability of the novel fuels in such applications will provide a significant incentive for rapid commercialization. Additional incentive will derive from the simplicity of the processing technology, its reasonable cost, and its environmentally benign nature.

6.0 PROJECT COST AND EVENT SCHEDULING

6.1 PROJECT BASELINE COSTS

The estimated cost and the cost sharing for the work to be performed under the Cooperative Agreement are as follows:

Pre-Award

DOE Share	$ 235,000	50%
Participant Share	235,000	50%
Total	$ 470,000	100%

Phase I

DOE Share	$ 5,495,000	50%
Participant Share	5,495,000	50%
Total	$10,990,000	100%

Phase II

DOE Share	$19,906,000	50%
Participant Share	$19,906,000	50%
Total	$39,812,000	100%

Phase III

DOE Share	$10,646,000	50%
Participant Share	$10,646,000	50%
Total	$21,292,000	100%

Total Estimated Project Cost

DOE Share	$36,282,000	50%
Participant Share	$36,282,000	50%
Total	$72,564,000	100%

At the beginning of each budget period, DOE intends to obligate sufficient funds to pay its share of the expenses for that period.

6.2 MILESTONE SCHEDULE

The project is divided into three phases and is expected to take 48 months to complete. The phases and their expected durations are as follows:

Phase I:	Design and Permitting	9 Months
Phase II:	Procurement, Construction, and Start-Up	22 Months
Phase III:	Operation and Data Collection	24 Months

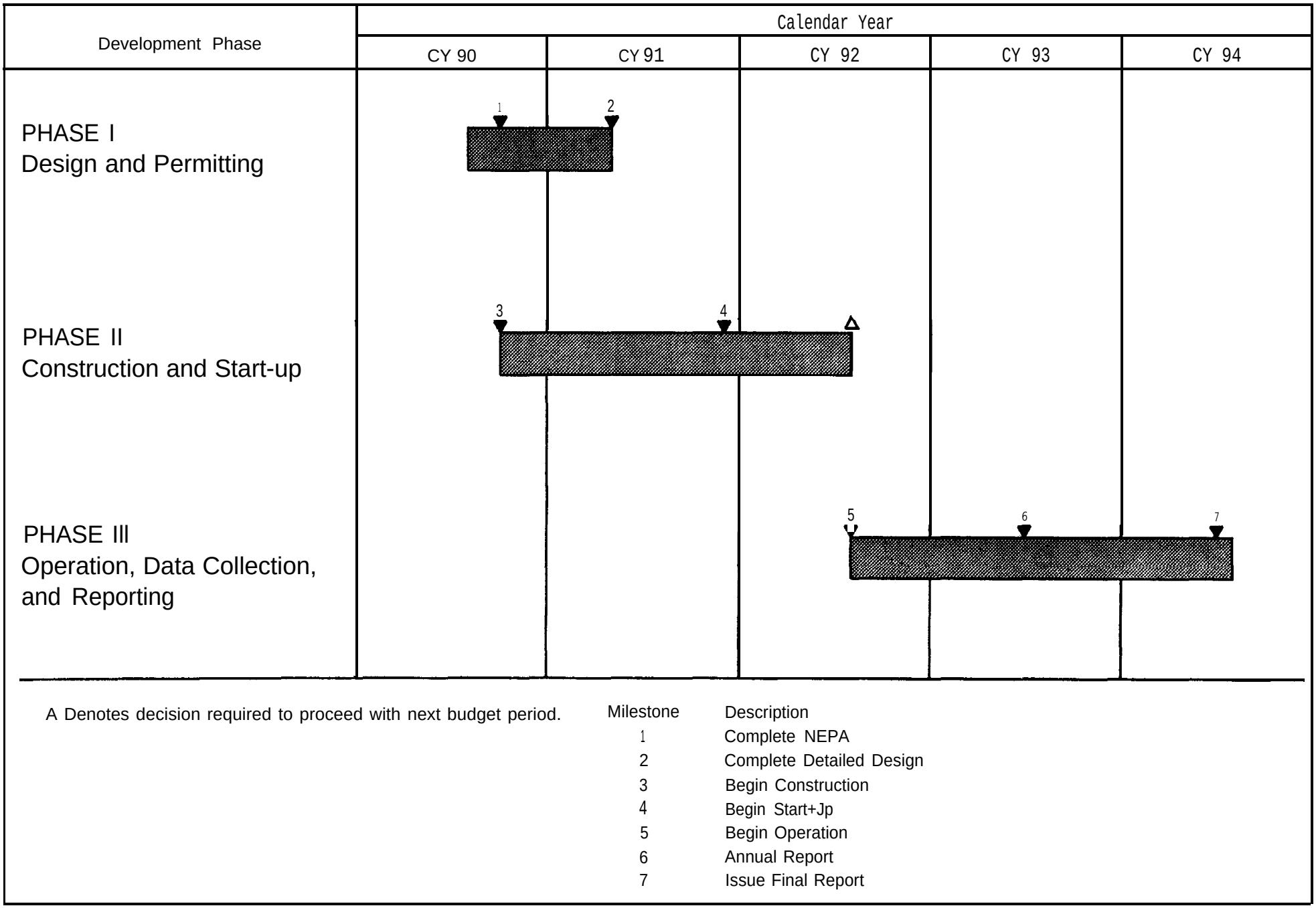
Phases I and II overlap by 7 months. The completion of the NEPA process will be required for DOE to share costs beyond Phase I.

A project schedule that includes the major milestones is shown in Figure 5.

6.3 REPAYMENT AGREEMENT

Based on DOE's recoupment policy as stated in Section 7.4 of the PON, DOE is to recover an amount up to the Government's contribution to the project. The Participant has agreed to repay the Government in accordance with a negotiated Repayment Agreement to be executed at the time of award of the Cooperative Agreement.

Figure 5 Milestone/Project Schedule



A Denotes decision required to proceed with next budget period.

Milestone	Description
1	Complete NEPA
2	Complete Detailed Design
3	Begin Construction
4	Begin Start+Jp
5	Begin Operation
6	Annual Report
7	Issue Final Report

M90001060