CALDERON COKEMAKING
PROCESS/DEMONSTRATION PROJECT

QUARTERLY TECHNICAL REPORT

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QUARTERLY TECHNICAL PROGRESS REPORT
CALDERON COKEMAKING PROCESS/DEMONSTRATION PROJECT
CALDERON ENERGY COMPANY
COOPERATIVE AGREEMENT NO. DE-FC22-95PC92638

Reporting Period: 2-26-99 to 5-25-99

Date of Report: 6-23-99; Award Date: 5-25-95; Anticipated Completion Date: 11-25-99

Total Project: \$ 7,354,195.00 Total DOE Share: \$3,039,389.00

Contracting Officer's Representative (COR): Dr. Michael J. Baird;

Project Director: Albert Calderon

Abstract

This project deals with the demonstration of a coking process using proprietary technology of Calderon, with the following objectives geared to facilitate commercialization:

- (i) making coke of such quality as to be suitable for use in hard-driving, large blast furnaces;
- (ii) providing proof that such process is continuous and environmentally closed to prevent emissions;
- (iii) demonstrating that high-coking-pressure (non-traditional) coal blends which cannot be safely charged into conventional by-product coke ovens can be used in the Calderon process;
- (iv) conducting a blast furnace test to demonstrate the compatibility of the coke produced; and
- (v) demonstrating that coke can be produced economically, at a level competitive with coke imports.

The activities of the past quarter were focused on the following:

- Detailed studies of LTV's site for the installation of the commercial Demonstration Unit with site specific layouts
- Environmental Work
- Firm commitments for funding from the private sector
- Federal funding to complement the private contribution

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Introduction

The commercialization path of the Calderon cokemaking process consists of the following general phases:

Phase I-- Proof of capability to produce acceptable product coke, proof of the process being environmentally closed, proof that non-conventional coal blends can be used, and proof that coke can be economically produced domestically using U.S. metallurgical coals at a level competitive with low cost-producer coke produced from foreign countries that are not subjected to U.S. environmental standards.

Phase II-- Scale-up of coking reactor to full commercial size Demonstration Module (DEMO) in support of first commercial facility.

Phase III-- Construction and operation of first commercial facility.

Phase IV-- Worldwide commercialization of the technology to produce coke competitive with that produced by low-cost producer coke-exporting countries.

Accomplishments and Discussion

Originally, the Demonstration Unit was to be sited in Alliance, Ohio, but because of lack of space, transportation costs, availability of utilities and requirements for a blast furnace test with the coke produced, it has been decided to locate the Demonstration Unit at LTV Steel's former Coke Plant No. 1 in Cleveland, Ohio.

Facility Description

This coke plant (illustrated in Figure 1 in the Appendix) was de-commissioned in 1990, because of environmental reasons. Before being de-commissioned the plant operated four coke batteries producing 1.2 million tons of coke/year. In 1996, the four batteries and the by-product plant were demolished, leaving the battery pads and the pusher rails foundation intact and also providing a large open area where the by-product plant was situated (see Figure 2).

LTV has agreed to cooperate with Calderon by making available the site and utilities, supply coal, purchase coke and possibly gas produced by the Demonstration Module (DEMO) and conduct a blast furnace test by using such purchased coke, in support of the construction and operation (demonstration) of one full size commercial reactor module to produce 8 tons of coke/hour or approximately 200 tons of coke/day. This reactor module will serve as the bases of scale-up to a coke plant of a capacity which is commercially acceptable, by replicating such module to whatever productive capacity is required. As for example, a facility requiring 1 million tons of coke/year would need about 16 modules operating at a capacity of 90%.

The DEMO will be located in the area shown in Figure 3, and will include the following boundaries:-

On the North— The road north of former batteries #1 through #4

On the East— The road east of former battery #4

On the South— The retaining wall south of former batteries #1 through #4

On the West— To, but not including, the road west of former battery #1 through #4

The buildings which will be included are:

- The former coke plant office
- The spare storage building
- The millwright shop
- The electrical shop
- The test oven/laboratory building

The pusher pads for the previous batteries include the pusher rail foundations which are in useable condition and are above the floor of the batteries' pad by twelve inches forming side walls. These pusher rail foundations extending the length of #1 and #2 battery foundations will be used for coal storage. Coal inventory for the project will be stored on these pusher pads and their side walls will contain rain water and thus prevent a runoff problem. It is estimated that the area occupied by these foundations will provide a capacity of 2,000 tons of coal, a week's supply at 100% operating capacity of the coking reactor module.

As shown in Figure 3, the coking reactor will be located on the longitudinal axis of the existing pad of the former #1 coke battery; this will work well since the foundation of this pad is on piling. The total length of the pad is approximately 180 ft. This length allows room to install the reactor as well as the supporting structure on the west end of the pad for the insertion of the inner tube of the reactor during assembly and for the extraction of the inner tube during disassembly for inspection. The hot gas cleanup will be situated in the space presently occupied by the western coal bunker which is scheduled to be torn down since it is in poor condition.

Equipment Arrangement

The DEMO which is illustrated in Figures 4 and 5, is essentially made up of the following major components:

- Coal handling
- Coal drying
- Coal charging
- Coking reactor
- Coke soaking
- Coke quenching
- Hot gas cleanup
- Coke handling
- Ancillary Facilities

Coal Handling

Blended and crushed coal will be supplied by truck (20 to 25 ton capacity) by LTV from its Warren coke plant. As illustrated in Figure 3, the coal will be stored between the pusher rails, east and west an area of 26 ft wide by 600 feet long, north of former batteries 1 and 2. This area will be divided into the East Coal Section and the West Coal Section. When coal is dumped by truck into the East Coal Section, coal will be reclaimed from the West Coal Section. Once the coal is depleted from the West Coal Section, coal will be reclaimed from the East Coal Section while coal will be dumped into the West Coal Section. The reclamation of the coal from such storage will proceed by making use of a dump weight hopper serviced by a front-end loader.

Coal Drying

The dump hopper will in turn feed the coal gravimetrically to a pneumatic transporter which will elevate the coal (approximately 100 feet) via a dilute phase system by means of hot flue gas lift containing about 1% oxygen; this gas will dry the coal to 250°F while it is being transported pneumatically in order to increase the efficiency of processing the coal into coke and also improve the flow characteristics of the coal. The gas and coal will enter a separator where centrifugal force will separate the dry coal from the transport gas. The transport gas which will contain moisture and some particulate from the coal will be directed to a baghouse to remove coal fines which will be recycled. The cleaned, moist flue gas will be heated prior to being discharged into the atmosphere to minimize the formation of a vapor plume in cold weather. The dried coal will move from the bottom of the separator into a lockhopper/surgehopper arrangement which will raise the coal charge to the pressure of the pyrolysis system (≤ 15 psig) prior to feeding it to the reactor charger through a reactor feed hopper.

Coal Charging

Dry coal from the reactor feed hopper will flow through the inlet and enter the annular chamber of the charging unit. Every 12 minutes 2 to 3 tons of dry coal are fed in the annular chamber. This coal will first be compressed and then pushed into the reactor by a hydraulically operated ram. The coal will be advanced through the heated zone of the coking reactor with each successive push of the ram, and convert into coke after an estimated residence time of 8 to 9 hours.

Coking Reactor

The reactor is constructed of a carbon steel shell, castable refractory insulation and silicon carbide tiles assembled to form an annulus for the coking chamber. The silicon carbide provides the wear and chemical resistant working surface of the reactor. Combustion chambers are located external to the reactor supplying hot exhaust gas to the flues cast into the silicon carbide tiles. Air/gas ratios to the burners will be set to maintain stoichiometric combustion. The exit flue gas will be throttled to maintain the flue gas pressure inside the tiles at slightly below the pressure of the pyrolyzing gas effluent, thus favoring the sealing of any leak with carbon in the hot tile joints. After heat exchange in the reactor, the exhaust gas exits the flues and is directed through a limestone guard bed (Figure 5). A portion of this gas will be boosted in pressure and used for transport and drying the coal, the balance will be directed to the flue stack. The coal is indirectly heated as it advances through the reactor at a rate such that 8 tons of coke per hour are pushed from the hot end of the reactor into the discharge elbow.

Coke Soaking

The coke extruded from the annular heating zone shatters at its fissures under its own weight. The coke falls into the soaker (Figure 4) where hot process gas, elevated in temperature by partial combustion with air introduced at the top of the soaker, will be forced downward through the bed and out the bottom of the soaker. This equilibration improves the properties of the coke and helps increase production. The refractory lined soaker is provided with enough capacity so that coke leaving the bottom of the soaker will have had a residence time of at least 1 hour. The submerged coke crusher/feeder located at the bottom of the

soaker provides a means for feeding the coke into the quencher as well as eliminating any oversized coke.

Coke Quenching

As shown in Figure 4 coke leaving the soaker will enter a barometric leg (water seal). The column of water is such that the difference in levels at the coke inlet (process pressure side) and coke discharge (atmospheric side) corresponds to the process pressure of 1 atmosphere plus a margin of safety. The column of coke in the soaker will be fed at a rate corresponding to but not dependent on the coal charge rate, that is to say as coal is being pushed into the reactor, coke is being fed by the crusher into the barometric leg. Water jets located just beneath the coke crusher/feeder will entrain the coke and cause it to flow through the barometric leg and be discharged at the top of the dewatering leg. The flow rate at the water jets will determine the residence time of the coke in the barometric leg and as a result provide a means of controlling the product moisture content. Water from the dewatering leg will flow to an existing settling sump located west of the No. 1 coke battery. Pumps connected to the hot sump will deliver the water to the water jets during the quench cycle.

Hot Gas Cleanup

The gaseous products (raw gas) of the coal pyrolysis together with the water gas formed during the quenching of the coke will be processed to remove sulfur compounds and to crack the remaining tars and lighter hydrocarbons not cracked in the coke soaker. After passing through a hot gas cyclone to remove coke fines additional air is added to the gas stream to further elevate the gas temperature. The sulfur removal and gas cracking is

then performed by contacting the gases with a countercurrent flow of lime pebbles used as the sorbent in the free standing pyrolysis gas cracker (Figure 5). Provisions for air injection in the upper portion of the vessel will insure temperatures adequate for total cracking within the vessel. The hot, clean gas coming out of the gas cracker will be cooled with water injection, cleaned up in a cyclone, and finally discharged to the LTV gas header located north of No. 110 substation (Figure 3) or to the flare system. The lime in the pyrolysis gas cracker will be recycled pneumatically until the sulfur content reaches approximately 30% with a corresponding carbon content. Heavy oil will be injected at the bottom of the cracker vessel against hot pebbles to adjust the carbon content to that necessary for regeneration. Lime fines removed by a separator located above the cracker, will be added to the coal feed. A slip stream of lime (approximately 15 percent) will be diverted to the regenerator located adjacent to the cracker as shown in Figure 5. In this vessel, elemental sulfur vapor is released and the lime pebbles regenerated. The vent gases from the regenerator will be directed to the sulfur condenser where liquid sulfur will be removed and stored in a steam traced tank. The uncondensed effluent from the sulfur condenser (predominantly N₂ and CO with traces of sulfur) will be boosted in pressure and used as the lime pebble transport medium. A startup burner located on the regenerator will be used to elevate the temperature of the carbon laden pebbles to initiate regeneration. Once the carbon impregnated pebbles reach the ignition point, air is added to the vessel to sustain the reaction. Limestone makeup will be elevated by bucket elevator to the limestone makeup surge hopper. From here it will be fed, as needed, to the hot gas cleanup via the pneumatic transport system.

Coke Handling

Coke leaving the dewatering leg will be classified using a double deck screen. Coke breeze will fall into a dumpster at ground level or be conveyed by means of a short conveyor to a storage pile. Coke will be elevated by conveyor to a 40 ton surge bin housed under the reactor support structure as shown in Figure 4. By means of dump truck, the coke will be transported from the surge bin to the coke storage area located on the east side of the DEMO site. Once enough coke has been accumulated for the blast furnace test (80,000 tons) it will be transferred by an existing conveyor to the LTV blast furnace located just west of the DEMO site.

Ancillary Facilities

Instrumentation and Controls

All process operations will be monitored and controlled from a central control room located under the reactor support structure as shown in Figure 4. A distribution control system (DCS) located in the control room will receive input from the various sensors, controls, valves and load cells associated with the process. The DCS will either automatically control the associated functions or provide the operator with the information required to manually override the automatic control of the process.

Natural Gas Fuel

Natural gas for the reactor combustion chambers and the regenerator startup burner will be supplied at pressure from the line serving the LTV plant just north of the DEMO site.

Compressed Air

20 psig air for the coking reactor burners will be supplied by a 400 hp blower. Air for regeneration, gas cracking and regenerator startup burner will be supplied by a 300 hp blower. Additional air requirements will be supplied by a 250 HP compressor at 150 psig.

Nitrogen

Nitrogen from a liquid nitrogen surge tank and vaporizer (or from a leased high pressure gas bottle truck) will supply the plant needs for inert gas and instrument air backup.

Water

Service water, recycled from the LTV Steel Plant WWTP, available at 85 psig, through a 20-inch line will provide the source for quench water makeup (4 GPM) as well as injection to the reactor burners (11 GPM) and desuperheating of the product gas. A 6-inch, 90 psig potable water supply is presently available to provide process and personnel needs.

Steam

Heat tracing to prevent freezing during cold weather and also to maintain the liquid sulfur at 300°F will be provided by steam at 185 psig from a 4-inch line at the pipe bridge over the road to the DEMO site. Steam from this supply will also be used to maintain adequate temperature in the quench water sump.

Hydraulic System

Hydraulic requirements for the 6 hydraulic cylinders on the reactor charger will be met by a hydraulic power supply.

Sewers

Sanitary sewers are available throughout the DEMO site. Storm sewers are also available, but there will be no process discharges into the storm sewers since the process is a net user of water. Steam condensate from heat tracing will be directed to the coke quench sump and used as water makeup.

Electrical Supply

Substation 110, located northwest of the DEMO site, contains the following transformers which are adequate to supply the electrical needs of the project.

<u>Primary Volts</u>	<u>Secondary Volts</u>	<u>Kva</u>
11,000	2,300	1,000
11,000	2,300	1,000
11,000	480	1,000
11,000	480	1,000

Other Accomplishments

The other accomplishments that occurred during the quarter relate to the environment, the commitments from the private sector for 50% of the funding, and the request from Congress for matching funds.

The LTV Steel complex in Cleveland has a limitation regarding No_x emission. In order to mitigate this situation work was begun towards designing the burners to operate at reducing conditions. This work will continue into the next quarter to result in producing a detailed material and energy balance for the process with negligible generation of No_x in the cokemaking process.

Bethlehem Steel, Bechtel, LTV Steel and Alliance Machine have committed a total of \$16 million in cash and in-kind with a further commitment by LTV to purchase the coke which will lead to a program income of \$4 million. All these contributions when added together amount to \$20 million (letters from contributors are attached in the Appendix).

A request of \$20 million made to Congressman Ralph Regula, Chairman of the Subcommittee of the Interior was put in place by Mr. Malcolm Roberts, Vice President of Technology of Bethlehem Steel in support of the Calderon Cokemaking Process (see at end of Appendix). The response from Congressman Regula indicates that the U.S. Government views the request favorably.

Conclusion

The past quarter was quite productive in the four areas mentioned above. Preliminary design will continue, an environmental assessment of the new site will be initiated, and a statement of work will be concluded for the DEMO during the next quarter.

Submitted by:

Albert Calderon
Project Director

APPENDIX

FIGURE 2

LTV STEEL NO. 1 COKE PLANT
CLEVELAND, OH
GENERAL ARRANGEMENT
WITH GALLERY
NOV 1988

FIGURE 3

CALDERON
 3000 W. 20TH AVE. #100, L.A. 90024
 CALDERON COKE MAKING PROJECT
 PDU SITE ELEVATION
 LTV-CLEVELAND NO. 1 COKE PLANT

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FIGURE 5

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CALDERON
CALDERON CORP. MAKING PROJECT
HOT GAS CLEANUP
LTV-CLEVELAND NO. 1 COKE PLANT
MADE IN U.S.A. DESIGNED BY CALDERON CORP.
MADE IN U.S.A. DESIGNED BY CALDERON CORP.

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Bethlehem Steel Corporation

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April 13, 1999

Mr. Albert Calderon
Calderon Energy Company
P.O. Box 126
Bowling Green, OH 43402

Ref: 50a-0872

Dear Albert:

I am pleased to report that Bethlehem Steel has agreed to provide \$5 million in support of a process demonstration unit for the Calderon Cokemaking Process. This support will be in the form of \$3.5 million in cash, \$0.5 million in technical support and \$1.0 million in coal. Our executive officers including Hank Barnette, CEO, and Roger Penny, COO, are very supportive of our involvement in the process development. They fully understand the strategic importance of low cost coke and the potential for developing an environmentally friendly cokemaking process.

Very truly yours,

A handwritten signature in black ink that reads "Bob".

R. W. Bouman

April 13, 1999

The Honorable Ralph Regula
2300 Rayburn House Office Building
Washington, DC 20515

Re: Calderon Cokemaking Technology

Dear Congressman Regula:

This letter is to confirm our interest in and involvement with the development of an innovative cokemaking process led by Calderon Energy Company. It is Bechtel Corporation's current intention, subject to complete subscription of necessary funds (including public funding) and satisfaction of certain legal, financial and technical requirements, to contribute \$5 million in cash and in-kind support to the commercialization of Calderon's cokemaking process in a full scale process demonstration unit.

We thank you in advance for your support of this important process that we believe will raise the global standard for cokemaking from an environmental and economic standpoint.

Very truly yours,

BECHTEL CORPORATION

By:

J. A. MacDonald

EXECUTIVE VICE PRESIDENT

April 16, 1999

Congressman Ralph Regula
2309 Rayburn House Office Building
Washington, DC 20515

Dear Congressman Regula:

As you are aware, the worldwide competitive pressures on the U.S. steelmaking industry are unprecedented. The industry must manage both the short-term issues such as unfair trade practices, and long term issues such as ongoing cost reduction and environmental improvements.

The proposed Calderon cokemaking project is very exciting because it offers a leapfrog technology which could significantly improve our long term competitive cost structure, significantly reduce environmental emissions, and help to avoid the export of U.S. jobs.

LTV has provided support for this project for several years, and is now considering providing additional support for the commercial-scale demonstration of the Calderon cokemaking project. It is envisioned to support the project by providing the site, up to \$5 million in coal for producing coke, and an in-situ blast furnace test from purchased coke which meets the specifications. We are currently working through the details of the arrangement with Calderon.

We recognize the difficult situation brought about by the Federal budget cuts, but I am sure you will agree that this project meets the standards of a critical long-term priority for this country, with the potential of near term commercialization of the technology.

Sincerely,

A handwritten signature in black ink, appearing to read "RJH", with a long, sweeping horizontal line extending to the right.

Richard J. Hipple
Executive Vice President

RJH/sec

Alliance Machine

BUILDERS OF MATERIAL HANDLING SYSTEMS

April 26, 1999

Congressman Ralph Regula
2309 Rayburn House Office Building
Washington, DC 20515

Dear Congressman Regula:

Alliance Machine Company has been in the heavy equipment fabrication business for over ninety years, in service to the steel industry. Alliance Machine currently employs over 250 people, including engineers and highly skilled labor.

Alliance Cranes

Automated Systems

Specialty Equipment

Equipment Upgrades
& Modernizations

Engineering

Parts & Repairs

Custom Manufacturing

Our company's business relationship with Calderon dates from 1962. Through the years, we have supported Calderon's efforts to develop new technology for basic industry, beginning with Calderon's scrap-charging equipment for the basic oxygen furnace. The Calderon Cokemaking Process offers the U.S. integrated steel industry an important means of reducing operating costs through lower coke production costs, while avoiding emissions from cokemaking.

Alliance Machine plans to support the Calderon Cokemaking Project, to be sited at LTV Steel's Cleveland Works, by supplying equipment for this endeavor. We are able to cost share in this demonstration, provided that we recover our costs. The difference between our costs and our selling price will be our cost share contribution. We currently estimate that this cost-share contribution will amount to approximately \$1,000,000; however, the equipment supplied will be of a much larger value.

Alliance Machine is willing to cost share in this manner, during these difficult economic times for the steel industry and its supplier community, because we believe that new product development aimed at lowering operating costs, is a national issue vital to the long-term economic health of this industrial sector and, in particular, job creation for the Alliance Machine Company.

Very truly yours,

Christopher Sause
Director

**Statement of
Malcolm J. Roberts
Vice President & Chief Technology Officer
Bethlehem Steel Corporation**

Submitted to the

**U.S. House of Representatives
Appropriations Subcommittee on
Interior and Related Agencies**

for

**Fiscal Year 2000 Appropriations to
Demonstrate the Commercial Feasibility of
The Calderon Cokemaking Process**

April 15, 1999

Mr. Chairman and Members of the Subcommittee:

Thank you for the opportunity to submit this statement describing the US steel industry's need for an advanced and environmentally friendly cokemaking process.

Coke is an essential element in the steelmaking process. The current annual demand for coke in the United States is approximately 25 million tons. The annual capacity to produce coke domestically has been reduced to about 21.5 million tons. To make up for this shortfall, coke is being imported from countries such as Japan and China which adds to the US's trade deficit with these countries. Tighter environmental regulations placed on domestic producers, in particular the Clean Air Act Amendments of 1990, have resulted in significant coke plant shutdowns and will force more shutdowns in the future. This will further add to the trade deficit and reward less environmentally focused countries. The public policy benefits of an environmentally friendly cokemaking process definitely exist. A team of engineers from Bethlehem Steel, LTV Steel, Bechtel, Alliance Machine and Calderon Energy has been working to advance the development of a new cokemaking process which has the potential to drastically reduce air emissions as compared to currently available cokemaking technologies. However, both private and federal funds are needed to assure the technology is developed on a timely basis.

Background

Coke is the main reductant for the ironmaking blast furnace which, in turn, provides liquid iron for steelmaking in a basic oxygen furnace (BOF). The blast furnace and BOF processes are the most productive and most efficient method of producing steel from iron ore. Steel can be produced by melting scrap in electric arc furnaces. However, a significant portion of the steel made in this country must be produced from iron ore because there is not enough scrap to satisfy our steel requirements and the highest quality of steels cannot be produced from only scrap. Most importantly, the integrated steel sector continues to be very competitive with scrap-based producers, in large part due to the efficient and low cost blast furnace and BOF operations.

Because of steelmaking capacity reductions and technology advances that allow the use of other reductants in blast furnaces, the annual demand for coke in the US has decreased in the past 20 years from over 50 million tons to around 25 million tons. The annual US capacity to produce coke has decreased from over 50 million tons to about 21.5 million tons, thus leaving us with a national shortfall of about 3.5 million tons per year. Much of this shortfall is being imported from China and Japan.

Our domestic coke shortfall will increase in the next few years. Most cokemaking operations in the US use the slot-oven technology that has been the standard throughout the world for many years. Tighter environmental regulations mandated by the 1990 Clean Air Act Amendments have caused many slot-oven batteries to be closed, and many of the currently operating batteries will likely be shutdown because of the significant capital expenditures that will be required to meet the regulations. It is unlikely that any new slot-oven batteries will be installed in the US because of environmental regulations. Thus, there is a strong and growing need for a new cokemaking process that is environmentally friendly and still produces high quality coke at competitive costs.

Calderon Cokemaking Process

A new cokemaking process has been invented by Albert Calderon and is called the Calderon Cokemaking Process. The process utilizes a large ceramic tube where coal is charged in one end of the tube and hot coke is discharged from the other end. The coking operation is continuous and totally enclosed. As a result, the emissions from the process are much less than either the slot-oven technology or the non-recovery technology that is now being used in two locations.

An industry team composed of engineers from Bechtel, Bethlehem Steel, LTV Steel, Alliance Machine Co. and Calderon Energy has been working to advance the demonstration of the process over the past two years. Engineering design studies for both a process demonstration unit (PDU) and a commercial-scale plant to make 1.6 million tons per year have been completed. Cokemaking trials have been conducted in a small one ton per day pilot plant and the results of these trials verified that high quality coke can be produced in a continuous coking tube. In addition, an operating analysis by the industry team has shown that the Calderon process could produce coke for \$10-20 per ton lower in cost than existing technology.

A detailed engineering analysis of environmental emissions from commercial-scale operations using standard slot-oven batteries, non-recovery batteries and the proposed Calderon process has been completed. As a result of this analysis, it was concluded that the Calderon process would operate at a greatly reduced level of emissions compared to the standard slot-ovens or the non-recovery technology. For instance, we have estimated that there would be a 70% reduction in the sulfur dioxide emissions and a 90% reduction in nitrogen oxides emissions from a Calderon plant versus a non-recovery coke plant. The Environmental Protection Agency (EPA) has observed the pilot plant operation and also believes that the Calderon process would be much better environmentally than conventional cokemaking as stated in the attached letter and report. The Ohio EPA has also visited the pilot plant and their observations are noted in another attached letter.

The next step in the development program is the design, construction and operation of a 200 ton per day PDU. This PDU size is appropriate because commercial-scale plants would be made up of multiples of the 200 ton per day coking reactor. For instance, a commercial-scale plant to make 1.2 million tons per year would have sixteen 200 ton per day coking reactors. This is equivalent to the annual production of 100 standard slot-ovens or 250 non-recovery ovens.

The main objectives for the PDU are to test the equipment designs, to determine product quality and production rates, to make environmental measurements and, finally, to produce enough coke for a blast furnace trial. A blast furnace trial with coke produced in the PDU is needed in order to confirm coke quality and its suitability for continuous blast furnace operations.

The total cost of the PDU, including design engineering, construction and operation for two years is estimated to be \$40 million. As with any new process, there is considerable risk in scaling from a small pilot plant to a commercial scale. The industrial partners involved in this technology development understand the risk, but because of the strategic importance of coke to the steel industry, they have committed \$20 million to the PDU effort.

We estimate that 3½ years will be needed for the PDU design, construction and test operations. Bechtel will be responsible for the design and construction phase of the program. It is planned to locate the PDU at LTV's Cleveland, Ohio plant. The blast furnace trial is also planned at this location. We have developed a strong industrial team to carry out this difficult assignment, and we believe that this is an excellent opportunity to develop a totally new and environmentally friendly method of making coke for the 21st Century.

Calderon Energy has had a Cooperative Agreement with DOE since 1995 for the purpose of developing and demonstrating this new cokemaking process. Additional Federal funding of \$20 million, commencing in FY2000, is needed to design, construct and operate a PDU. Federal funding support will help significantly to assure that the new process is developed in a timely manner.

Thank you for your serious consideration of this technology that is important to cokemaking and the domestic steelmaking industry.