DOE/FE-0266P
Distribution Category UC-101

Comprehensive Report to Congress Clean Coal Technology Program

Self-Scrubbing Coal™: An Integrated Approach to Clean Air

**A Project Proposed By:
Custom Coals International**

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

October 1992

TABLE OF CONTENTS

TABLE OF CONTENTS

1.0 EXECUTIVE SUMMARY

Public Law No. 101-121 provided $600 million to conduct cost-shared Clean Coal Technology (CCT) projects to demonstrate technologies that are capable of replacing, retrofitting, or repowering existing facilities. Toward that end, a Program Opportunity Notice (PON) was issued by the Department of Energy (DOE) in January 1991. This PON solicited proposals to demonstrate innovative, energy efficient technologies capable of being commercialized in the 1990s. These technologies were to be capable of (1) achieving significant reductions in the emissions of sulfur dioxide and/or nitrogen oxides 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, 33 proposals were received by DOE in May 1991. After evaluation, nine projects were selected for award. These projects involved both advanced pollution control technologies that can be "retrofitted" to existing facilities and "repowering" technologies that not only reduce air pollution but also increase generating plant capacity and extend the operating life of the facility.

One of the nine projects selected for funding is a project proposed by Custom Coals International (CCI) entitled "Self-Scrubbing Coal·: An Integrated Approach to Clean Air." This project will provide a commercial demonstration of the Custom Coals Coal Cleaning (CCCC) process for producing Carefree Coal· and Self-Scrubbing Coal·, as well as full-scale burns of the products in coal-fired utility boilers.

The Self-Scrubbing Coal· project involves the construction of a 350 tons/hr advanced coal cleaning plant that will be designed with a unique blend of existing and new process steps. In the cleaning plant, run-of-mine coal is crushed, screened, and cleaned in a proprietary dense-media cyclone circuit, using ultrafine magnetite slurries, to remove noncombustible material, including up to 90% of the pyritic sulfur in the coal. The Carefree Coal· produced by this cleaning process will allow many utilities to achieve compliance with the Clean Air Act Amendments (CAAA) sulfur emissions requirements.

Deep cleaning alone, however, cannot produce a compliance fuel from coals with high organic sulfur contents. In these cases, Self-Scrubbing Coal· will be produced. Self-Scrubbing Coal· is the same as Carefree Coal· except that the finest fraction from the cleaning circuit is mixed with limestone-based additives and pelletized. These additives react during combustion to remove an additional 70-80% of the sulfur remaining with the clean coal, thus achieving a total sulfur removal of 80-90%. Three U.S. coal seams (Sewickley, Lower Freeport, and Illinois No. 5), representing a range of raw coal qualities, will be the source of the feedstock.

The demonstration cleaning plant will be constructed at a site near Stoystown, Pennsylvania. The product from the demonstration plant will be test burned at three sites. Duquesne Light's 570 MW Cheswick Power Station near Pittsburgh, Pennsylvania, will burn Carefree Coal· produced from Sewickley Seam coal. Richmond Power & Light's (RP&L) 60 MW Whitewater Valley Station, Unit No. 2, in Richmond, Indiana, will burn Self-Scrubbing Coal· produced from Illinois No. 5 coal, and Centerior Service Company's 200 MW Ashtabula C-Plant in Ashtabula, Ohio, will burn Self-Scrubbing Coal· produced from Lower Freeport Seam coal. Data collected during these test burns will be critical to commercialization of Carefree Coal· and Self-Scrubbing Coal·. About 38% of the bituminous coal burned in 50-MW or larger generating stations in the U.S. cannot be sufficiently cleaned by conventional coal cleaning techniques to meet CAAA emissions limits, but this coal can be brought into compliance by the CCI technology.

This demonstration will be conducted over 38 months. Project activities include project definition, design and engineering, construction, start-up, operations, and test burns.

The total project cost is $81,726,346. DOE's share is $38,038,656. The co-funder is CCI, whose share is $43,687,690. Operations are scheduled to begin in 1994. The project is scheduled for completion in the first quarter of 1996.

2.0 INTRODUCTION AND BACKGROUND

2.1 Requirement for a Report to Congress

On October 23, 1989, Congress made available funds for the fourth clean coal demonstration program (CCT-IV) in Public Law 101-121, "An Act Making Appropriations for the Department of the Interior and Related Agencies for the Fiscal Year Ending September 30, 1990, 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 November 5, 1990, Public Law 101-512 was signed into effect, requiring "a general request for proposals for CCT-IV by no later than February 1, 1991, and to make selections of projects for negotiations no later than eight months after the date of the general request for proposals."

Public Law 101-121 appropriates a total of $600 million for executing CCT-IV. Of this total, $7.2 million are required to be reprogrammed for the Small Business Innovative Research Program (SBIR), and $25.0 million are designated for Program Direction Funds for costs incurred by DOE in implementing the CCT-IV program. The remaining $567.8 million was available for award under the PON.

The purpose of this report is to comply with Public Law 101-512, which directs the Department to prepare a full and comprehensive report to Congress on each project selected for award under the CCT-IV program.

2.2 Evaluation and Selection Process

DOE issued a draft PON for public comment on November 20, 1990, receiving a total of 19 responses from the public. The final PON was issued on January 15, 1991, and took into consideration the public comments received on the draft PON. DOE received 33 proposals in response to the CCT-IV solicitation by the May 17, 1991, deadline.

2.2.1 PON Objective

As stated in PON Section 1.2, the objective of the CCT-IV solicitation was to obtain "proposals to conduct cost-shared Clean Coal Technology projects to demonstrate innovative, energy efficient, economically competitive technologies that are capable of being commercialized in the 1990s. These technologies must be capable of (1) retrofitting, repowering or replacing existing facilities while achieving significant reductions in the emissions of sulfur dioxide and/or the oxides of nitrogen 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% of total allowable project costs, with at least 50% 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 7.7.

(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 objectives of the PON and must contain sufficient information on finance, management, technical, cost, and other areas 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) the Demonstration Project Factors were used to assess the technical feasibility and likelihood of success of the project, and (2) the Commercialization Factors were 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 Cost and Finance Evaluation criteria 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 original 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 nitrogen oxides.

(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.

(e) The desirability of selecting projects that provide strategic and energy security benefits for remote, import-dependent sites, or that provide multiple fuel resource options for regions which are considerably dependent on one fuel form for total energy requirements.

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 stated 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 received identical evaluation scores and remained essentially equal in value. This consideration would not be applied if, by so doing, the regional geographic distribution of the projects selected would be significantly altered.

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 (NEPA), the Council on Environmental Quality NEPA regulations (40 CFR 1500-1508), and the DOE guidelines for compliance with NEPA (52 FR 47662, December 15, 1987). DOE final NEPA regulations replacing the DOE guidelines were published in the Federal Register on April 24, 1992 (57 FR 15122). 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 preselection 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 nine projects as best furthering the objectives of the CCT-IV PON. These selections were announced on September 12, 1991, during a press conference.

3.0 TECHNICAL FEATURES

3.1 Project Description

CCI will demonstrate the production and utilization of Carefree Coal· and Self-Scrubbing Coal· by constructing a processing plant and having the product clean coal test burned in utility burners. Figure 1 presents a schematic flow diagram of the project. Three U.S. coal seams (Sewickley Seam, Greene County, Pennsylvania; Lower Freeport Seam, Belmont County, Ohio; and Illinois No. 5 Seam, Wabash County, Illinois), representing a range of raw coal properties, will be the source of the feedstock. Carefree Coal· is coal cleaned in a proprietary dense-media cyclone circuit, using ultrafine magnetite slurries, to remove noncombustible material, including up to 90% of the pyritic sulfur. The Carefree Coal· produced by this cleaning process will allow many utilities to achieve compliance with the CAAA sulfur emissions requirements without major power plant modifications or capital expenditures.

Deep cleaning alone, however, cannot produce a compliance fuel from coals with high organic sulfur contents. In these cases, Self-Scrubbing Coal· will be produced. Self-Scrubbing Coal· is the same as Carefree Coal· except that the finest fraction from the cleaning circuit is mixed with limestone-based additives and pelletized. The reduced ash content of the Self-Scrubbing Coal· will permit the addition of relatively large amounts of sorbent without exceeding boiler ash specifications or overloading electrostatic precipitators. This additive reacts with sulfur dioxide (SO_2) during combustion of the coal to remove most of the remaining sulfur. Overall sulfur reductions in the range of 80-90% are achieved.

The CCI demonstration coal cleaning plant will be constructed at a site near Stoystown, Pennsylvania, as shown in Figure 2. ICF Kaiser Engineers, Inc. (Kaiser) will provide the design and engineering for the project. Test burns will be conducted by Duquesne Light, RP&L, and Centerior Service Company. Duquesne Light's 570 MW Cheswick Power Station near Pittsburgh will burn Carefree Coal· produced from Sewickley Seam coal. RP&L's 60 MW Whitewater Valley Power Station in Richmond, Indiana, will burn Self-Scrubbing Coal· produced from

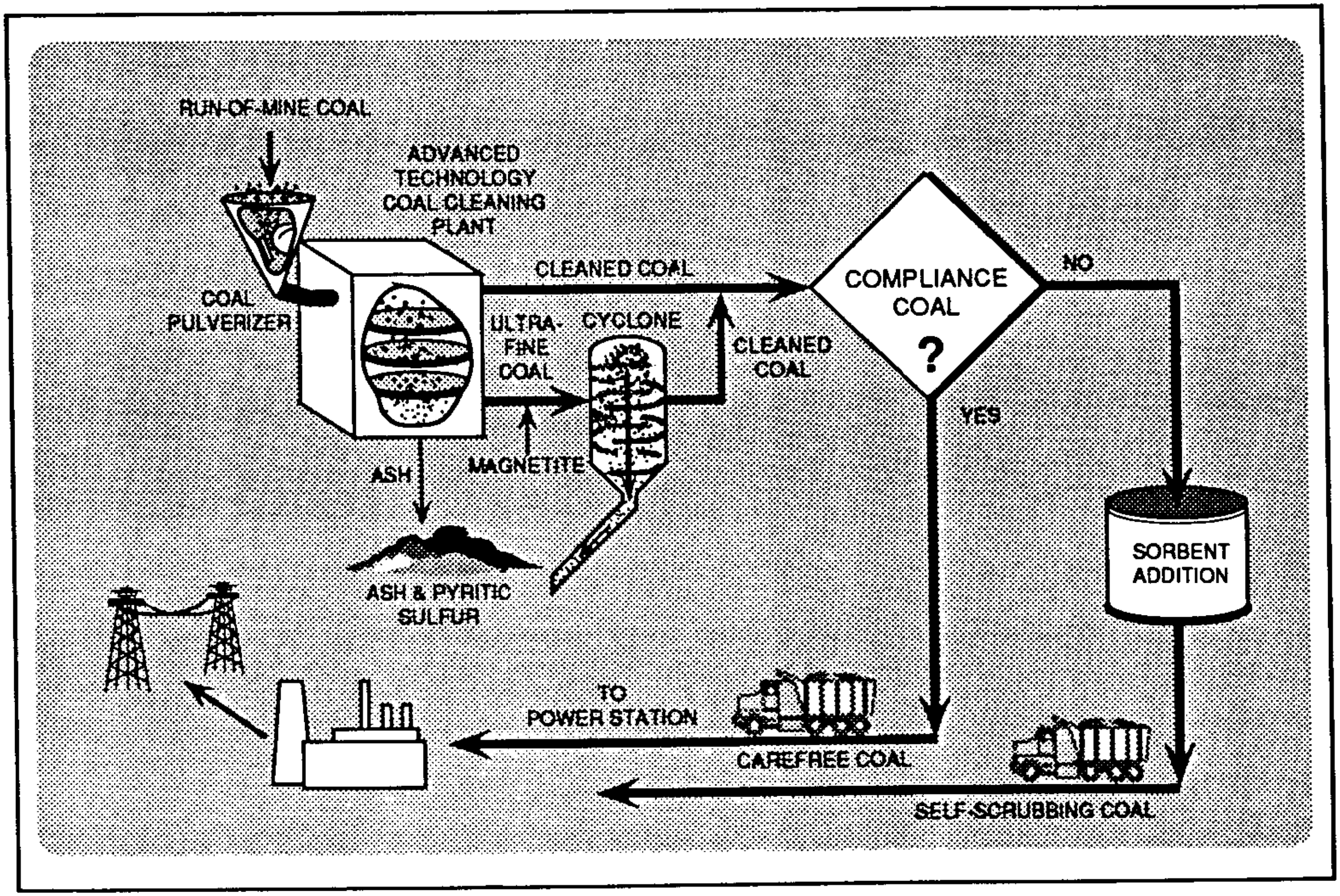

FIGURE 1. SCHEMATIC FLOW DIAGRAM
SELF-SCRUBBING COAL™ DEMONSTRATION PROJECT

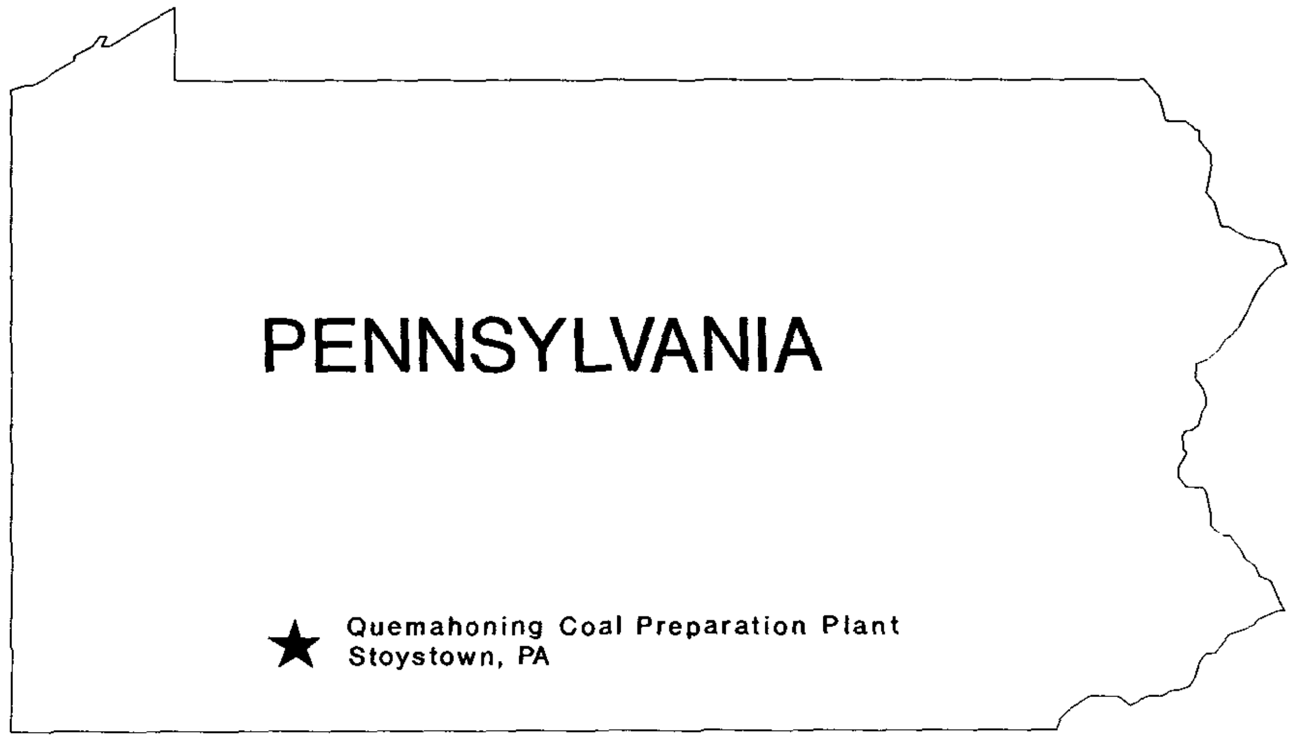

FIGURE 2. CCI SELF-SCRUBBING COAL™ DEMONSTRATION PROJECT LOCATION

Illinois No. 5 coal; and Centerior's 200 MW Ashtabula C-Plant in Ashtabula, Ohio, will burn Self-Scrubbing Coal· produced from Lower Freeport Seam coal.

3.1.1 Project Summary

Project Title:	Self-Scrubbing Coal·: An Integrated Approach to Clean Air
Proposer:	Custom Coals International
Project Location:	Quemahoning Coal Preparation Plant Stoystown, Pennsylvania Somerset County
Technology:	A combination of deep cleaning and use of a limestone-based additive to produce a coal that can be burned with low-SO_2 emissions
Application:	Reduction of SO_2 emissions from coal-fired furnaces
Type of Coal Used:	Medium- to high-sulfur bituminous (Sewickley, Lower Freeport, and Illinois No. 5 Seams)
Product:	Low-SO_2 Emitting Coal
Project Size:	350 tons/hr
Project Start Date:	Fourth quarter 1992
Project End Date:	First quarter 1996

3.1.2 Project Sponsorship and Cost

Project Sponsor: Custom Coals International

Estimated Project Cost: $81,726,346

Estimated Cost Distribution:

Participant Share (%)	DOE Share (%)
53.5	46.5

3.2 Self-Scrubbing Coal· Technology

3.2.1 Overview of Technology Development

In 1988, Genesis Research Corporation approached Duquesne Light to cosponsor development of an SO_2 emissions control technology, which Genesis had conceived. Duquesne Light contacted CQ Inc. (CQ), then the Electric Power Research Institute's (EPRI) Coal Quality Development Center, to perform an independent review of the proposed technology. A favorable review led to Duquesne Light's support of the effort in return for partial ownership of any commercial technologies that might result from the work. Duquesne Light and Genesis agreed on a three-step project for validation of the technology for Duquesne Light applications. The three-step plan included:

- Verification of Genesis's theories on fine-coal cycloning using ultrafine magnetite. This effort was conducted at CQ's demonstration-scale facility using a modified Krebs Heavy-Media Cyclone.

- Semi-continuous, commercial-scale testing of an integrated fine coal sizing, desliming, heavy-media cycloning, and media recovery unit, using specifically designed cycloning circuits installed in CQ's demonstration plant, including submitting samples of fine clean coal for pelletizing tests.

- Technology feasibility case studies.

Based on promising results from the experimental work and favorable economics evaluations, Duquesne Light and Genesis formed a joint venture (Custom Coals International), whose mission is to commercialize the technology. The following discussion summarizes the results from the three steps of process development and illustrates the readiness of CCI's technology for commercialization.

The initial bench-scale tests in 2-inch cyclones achieved greater than 90% rejection of the pyritic sulfur in Sewickley Seam coal and greater than 90%

retention of the coal's heating value. Furthermore, the coal's SO_2 emissions potential was reduced from about 8 lb/million Btu to about 2 lb/million Btu.

In 1989, DOE conducted a series of process optimization tests on cyclone separations in ultrafine magnetite media. The DOE results confirmed the Genesis/Duquesne Light results. The Genesis/Duquesne Light results also compared favorably with results obtained by Process Technology, Inc. using true heavy liquids (mixtures of methylene chloride and Freon).

Based on these promising bench-scale results, Genesis and Duquesne Light decided to move ahead with commercial-scale validation of the technology. This work included testing larger diameter cyclones (6 and 10 inch), as well as integrating additional unit operations (i.e., coal sizing, desliming, magnetite production and recovery, coal dewatering, and coal pelletizing) into the testing scope.

The performance of key process steps of the CCCC process was validated at semi-commercial scale in late 1989 and mid-1990. The majority of the testing was again performed at CQ's facilities. The key process steps which were validated include:

- Preparing ultrafine magnetite by more efficient methods than in earlier testing

- Desliming the less than 15-micron, high-ash material from the raw coal in a 10-inch diameter classifying cyclone

- Separately beneficiating two size fractions of the raw coal fines (600 x 100 microns and 100 x 15 microns) in a 10-inch diameter dense-media cyclone

- Separating and recovering the ultrafine magnetite from the various clean coal and refuse streams

- Dewatering the finest size fraction of clean coal (100 x 15 micron) in a high-G centrifuge

An important adjunct to the operation of the CCCC process is the production of ultrafine magnetite. Since grinding magnetite to the extremely fine particle size required is very expensive, another approach was developed. The method used is first to spray-roast a solution of ferrous chloride in a restricted air environment, according to the following reaction:

$$2FeCl_2 + 2H_2O + \frac{1}{2}O_2 \rightarrow Fe_2O_3 + 4HCl$$

The fine-grained hematite can then be reduced to magnetite by reaction with either hydrogen (H_2) or carbon monoxide (CO), as indicated by the following reactions:

$$3Fe_2O_3 + H_2 \rightarrow 2Fe_3O_4 + H_2O$$

$$3Fe_2O_3 + CO \rightarrow 2Fe_3O_4 + CO_2$$

Hundreds of thousands of tons of spray-roasted hematite are produced in this country each year. Hazen Research Inc. prepared separate samples of magnetite for the bench-scale and commercial-scale testing programs. In both cases, the less than 5-micron hematite was obtained as a readily available by-product from a Kerr McGee Corporation plant in Mobile, Alabama, where titania is manufactured from illminite. For the bench-scale testing, magnetite was produced by reducing the hematite to magnetite in a screw reactor using hydrogen. For the commercial-scale tests, the hematite was reduced in a rotary kiln reactor using a mixture of CO and H_2.

3.2.2 Process Description

The production of Self-Scrubbing Coal· involves the application of three different novel technologies that interact and make the process applicable to many medium- to high-sulfur eastern and midwestern bituminous coals. The integration of these technologies creates a synergistic effect, so that the efficiency and cost-effectiveness of the combination is superior to any technology applied alone. The three novel technologies are:

- Advanced Coal Cleaning, which involves the application of a unique flowsheet design incorporating the use of modified, novel, fine coal classifiers and heavy-media cyclones to reduce the pyritic sulfur content of the coal by up to 90%.

- Magnetite Production, which involves the production of ultrafine crystalline magnetite for use in the advanced coal cleaning heavy-media processes by reducing hematite produced by spray roasting a solution of ferrous chloride in a restricted air environment.

- Sulfur-Capture Agents, which involves the addition of limestone-based sulfur-capture agents to the advanced clean coal product to provide increased SO_2 capture efficiency to as high as 70% when the coal is burned in existing pulverized coal boilers.

Figure 3 presents a block flow diagram of the CCCC process. The raw coal is first sized into an intermediate size fraction (1.5 in x 0.5 mm), a fine size fraction (0.5 mm x 0.105 mm) and an ultrafine size fraction (0.105 mm x 15 microns) with the fractions being processed in separate heavy-media cyclone coal cleaning circuits. The intermediate and fine-size coal cleaning circuits will be two-stage, with the capability of producing a low-gravity clean coal, a high-gravity refuse, and an intermediate-gravity middlings fraction, which contains coal particles with pyrite and other mineral matter locked in the coal matrix. The middlings fraction will be crushed or ground to a finer size to liberate the sulfur-bearing mineral matter from the coal matrix. The coal will then be processed in either the fine or ultrafine coal cleaning circuits to separate clean coal from refuse.

The effect of the cleaning process is to maximize clean coal recovery while simultaneously maximizing pyritic sulfur and ash rejection. If the composite clean coal can meet overall SO_2 compliance levels, then the product is ready for shipment as Carefree Coal•. If the sulfur content of the composite clean coal is too high (primarily due to the organic sulfur content), then before being blended with the other fractions, the ultrafine clean coal fraction is pelletized with enough sorbent to enable the clean coal to meet compliance levels. If this

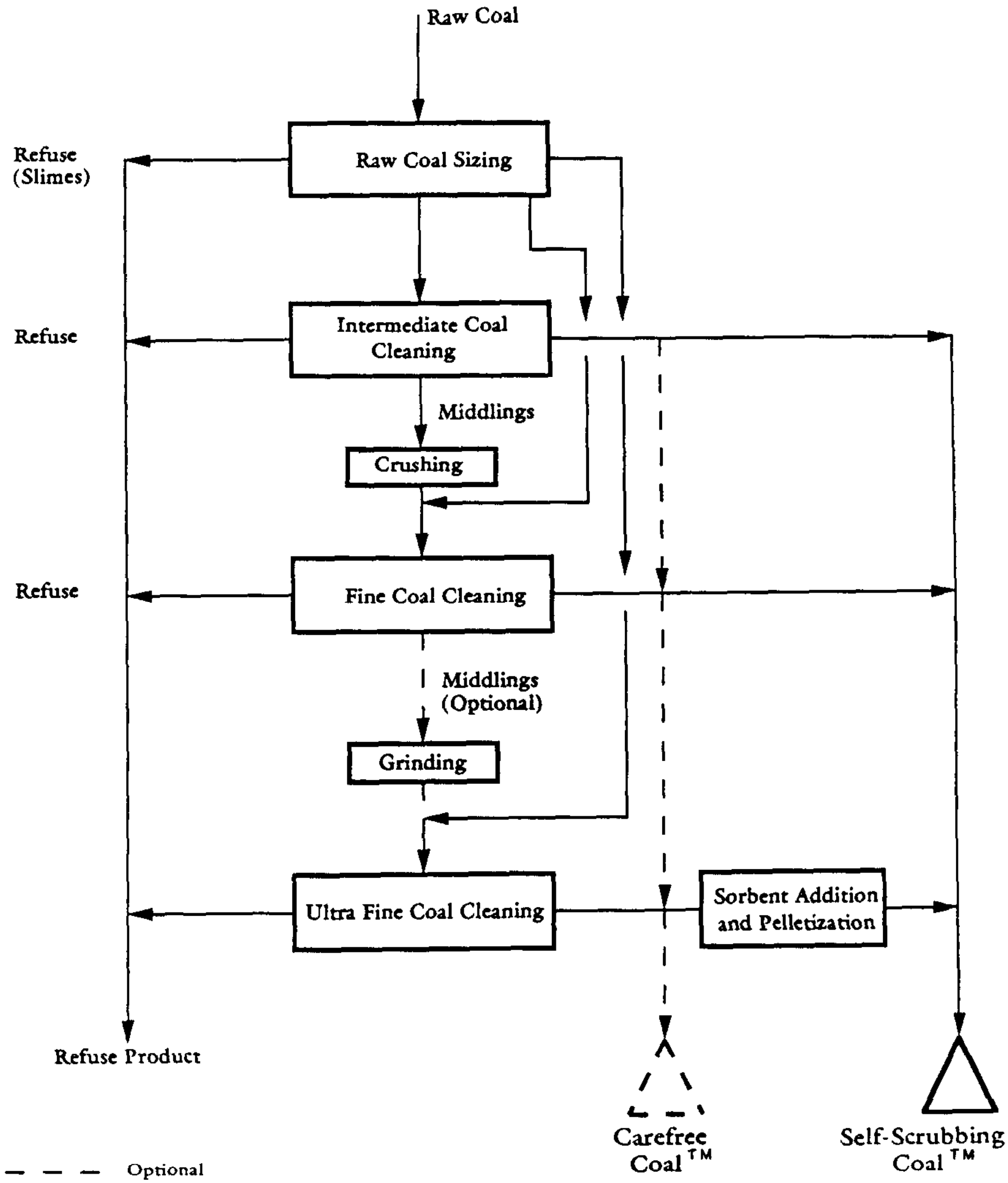

FIGURE 3. BLOCK FLOW DIAGRAM
SELF-SCRUBBING COAL™ PRODUCTION

option is taken, then the coal product is called Self-Scrubbing Coal·. The reduced ash content of the clean coal allows the addition of relatively large amounts of sorbent without exceeding the ash specifications of the boiler or overloading the electrostatic precipitator (ESP).

3.2.3 Application of Technology in Proposed Project

Custom Coals will construct a 350 tons/hr demonstration plant to produce Carefree Coal· and Self-Cleaning Coal· at the Quemahoning Coal Preparation Plant site near Stoystown, Pennsylvania. The coal cleaning plant at this site was previously operated by Solar Fuels. Two medium- to high-sulfur coals (Illinois No. 5 from Wabash County, Illinois, and Lower Freeport Seam coal from Belmont County, Ohio) will be used to produce Self-Scrubbing Coal·. Carefree Coal· will be made using Sewickley Seam coal from Greene County, Pennsylvania. The Carefree Coal· from the Sewickley Seam will be combustion tested at Duquesne Light's Cheswick Power Station. The Self-Scrubbing Coal· from the Illinois No. 5 Seam will be tested at RP&L's Whitewater Valley Station's No. 2 boiler, and the Self-Scrubbing Coal· from the Lower Freeport Seam will be test burned at Centerior's Ashtabula C-Plant.

Duquesne Light's Cheswick Power Station is located along the Allegheny River in Springdale, Pennsylvania, about 15 miles northeast of downtown Pittsburgh. The Cheswick Power Station has one operational unit that has been on-line since June 1970. The design rating of the unit is 570 MW.

RP&L's pulverized coal-fired Whitewater Valley Station, Unit No. 2, is located in Richmond, Indiana. Whitewater Valley No. 2, which is rated at 60 MW, began service in May 1973 and uses a Combustion Engineering, tangentially-fired boiler consuming 30 tons/hr of coal.

Centerior Service Company's Ashtabula C-Plant is located in Ashtabula, Ohio, on Lake Erie. The C-Plant is a conventional steam boiler unit built in the 1950s. Installed capacity is 200 MW, made up of 44 MW units.

3.3 General Features of the Project

3.3.1 Evaluation of Developmental Risk

As described in Section 3.2.1, all the aspects of the Self-Scrubbing Coal· project have been proven to varying extents. As with any developing technology, however, some risks are involved.

One area of potential risk is size degradation of the coal during processing. The effect of size degradation of friable coals on the loading of the fine and ultrafine processing circuits can be significant, particularly when there are numerous pumping and handling steps. Although the coals to be used in the demonstration testing are not extremely friable, CCI will take steps to mitigate potential problems during the design and layout of the facility. The potential for size degradation is most significant in the pumping and handling of coal in the intermediate size range. The first stage of dense-media cycloning will be fed by gravity, thus separating clean coal from the plus 0.5-mm fraction without a pumping stage. As a result, this coarsest size fraction needs to be pumped and handled only once before it is completely removed from the process circuit. CCI will build contingency into the design of the 0.5-mm by 0.105-mm and 0.105-mm by 15-micron circuitry to handle the increased capacity that could result from size degradation of the coarsest size fraction.

The CCCC process depends on a substantial amount of mechanical equipment, which raises a question as to the degree of availability and maintenance requirements of such a plant. These concerns will be addressed by a well-designed plant layout and the selection of equipment that has proven reliable in similar service.

A significant challenge to demonstration of this technology is the complete integration of all of the unit operations comprising the CCCC process. The Genesis Classifying Cyclone has been tested at commercial scale in an open loop for durations as long as 8 hr. Other circuits in the process have operated in closed-loop with commercial-scale equipment, but the process has not been fully integrated. For example, the dense-media cyclone circuits have operated independently of the media recovery circuits, but the two have not been joined and operated continuously. The key factor in the integration of these two circuits is the ability to separate the coal from the magnetite and subsequently recover the finest magnetite particle sizes. The demonstration plant design allows for adequate equipment sizes and number of stages to drain and rinse the coal in the 0.5-mm by 0.105-mm circuit and a unique, optimized design for separation of the coal from magnetite and subsequent recovery of the magnetite in the 0.105-mm by 15-micron circuit.

The process data is typical of information available to engineering design companies in the design of large-scale coal preparation and mineral processing plants. Kaiser has used this type of information in the design of numerous coal and mineral preparation facilities for various clients worldwide. This information, coupled with the experience of the process developer and Kaiser, enables sound engineering practice to be used in the design and choice of equipment in the demonstration plant.

Most of the equipment to be utilized in the demonstration plant has operated in continuous, closed-loop, commercial circuits at water and solids capacity levels equal to those proposed. Also, the physical size of key equipment items to be used in the demonstration plant is equal, or nearly equal, to the physical size of equipment tested in closed-loop, commercial-scale studies, with one exception; the size of the pellet press used to pelletize cleaned coal mixed with additives was much smaller than the press to be used in the demonstration plant. However, because similar equipment is in common use, no problems are anticipated in scaling up the pelletizer.

The final set of risks for the demonstration project and future commercial applications relates to downstream combustion of the Self-Scrubbing Coal·. Major concerns include possible coal handling problems, uncertainty over sulfur capture efficiency, and potential increases in fouling. Engineering analyses indicate that there should not be any significant problems in these areas, but mitigating strategies exist should problems arise, as indicated below:

- Materials Handling Problems - A low-moisture coal in which the fines have been pelletized is unlikely to cause materials handling problems. However, the demonstration plant has the flexibility to control the fines and moisture contents of the clean coal.

- Uncertain Sulfur Capture Efficiency - The required sorbent addition levels and anticipated sulfur capture efficiencies have been determined from conservative analysis of pilot-scale and commercial-scale sorbent injection tests. If problems arise, studies indicate that required removals can be achieved by increasing sorbent levels or adding relatively small amounts of a promoter. The power stations that will burn the demonstration fuel can tolerate a coal with a higher ash content than is expected with the Self-Scrubbing Coal·, thus allowing the use of higher additive levels, if required. Also, the cleaning operation can be adjusted to further reduce ash and sulfur at some loss of yield and associated economic penalty. Finally, the Whitewater Power Station is equipped with low-NO_x burners. Low-NO_x burners reduce flame temperature, and this will enhance sulfur capture.

- Increased Fouling Deposits - The rate of fouling deposit buildup may increase due to the addition of a sorbent, but these deposits should be at least as friable as existing fouling deposits as a result of the favorable impacts of advanced physical coal cleaning and sorbent addition on ash chemistry. If required, soot blowing frequency can be increased in both stations to handle these problems. If necessary, the number and locations of sootblowers could be increased at rather small marginal costs.

The Cheswick Power Station has a marginal ESP and, as part of this demonstration, it will be fitted with an SO_3 injection system. This fly ash conditioning is a well-established technology, and since ash loading will not be increased, no problems are anticipated.

In summary, the technical risks associated with this project are acceptable.

3.3.1.1 Similarity of the Project to Other Demonstration/Commercial Efforts

The objective of the technology to be demonstrated is the production of a coal product that will result in up to 90% reduction in sulfur emissions from coal-fired furnaces. Therefore, the principal existing competing technologies are conventional coal cleaning combined with flue gas desulfurization (FGD), advanced coal cleaning with or without FGD, and FGD without coal cleaning.

The two main separation techniques used in conventional coal cleaning are based either on density differences (gravimetric processes) or on differences in surface properties (physiochemical processes), such as froth flotation. Froth flotation is the only process used extensively for fine coal separation (less than 150 microns). Although froth flotation is effective for ash separation, it is not particularly effective for pyrite removal because of similarities in surface properties between coal and pyrite. Because it is a gravimetric process, the CCCC process is more efficient for cleaning pyritic sulfur from fine coal. Furthermore, since the CCCC process can incorporate sulfur removal additives in the coal, essentially no boiler modifications are required, as is necessary with conventional FGD.

Advanced coal cleaning processes are generally categorized into physical or chemical cleaning processes. Physical cleaning processes are only able to remove inorganic sulfur, that is, sulfur which is associated with the mineral matter and not bound to the organic coal structure; whereas chemical cleaning processes can to a certain degree remove both inorganic and organic sulfur.

Chemical coal cleaning processes can be categorized into three general groups:

- Those that use elevated temperatures and pressures to oxidize pyritic sulfur to water-soluble sulfur compounds.
- Those that use caustic chemicals to leach pyritic and/or organic sulfur species from the coal matrix.

- Those that use chemically induced alterations in the pyritic sulfur to enhance subsequent physical beneficiation.

These processes may remove as much as 90 to 95% of the pyritic sulfur and 40 to 85% of the organic sulfur associated with coal while attaining 90% recovery of the heating value of the coal. The most promising systems under development are:

- TRW's Meyers Process (an iron sulfate oxidation leach).

- The TRW-DOE MCL Process (a molten caustic leach).

- Hazen Research's Magnex Process (carbonyl alteration of pyritic sulfur with subsequent physical separation).

- The DOE PETC Oxi-Desulfurization Process (an elevated temperature and pressure leach).

None of these processes have been demonstrated at near commercial scale, and they are not likely to be demonstrated within the next five to ten years. These chemical cleaning processes require the use of severe operating conditions not currently being used in coal cleaning, and some of the processes use corrosive reagents and toxic gases. Recovering, treating, and disposing of the process chemicals and by-products are activities which are not yet well developed; neither are the handling techniques for the new types of sulfur and trace metal-containing solid residues. Thus, there are significant health, safety, and environmental concerns for these processes.

In summary, the cleaning of coal by chemical techniques is not likely to find near-term (five to ten years) application in the industry.

Numerous advanced physical coal cleaning processes are currently under development; however, the number of these processes that may be applied in the near term is limited. DOE, through its advanced coal cleaning initiatives, is sponsoring bench- to demonstration-scale engineering development projects for three of these technologies:

- Advanced cycloning
- Selective agglomeration
- Advanced froth flotation processes

All three processes involve an initial step of fine grinding of the coal to liberate mineral particles, particularly pyrite, from the coal. The selective agglomeration and froth flotation processes separate the coal based on physiochemical principles, whereas advanced cycloning utilizes density-based separation. Other potentially competing processes are Otisca's heptane-based selective agglomeration process and DOE's Micro-Mag process.

Because they involve chemical media and more complex chemical processing circuits, the advanced cycloning, selective agglomeration, and Otisca processes are less likely to be commercially successful in the near term. Therefore, the most serious competition to the CCCC process should come from the advanced froth flotation and the Micro-Mag process.

While advanced froth flotation systems may rival the CCCC process in ash reduction efficiency, matching CCCC's pyritic sulfur removal performance will be more difficult, particularly for low rank or oxidized coals. Advanced froth flotation may prove to be a significant competitor for making low-ash products from low-sulfur bituminous coals or as a pretreatment step for higher sulfur content bituminous coals to reduce scrubbing costs. However, it is not likely to compete in cases where coal cleaning is used as the primary SO_2 emission-control strategy.

The Micro-Mag technology is similar to the CCCC process in that both use ultrafine magnetite for cleaning coal in cyclones. As the processes are somewhat similar, cleaning efficiencies may be similar in the small-diameter cyclones used in DOE testing to date. However, the Micro-Mag cyclone does not use a reduced-diameter inlet to achieve the high particle accelerations necessary for fine coal cleaning in a cyclone. Fairly high accelerations can be achieved in small-diameter cyclones without a reduced-diameter inlet; however, this is not possible in a cyclone of the size normally used to clean coal without overloading the cyclone and reducing performance. Thus, the Micro-Mag technology will require the use of large numbers of small-diameter cyclones, greatly increasing capital and operating costs.

Efficient classification at ultrafine sizes (desliming) is also necessary for efficient application of dense-media technology to fine-size coal, because slimes increase media viscosity and make magnetite recovery more difficult and costly. The Genesis cyclone geometry that allows efficient fine coal cleaning also allows efficient desliming at 15 microns with inexpensive 10-inch diameter cyclones.

3.3.1.2 Technical Feasibility

As discussed previously, all parts of this process have been demonstrated at pilot to semicommercial scale; but integrated operation of all parts of the process has not been demonstrated. However, because of the design data available from previous testing and because the operations involved in the demonstration are similar to those used extensively in coal cleaning and mineral processing, the probability of successful operation of the integrated plant is high.

The pelletizer must be scaled up from the size used previously for installation in the demonstration plant, but there is no reason to expect that this will not be accomplished successfully. Also, no significant problems are anticipated in burning the cleaned coal in commercial furnaces. Thus, the project has a good probability of technical success.

3.3.1.3 Resource Availability

Adequate resources are available for this project over the 38-month demonstration period. CCI has committed funds, as discussed in Section 6.1, adequate to cover the proposed project cost. They have also dedicated the personnel necessary to conduct this demonstration program.

After removal of an existing coal cleaning plant, sufficient space will be available at the Stoystown site for installation of the equipment required for the demonstration. Coal can be delivered to the site either by trucks, rail, or overland belt, and product can be shipped by truck or rail. Electric power is available at the site, and service will be upgraded to meet the project's needs. Adequate water is available from Stony Creek, the source previously used at this site. Low-sulfur fuel oil will be purchased for use in the thermal driers.

CCI has made arrangements to supply coal and limestone-based additives in the necessary quantities. Ultrafine magnetite will be purchased from an outside vendor and delivered to the site by truck. Adequate facilities are available to provide storage for the product at the test burn sites.

3.3.2 Relationship Between Project Size and Projected Scale of Commercial Facility

The demonstration project involves a plant rated at 350 tons/hr or about 1.5 million tons/yr at 50% utilization. This size plant is well within the commercial facility range and could supply all the fuel required by a 350-400 MW power station, so commercialization will require little or no scaleup after operation of the demonstration plant.

3.3.3 Role of the Project in Achieving Commercial Feasibility of the Technology

The demonstration project is crucial to achieving commercialization of the technology, as it will demonstrate, at full commercial scale, the integrated operation of the cleaning plant. This project will confirm plant operability, product quality, and process costs, providing information that is vital to the commercialization effort.

3.3.3.1 Applicability of the Data to be Generated

The demonstration project will test all aspects of the cleaning technology at commercial scale, and the product will be burned in commercial, coal-fired units. Data collection, analysis, and reporting will be performed during the operations phase and will include on-stream reliability, coal recovery efficiencies, and equipment performance. Data from the test burns will include boiler efficiencies and SO_2 and particulate emission levels. The data that will be generated will be applicable directly to the design of other facilities and will provide valuable information which will facilitate the commercialization effort.

3.3.3.2 Identification of Features that Increase the Potential for Commercialization

The 1990 Clean Air Act Amendments (CAAA) require existing coal-burning power plants to reduce SO_2 emissions. Of the options that exist for accomplishing this, one of the most acceptable to power plant operators is switching to low-sulfur coal, providing that this can be done without unit derating. The advantage of fuel switching is that it avoids the capital investment required for FGD processes, as well as the operating and waste or by-product disposal problems inherent in FGD. Because Carefree Coal· and Self-Scrubbing Coal· have high Btu contents and can be burned with little or no equipment modifications, they should be able to achieve significant penetration of the low-sulfur coal market.

Features of the CCCC technology that improve its potential for commercialization are its high energy recovery efficiency, its ability to reject pyritic sulfur, and its ability to handle lower ranked and oxidized coals. The technology's high efficiency and flexibility should give it wide appeal and applicability.

3.3.3.3 Comparative Merits of the Project and Projection of Future Commercial Economics and Market Acceptability

This project will produce a low-sulfur, low-ash coal that can be used as a replacement fuel in coal-fired boilers. Because it uses gravimetric separation, it has a number of advantages over froth flotation technologies, such as the ability to remove pyrite efficiently and the flexibility to handle lower rank and oxidized coals. Compared to most other gravimetric coal cleaning processes, the CCCC technology has the advantage of being able to clean finer size coal effectively, resulting in a higher recovery efficiency.

The product coal offers the potential for use in coal-fired boilers to achieve CAAA SO_2 emission standards without derating the unit or producing hard-todispose-of by-products. Furthermore, few, if any, modifications to the boiler are required.

Economic evaluations indicate that the cost of producing electricity may be 5-15% lower when using Carefree Coal· or Self-Scrubbing Coal· than when using conventionally cleaned coal together with FGD.

Carefree Coal· and Self-Scrubbing Coal· should be well received in the marketplace because of favorable economics and high product quality.

4.0 ENVIRONMENTAL CONSIDERATIONS

The NEPA compliance procedure, cited in Section 2.2, contains three major elements: a Programmatic Environmental Impact Statement (PEIS); a preselection, 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 expected to occur in 2010 if each technology were to reach full commercialization and capture 100% of its applicable market. These impacts were compared with 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.

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

As the final element of the NEPA strategy, the Participant (CCI) will submit to DOE the Environmental Information Volume soecified in the PON. This detailed site- and project-specific information will form the basis for the NEPA documents prepared by DOE. These documents, prepared in compliance with the Council on Environmental Quality regulations for implementation of NEPA and the DOE regulations for NEPA compliance, must be approved before Federal funds can be provided for detailed design, construction, and operation activities.

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 Self-Scrubbing Coal· project affects two venues: the site of the demonstration plant and the power plants burning the Carefree Coal· and Self-Scrubbing Coal·. The environmental impacts caused by operation of the demonstration plant fall into three categories: air emissions, water discharge, and solid waste disposal.

The demonstration plant will use indirect thermal dryers, which eliminate the direct burning of coal and particulate or combustibles emissions. Only water vapor is vented to the atmosphere from the process. Low-sulfur fuel oil will be burned to heat the thermal dryers; emissions from this source will meet regulations.

When producing Self-Scrubbing Coal·, the fine coal (less than 150 microns) is pelletized with limestone and binders. Therefore, the Self-Scrubbing Coal· will generate little fugitive dust during handling, storage, and transport.

Wastewater from the plant will be clarified in thickeners and reused in the plant with no discharge of wastewater to the environment. The major environmental issue concerns solid waste disposal. Coal cleaning plant waste is classified nonhazardous by EPA. Plant solid waste will be trucked to a permitted disposal site.

With regard to the power plant operations, due to the deep cleaning associated with Self-Scrubbing Coal· and the minor addition of dolomite, SO_2 emissions are considerably reduced. No detrimental environmental impacts due to the use of Self-Scrubbing Coal· are anticipated from coal handling, storage, or transport. Since the Self-Scrubbing Coal· fines are pelletized, less fugitive dust will be generated at the power plant. There will be no need to increase coal stockpile requirements; therefore, there will be no increase in surface water runoff or treatment.

The ash from Carefree Coal· is very similar to the ash from the base coal, except for a reduced iron content due to pyrite removal. In addition to a lower iron content, the ash from Self-Scrubbing Coal· has higher calcium and magnesium contents, because of the added dolomite. These changes in ash composition should cause no significant change in handling or disposal practices. There will be a significant reduction in the quantity of ash which needs to be disposed of when burning Carefree Coal· and a small decrease when burning Self-Scrubbing Coal·.

Advanced coal cleaning decreases the concentration of many trace elements of environmental concern, such as antimony, arsenic, chromium, lead, mercury, and nickel, resulting in reduced emissions of air toxics. The level of particulate emissions is not expected to decrease compared to burning the base coal.

5.0 PROJECT MANAGEMENT

5.1 Overview of Management Organization

The project will be managed by a CCI Project Manager. This individual will be the principal contact with DOE for matters regarding the administration of the Cooperative Agreement between CCI and DOE. The DOE Contracting Officer is responsible for all contract matters, and the DOE Contracting Officer's Technical Project Officer (TPO) is responsible for technical liaison and monitoring of the project.

5.2 Identification of Respective Roles and Responsibilities

DOE

DOE shall be responsible for monitoring all aspects of the project and granting or denying approvals required by the Cooperative Agreement. The DOE Contracting Officer is DOE's authorized representative for all matters related to the Cooperative Agreement.

The DOE Contracting Officer will appoint a TPO who will be the authorized representative for all technical matters and will have the authority to issue "Technical Advice" which may:

- Suggest redirection of the Cooperative Agreement effort, recommend a shifting of work emphasis between work areas or tasks, or suggest pursuit of certain lines of inquiry which assist in accomplishing the Statement of Work.

- Approve all technical reports, plans, and items of technical information required to be delivered by the Participant to the DOE under the Cooperative Agreement.

The DOE TPO does not have the authority to issue technical advice which:

- Constitutes an assignment of additional work outside the Statement of Work.

- In any manner causes an increase or decrease in the total estimated cost or the time required for performance of the Cooperative Agreement.

- Changes any of the terms, conditions, or specifications of the Cooperative Agreement.

- Interferes with the Participant's right to perform the terms and conditions of the Cooperative Agreement.

All technical advice shall be issued in writing by the DOE TPO.

Participant

The following organizations will interact effectively to meet the intent of the PON and to assure timely and cost-effective implementation of the Self-Scrubbing Coal· project from conceptual design to start-up and operation:

- Custom Coals International (CCI)
- Duquesne Light Company
- Richmond Power & Light (RP&L)
- Centerior Energy
- CQ, Inc. (CQ)
- ICF Kaiser Engineers Inc. (Kaiser)

CCI will be primarily responsible for reporting to and interfacing with DOE. CCI will be responsible for all phases of the project.

The overall project approach of the above Participants will include, but not necessarily be limited to the following:

- A single project manager will be responsible to DOE and all project Participants for all three project phases.

- Custom Coals will be the primary liaison between the Government and all other organizations, as shown in Figure 4, Project Organization.

- Duquesne Light will conduct a test burn of Carefree Coal· at its Cheswick Power Station.

- RP&L will conduct a test burn of Self-Scrubbing Coal· at its Whitewater Valley Unit No. 2.

- Centerior Energy will conduct a test burn of Self-Scrubbing Coal· at Centerior Service Company's Ashtabula C-Plant.

- Kaiser will be responsible for the design, procurement, permitting, and construction of the demonstration plant. Kaiser will also be responsible for assembling the Environmental Information Volume and the Environment Monitoring Plan required as part of the NEPA process.

- CQ will be subcontracted to provide demonstration plant operating and testing staff. It will also be responsible for test planning and conducting the combustion tests at the Cheswick Station, the Whitewater Valley Unit No. 2, and the Ashtabula C-Plant. CQ staff will be responsible for preparation of test reports and environmental monitoring.

5.3 Project Implementation and Control Procedures

All work to be performed under the Cooperative Agreement is divided into four phases. These phases are:

Phase IA: Project Definition (6 months)
Phase IB: Design and Engineering (6 months)
Phase II: Construction (16 months)
Phase III: Operations (16 months)

Phase II overlaps Phase IB by 6 months. As shown in Figure 5, the total project encompasses 38 months.

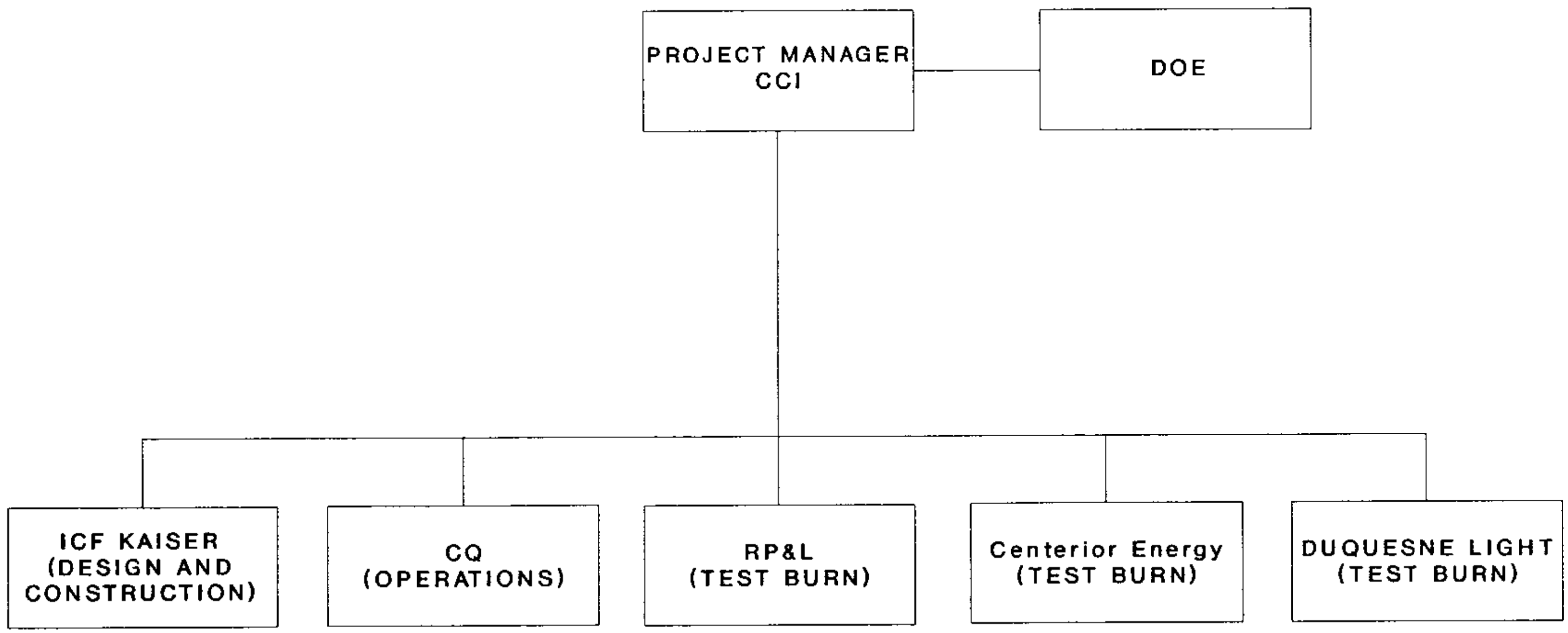

FIGURE 4. PROJECT ORGANIZATION FOR SELF-SCRUBBING COAL™ DEMONSTRATION PROJECT

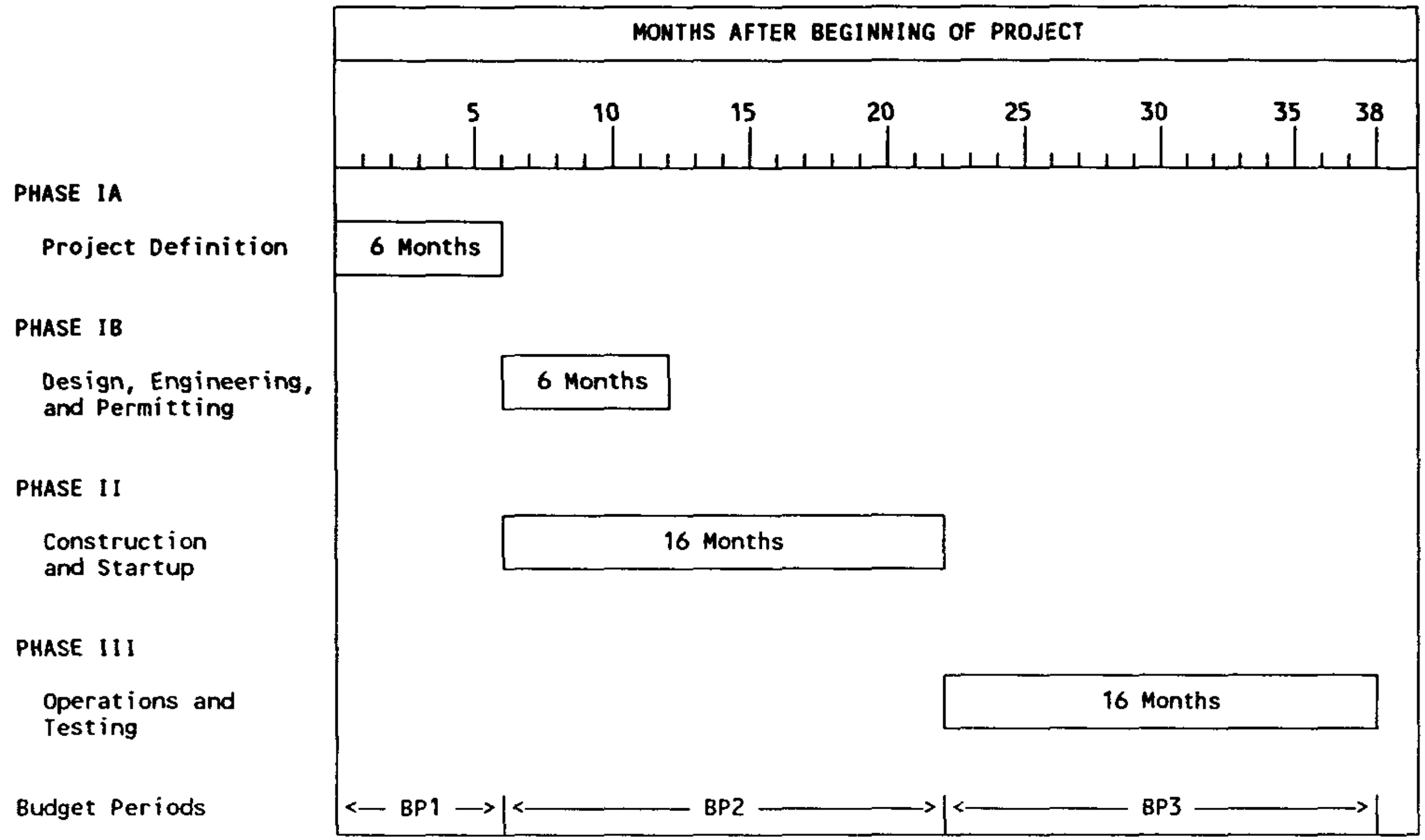

FIGURE 5. OVERALL SCHEDULE FOR SELF-SCRUBBING COAL™ DEMONSTRATION PROJECT

Three budget periods will be established. Consistent with P.L. 101-512, DOE will obligate funds sufficient to cover its share of the cost for each budget period. Throughout the course of this project, reports dealing with the technical, management, cost, and environmental monitoring aspects of the project will be prepared by CCI and provided to DOE.

5.4 Key Agreements Impacting Data Rights, Patent Waivers, and Information Reporting

The key agreements in respect to patents and data are:

- Standard data provisions are included, giving the Government the right to have delivered and use, with unlimited rights, all technical data first produced in the performance of the Agreement.

- Proprietary data, with certain exclusions, may be required to be delivered to the Government. The Government has obtained rights to proprietary data and non-proprietary data sufficient to allow the Government to complete the project if the Participant withdraws.

- Rights in background patents and background data of CCI and all of its subcontractors are included to assure commercialization of the technology.

CCI will make such data, as is applicable and non-proprietary, available to the U.S. DOE, U.S. EPA, other interested agencies, and the public.

5.5 Procedures for Commercialization of the Technology

CCI has defined its priority market as the market for clean coal products that will be sold to the domestic electric utility industry to facilitate that industry's compliance with the provisions of the CAAA. Virtually all of CCI's current efforts are concentrated on this market because of the relatively short time frame during which utilities must define their compliance strategies.

The available market for CCI products is believed to be in the order of 250 million tons/yr of the one billion tons/yr expected to be used by utilities. CCI plans to obtain a 10 to 20% share of the available market, that is, 25-50 million tons/yr. This would require CCI to commission 10-20 2.5 million ton/yr plants over the next 10 years. However, the market could expand beyond 50 million tons/yr, either through better market penetration or because of expansion into other market areas.

While CCI will concentrate initially on the domestic market for clean coal for electric utilities, a number of other important opportunities exist for the CCCC technology. These include:

- Coal/Water Fuels--Two major impediments to large-scale application of this technology have been lack of a commercial method for producing a low-ash coal feedstock and low oil prices. The ability to clean coal to 1-2% ash as part of the CCCC process overcomes the first of these impediments. Also, it is calculated that coal/water fuels can be delivered at $1.50-$2.00/million Btu, compared to $3.00/million Btu for oil at about $20/barrel. The market is potentially large, but will probably take some time to develop.

- Overseas Markets--A large market for the CCI technology is believed to exist in overseas markets. The European Community is expected to adopt new clean air standards during the next few years, and it is likely that these standards will parallel those of the United States. A large market for the application of the technology may exist in the former Eastern Bloc countries, which have particularly serious air quality problems. The shortage of capital in the former Eastern Bloc nations should make the less capital intensive Self-Scrubbing Coal· technology preferable to flue gas scrubbers.

- Industrial Markets--Large industrial customers will probably constitute a smaller, but significant, market for clean coal. These customers will identify themselves as the Self-Scrubbing Coal· technology becomes more widely known and accepted. Important factors will be the need to comply with local emissions standards and the CCCC process's ability to deliver uniform, customized stoker coal.

CCI has developed a detailed, three-phase test program to speed commercialization of Self-Scrubbing Coal·. Phase 1 is an economic study which uses a computer model to predict the cost of compliance for a particular station based on coal characteristics.

If Phase 1 yields positive results, Phase 2 will follow with a pilot-scale combustion evaluation of either a Carefree Coal· or a Self-Scrubbing Coal·, depending on coal properties and station requirements. The selected coal will be cleaned to CCI's specifications at CQ. The coal will then be shipped to a major boiler manufacturer's combustion laboratory for a pilot-scale test burn, and a boiler performance evaluation using a boiler performance model will be performed.

Phase 3 of the test program involves production of Self-Scrubbing Coal· in a pilot plant in quantities sufficient for a field combustion test. The coal will be produced at CQ's Coal Quality Development Center (CQDC).

In order to achieve its longer term sales goal, CCI is organizing its marketing primarily to accomplish high-level sales and marketing to the 25 to 50 electric utility companies considered to be its prime customer candidates. The elements of the plan are to:

- Perform a study of the marketplace to identify utility plants that could effectively use Self-Scrubbing Coal· and to establish background information on each potential customer.

- Establish contact with each potential customer, and follow up each contact with appropriate sales calls.

- Describe CCI's products to each customer and contract with them to enter into the test process described above. Completion of the test will provide the customer with data to conduct an economic study supporting Self-Scrubbing Coal· as a low cost compliance option and to support the compatibility of Self-Scrubbing Coal· with the customer's boiler.

- Devise and negotiate a long-term supply arrangement.

6.0 PROJECT COST AND EVENT SCHEDULING

6.1 Project Baseline Costs

The total estimated cost for this project is $81,726,346. The Participant's share and the Government's share in the costs of this project are as follows:

	Dollar Share ($)	Percent Share (%)
Pre-Award		
Government	346,375	47
Participant	390,594	53
Phase IA		
Government	1,000,000	50
Participant	1,000,000	50
Phase IB		
Government	8,783,827	50
Participant	8,783,828	50
Phase II		
Government	20,058,437	50
Participant	20,058,437	50
Phase III		
Government	7,850,017	36.8
Participant	13,454,831	63.2
Total Project		
Government	38,038,656	46.5
Participant	43,687,690	53.5

Budget Period 1 will include Pre-Award and Phase IA; Budget Period 2 will include Phase IB and Phase II; and Budget period 3 will include Phase III. At the beginning of each budget period, DOE will obligate funds sufficient to pay its share of expenses for that budget period.

The project will be co-funded by DOE and CCI, as follows:

	BP1	BP2	BP3	Total
DOE	$1,346,375	$28,842,264	$ 7,850,017	$38,038,656
CCI	$1,390,594	$28,842,265	$13,454,831	$43,687,690
TOTAL	$2,736,969	$57,684,529	$21,304,848	$81,726,346

6.2 Milestone Schedule

The overall project will be completed in 38 months. The project schedule, by phase and activity, is shown in Figure 5.

Phase IA, project definition, will last 6 months. Phase IB, which involves design and engineering, will continue for 6 months. Phase II, construction, will last a total of 16 months and overlap Phase IB by 6 months. Phase III, operations, will last 16 months.

6.3 Repayment Plan

In response to DOE's stated policy to recover an amount up to the Government's contribution to the project, the Participant has agreed to repay the Government in accordance with the Repayment Agreement, which is consistent with the model repayment agreement in the CCT-IV PON.