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(DE95009710)

ENCOAL Mild Coal Gasification Demonstration Project

Annual Report
October 1993 - September 1994

March 1995

Work Performed Under Contract No.: DE-FC21-90MC27339

For
U.S. Department of Energy
Office of Fossil Energy
Morgantown Energy Technology Center
Morgantown, West Virginia

By
ENCOAL Corporation
Gillette, Wyoming

DISCLAIMER

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Distribution Category UC-109

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

INTRODUCTION

This document is the combination of the fourth quarter report (July - September 1994) and the 1994 annual report for the ENCOAL project. The following pages include the background and process description for the project, brief summaries of the accomplishments for the first three quarters, and a detailed fourth quarter report. Its purpose is to convey the accomplishments and current progress of the project.

BACKGROUND INFORMATION

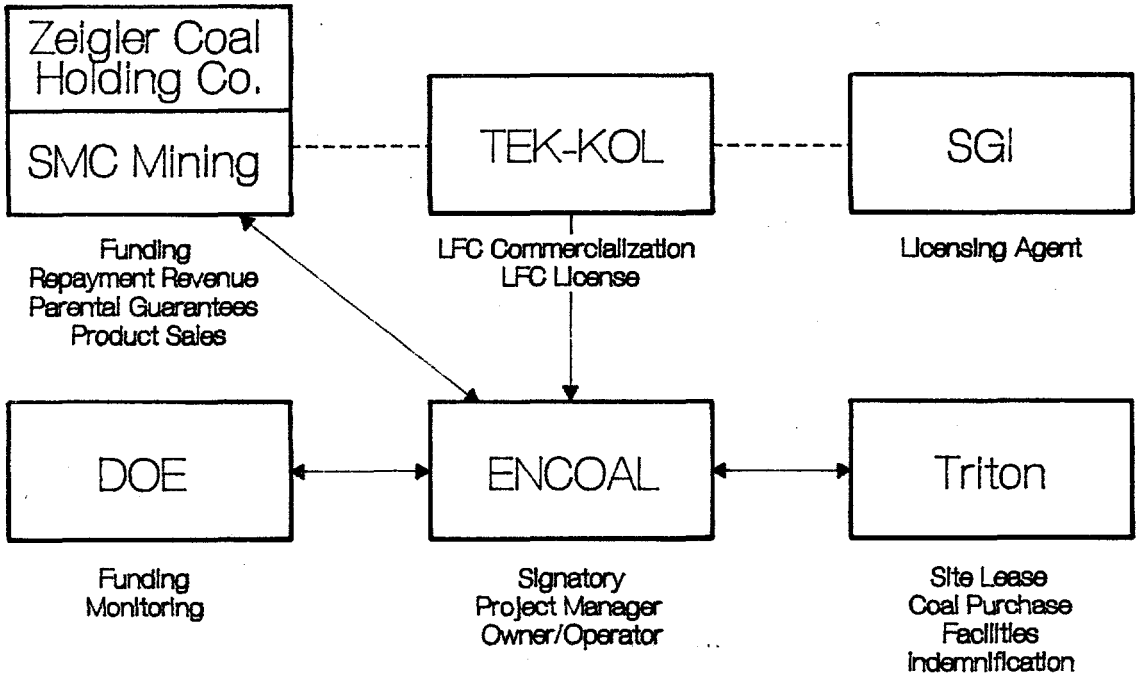
ENCOAL Corporation, a wholly-owned subsidiary of SMC Mining Company (formerly Shell Mining Company, now owned by Zeigler Coal Holding Company), has completed the construction and start-up of a mild gasification demonstration plant at Triton Coal Company's Buckskin Mine near Gillette, Wyoming. The process, using Liquids From Coal (LFC) technology developed by SMC and SGI International, utilizes low-sulfur Powder River Basin coal to produce two new fuels, Process Derived Fuel (PDF) and Coal Derived Liquids (CDL). The products, as alternative fuels sources, are expected to significantly lower current sulfur emissions at industrial and utility boiler sites throughout the nation, thereby reducing pollutants causing acid rain.

ENCOAL submitted an application to the U.S. Department of Energy (DOE) in August, 1989, soliciting joint funding of the project in the third round of the Clean Coal Technology Program. The project was selected by DOE in December, 1989 and the Cooperative Agreement approved in September, 1990. Construction, commissioning, and start-up of the ENCOAL mild coal gasification facility was completed in June of 1992. On July 17, 1994, ENCOAL requested a two-year extension of the Cooperative Agreement with the DOE that will carry through September 17, 1996. Some plant modifications have been required as discussed below.

PROJECT ORGANIZATION OVERVIEW

ENCOAL is the participant with the DOE and the signatory to the Cooperative Agreement and is the owner, manager and operator of the demonstration plant. ENCOAL is responsible for all aspects of the project, including design, permitting, construction, operation, data collection and reporting. ENCOAL managed the design and construction of the project through a project manager, who was assisted by a team of technical and managerial personnel. The engineering, procurement and construction of the plant was contracted to The M. W. Kellogg Company. Coal that is processed during plant operation is purchased from the site host, Triton Coal Company. Triton also provides access to the site, associated facilities and infrastructure vital to the project and administrative services. Equity funding, administrative services, and product marketing services for the project are provided by service subsidiaries of Zeigler Coal Holding Company. Additional technical development support is provided by TEK-KOL, which also has the primary responsibility for commercialization. All assets are assigned to ENCOAL, while all technology rights are held by TEK-KOL and licensed to ENCOAL. *(See Figure 1: ENCOAL Project Organization)*

Figure 1. ENCOAL Project Organization



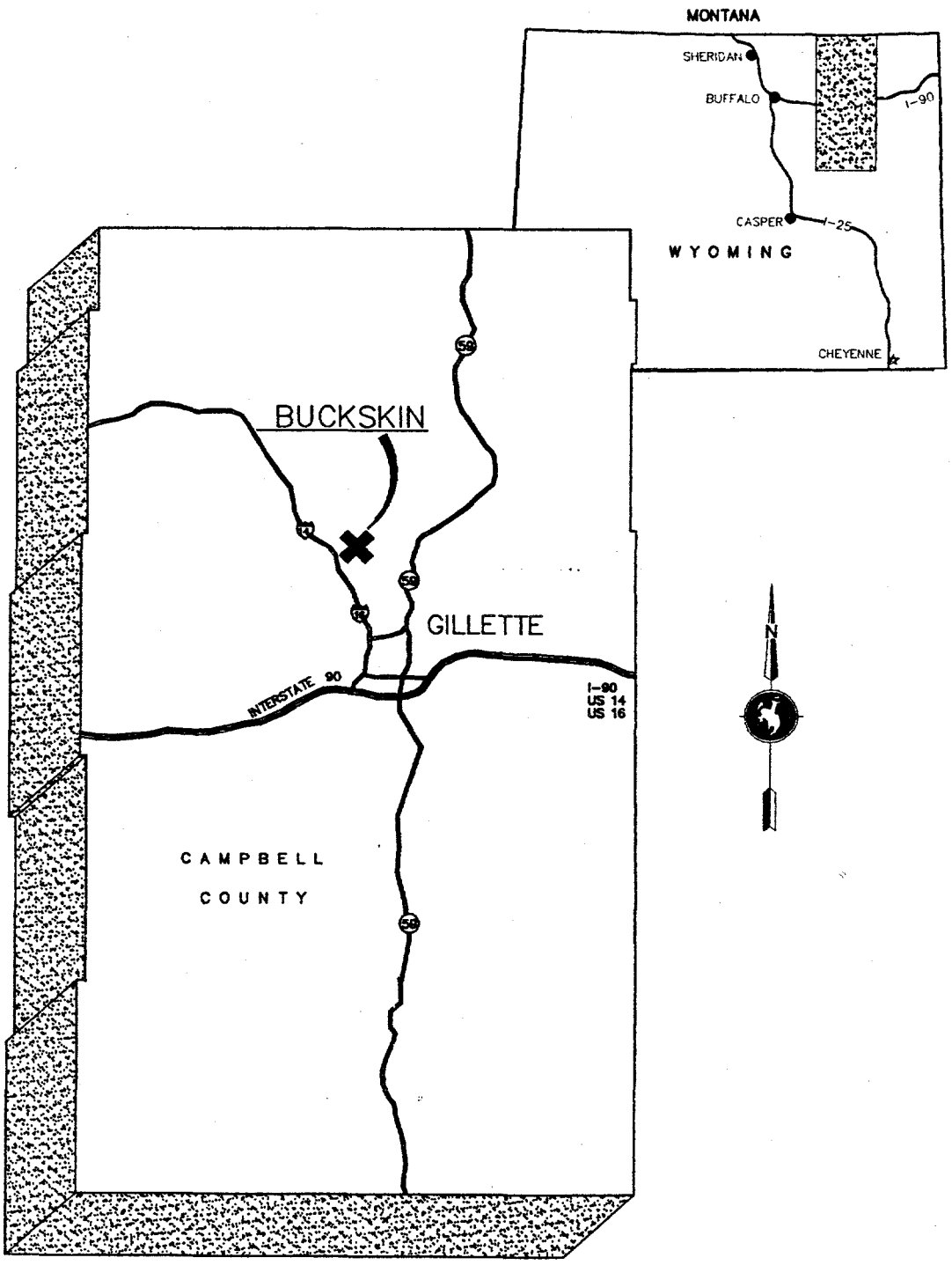
LOCATION

The demonstration plant site is located in Campbell County, Wyoming, approximately ten miles north of the county seat of Gillette. *(See Figure 2: ENCOAL Project Location).* The site is within the Triton Coal Company's, (a wholly owned subsidiary of SMC Mining Company), Buckskin Mine boundary, proximal to the mine's rail transportation loop. Active coal mining and reclamation activities surround the demonstration plant site.

PROCESS CONCEPT

The LFC technology uses a mild pyrolysis or mild gasification process which involves heating the coal under carefully controlled conditions. The process causes chemical changes in the feed coal in contrast to conventional drying, which leads only to physical changes. Wet subbituminous coal contains considerable water, and conventional drying processes physically remove some of this moisture, causing the heating value to increase. The deeper the coal is physically dried, the higher the heating value and the more the pore structure permanently collapses, preventing resorption of moisture. However, deeply dried Powder River Basin coals exhibit significant stability problems when dried by conventional thermal processes. The LFC process overcomes these stability problems by thermally altering the solid to create PDF and

Figure 2. ENCOAL Project Location

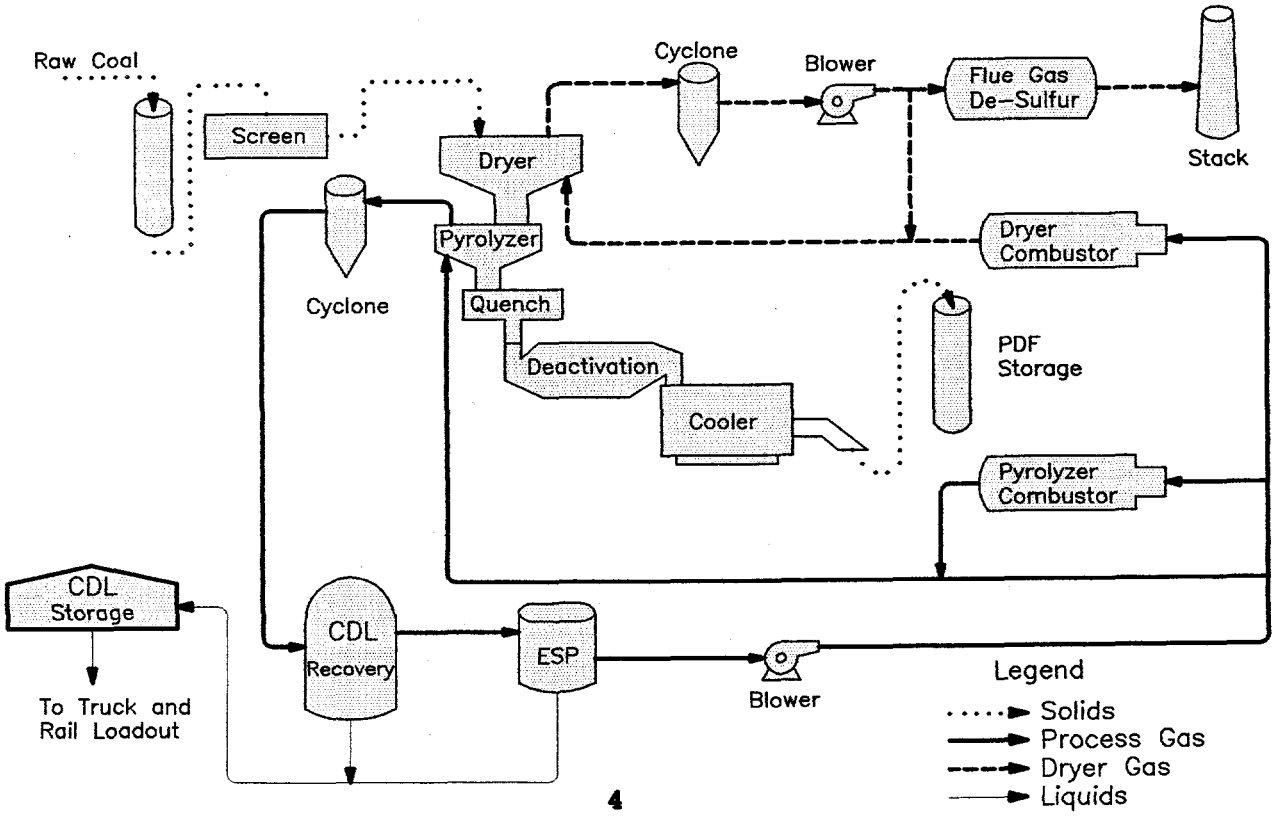


CDL. Specification PDF is a stable low sulfur, high BTU fuel similar in composition and handling properties to bituminous coal. CDL is a heavy, low sulfur hydrocarbon liquid that can be used as an industrial fuel or perhaps upgraded for chemical feed stock or transportation fuels.

Briefly, in the LFC technology, coal is first deeply dried to remove water physically. The temperature is further raised in a second stage which results in decomposition reactions that form the new products. This chemical decomposition (mild gasification) creates gases by cracking reactions from the feed coal. The chemically altered solids are cooled and further processed to make PDF. The gases are cooled, condensing liquids as CDL, and the residual gases are burned in the process for heat. The process release for the ENCOAL plant predicted that one ton of feed coal would yield roughly ½ ton of PDF and ½ barrel of CDL. By varying plant running conditions, however, it has since been learned that the actual CDL recovery rate may be as much as 15% to 20% above the projections.

Figure 3 is a simplified flow diagram of the ENCOAL process. Run-of-mine coal is supplied to the demonstration plant from existing Buckskin Mine storage silos. The coal is transferred periodically to a new 3000-ton storage silo. Coal from this silo is sized by crushing and screening to 2" X 1/8", continuously fed (up to 1000 ton/day) onto a conveyor belt by a vibrating feeder and lifted about 195 feet to the top of the plant building (the entry point to the dryer on Figure 3).

Figure 3.
Simplified Process Flow Diagram

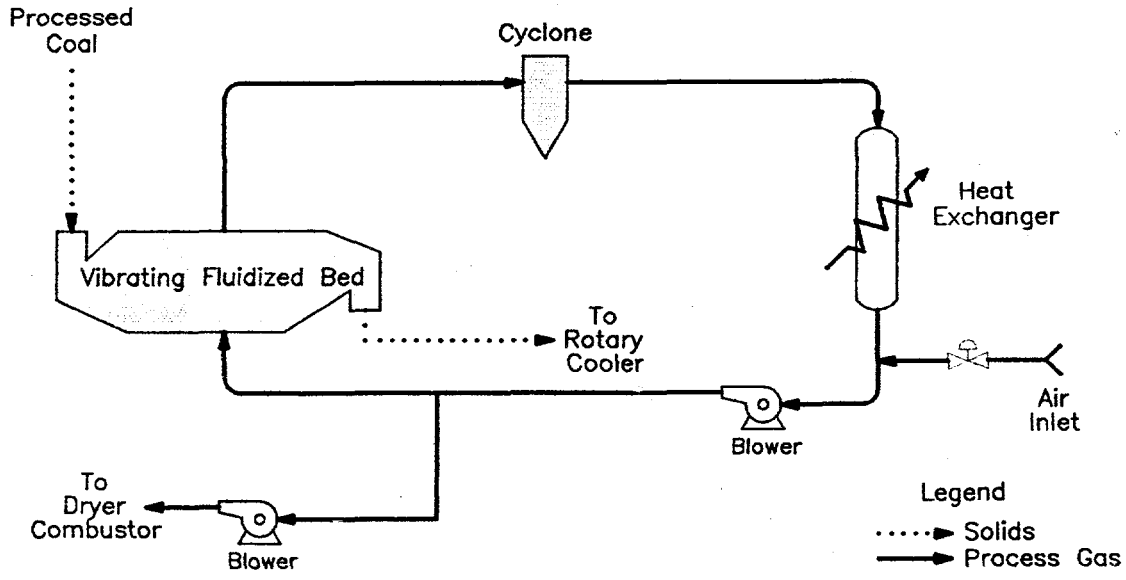


The coal is then fed into a rotary grate dryer where it is heated by a hot gas stream. The residence time and temperature of the inlet gas have been selected to reduce the moisture content of the coal without initiating pyrolysis or chemical changes. The solid bulk temperature is controlled so that no significant amounts of methane, carbon monoxide, or carbon dioxide are released from the coal.

The solids then report to the pyrolyzer where the temperature is further raised to about 1000 °F on another rotary grate by a hot recycled gas stream. The rate of heating of the solid and its residence time are carefully controlled as these parameters affect the properties of both products. During processing in the pyrolyzer, all remaining free water is removed and the chemical reactions occur. After leaving the pyrolyzer, the solids are quickly cooled to stop the pyrolysis reactions.

The processed coal is then fed into the deactivation loop were it is partially fluidized and treated with a controlled temperature and oxygen gas stream in a vibrating fluidized bed, (VFB), unit. The deactivation gas stream consists of a blower to move the gas stream, a cyclone to remove entrained solid fines, a heat exchanger to control gas temperature, and a booster blower to bleed off gas to the dryer combustor. *(See Figure 4: PDF Deactivation Loop Simplified Process Flow Diagram)* The residence time, oxygen content, and temperature of the gas stream have been selected to deactivate the coal within the VFB unit.

Figure 4.
PDF Deactivation Loop Simplified Process Flow Diagram



Once treated in the VFB, the solids exit the deactivation loop and are further cooled and transferred to a surge bin. Since the solids are dusty, having no surface moisture, they require dust suppression. A very effective dust suppressant patented by SMC Mining Company, called MK, is added to the solid product as it leaves the surge bin. The resulting new fuel form is now called PDF. It is transferred to storage silos where it is held for shipment by rail through existing Buckskin loadout facilities.

In the liquids recovery section of the plant, the pyrolysis gas stream leaving the pyrolyzer is cooled in a quench tower to stop any additional pyrolysis reactions and to condense the desired hydrocarbons. The gas temperature is kept above the dew point of the water so that only CDL is condensed. This step prevents the formation of water in the process and the resulting separation and disposal problems.

Most of the residual gas from the condensation unit is recycled to the pyrolyzer by a blower. Some of this gas is burned in the pyrolyzer combustor and blended with the recycled gas which provides heat for the pyrolyzer.

The remaining gas is burned in the dryer combustor which converts all sulfur compounds to sulfur oxides. Nitrogen oxide emissions are controlled by appropriate design of the combustor, based on evaluation of NO_x control technologies for low BTU gases. The hot flue gas is blended with the recycle gas from the dryer to provide heat and gas flow necessary for drying. The exhaust gas from the dryer gas loop is treated first in a wet scrubber followed by a horizontal scrubber, both using a water-based sodium carbonate solution. The wet gas scrubber recovers fine particulates that escape the dryer cyclone and the horizontal scrubber removes most of the sulfur oxides from the flue gas. The spent solution discharges into a clay lined pond for evaporation.

PROJECT DESCRIPTION

The ENCOAL project involves the design, construction and operation of a 1000 ton per day mild coal gasification demonstration plant and all required support facilities. A significant reduction in work scope and cost is being realized on the project due to the existence of the host Buckskin Mine. Coal storage and handling facilities, rail loadout, access roads, utilities, office, warehouse and shop facilities are all present at the mine site and thus reduce the need for new facilities for the ENCOAL project. Operations staff, supervision, administrative services and site security are being provided under contract with Triton Coal Company. The balance of the project requirements are being provided by ENCOAL and its subcontractors.

The project is divided into three phases listed as follows:

Phase I -- Design and Permitting
Phase II -- Construction and Start-up
Phase III -- Operation, Data Collection, and Reporting

Two budget periods encompass the work, the first covering Phases I and II and the second covering Phase III. A typical Work Breakdown Structure has been developed for the project.

Engineering, procurement and construction management (EPC) for the project was handled by The M.W. Kellogg Company. Kellogg's scope of work included home office design, project coordination, field construction supervision, scheduling, project controls, procurement and project management.

ENCOAL and Triton are handling the operations planning, training, maintenance planning, staffing, plant commissioning and start-up, data gathering and plant operation. Other than the actual plant operation, many of these activities took place in Phase II. Preparation of written plans and manuals was also a part of these activities. All permitting requirements were handled by ENCOAL, and field engineering and construction support was handled by ENCOAL's technical team. ENCOAL submitted its Continuation Application to the DOE on May 17, 1992, and the ENCOAL plant is currently operating under Phase III of the project.

INTERFACE WITH BUCKSKIN MINE PLANT EXPANSION

The Buckskin Mine plant expansion project commenced construction in 1990 adjacent to the ENCOAL project site. Construction of the expansion was completed in January 1993 and the new facilities are currently in operation. The expansion allows the mine to eventually increase coal production to 20 million tons per year and consists of three new 12,000 ton silos, an automated batch loadout facility, a transfer tower, and an in-pit hopper with associated conveyors.

The decisions and approvals of the Buckskin Mine project were made independent of and subsequent to ENCOAL's Cooperative Agreement with the DOE. The interface and proximity of the ENCOAL project and the plant expansion provided optimization opportunities for ENCOAL, but also required changes in some instances from ENCOAL's original plans. Examples were changes in grade elevations, moving conveyor supports, use of existing MCC buildings, and moving temporary construction facilities.

MAJOR PLANT MODIFICATION -- PDF DEACTIVATION FACILITIES

Problems with PDF product self heating in 1992 and 1993 led to several minor plant modifications and extensive testing in hopes of using original plant equipment to produce stable PDF. Results of a January 1993 test run, however, indicated that PDF deactivation would require a separate, sealed vessel. Subsequent plant and laboratory tests were run in February and March of the same year in order to establish effective criteria for deactivation. Based upon the results of these tests, an option for PDF deactivation was chosen. The deactivation process is discussed above and is shown in Figure 4. For the modification, a 6'X30' vibrating fluidized bed unit and support equipment were installed in series with the original plant equipment to deactivate PDF. Installation of the PDF deactivation facilities, *(ie VFB project)*, began in June 1993 adjacent to the ENCOAL plant. Construction and start-up of the facilities was completed in January 1994 and the new equipment is currently in operation.

EXECUTIVE SUMMARY FOR QUARTERS 1, 2, AND 3 -- *October 1993 through June 1994*

During the first three quarters, ENCOAL's primary objective was the continuous production of stable PDF for test burn shipments. Several design modifications to the pyrolyzer, s-belts, and process water system were implemented, and ENCOAL completed installation and start-up of the new PDF deactivation equipment. ENCOAL conducted four runs during the period, the last of which was still in progress on June 30th and was a record 54 days of continuous operation. With the extended run, the ENCOAL plant successfully made the transition to production mode at 50% plant capacity, as constrained by size and throughput of the VFB subsystem. Results of the runs indicated that the new VFB deactivation equipment accomplished most of the PDF stabilization, however, PDF still required additional "finishing" outside the plant using pile layering. *(This method of "pile layering" is further described on pages 15 and 16 of this report.)* Over 9,600 tons of PDF was stabilized using this method and stored for future test burn shipments. Higher rehydration rate and longer silo retention times were also tested and seemed to have good effect on stabilizing PDF for storage. Approximately 2000 tons of PDF was successfully stored in a silo for over two weeks prior to placement in the layered pile.

Plant CDL product quality showed excellent improvement during the period. Tests on the CDL indicated that the pour point had decreased and the flash point had increased to acceptable levels. Water and solids content were improved and the plant made specification CDL for the first time. Over 230,000 gallons of CDL were shipped by the end of June and shipments were being made routinely as CDL became available.

Several plant operability and safety projects were also completed by the end of June 1994. These included an improved instrument air system, installation of a VFB bypass chute, and miscellaneous pyrolyzer grate cleaning devices. These projects were necessary to ensure the safe and efficient continuous operation of the ENCOAL plant.

I. FIRST QUARTER ACCOMPLISHMENTS - *October through December 1993*

3.0 PHASE III -- OPERATION, DATA COLLECTION, AND REPORTING

ENCOAL concentrated on the PDF deactivation and plant operability projects during the quarter; mainly S-belt clean-up modifications, pyrolyzer water seal modifications, fines handling, equipment maintenance, training, and construction of the PDF deactivation facilities. Major construction of the PDF deactivation facilities was completed in December, and the mechanical contractor was working on contract adders and punch list items. *(See Figures 5 through 7: PDF Deactivation Facilities Construction)* All of the VFB building and sump building siding was in place, and the heating, ventilating and air conditioning (HVAC) system was completed and commissioned. VFB equipment insulation was approximately 95% complete, and installation of electrical wiring, and instrumentation for the PDF deactivation project was well underway. The ENCOAL technical staff completed plant run plans and a final plant Haz-Op review was conducted. Commissioning of the plant was begun and 6 of 21 systems were commissioned for a scheduled January 1994 run.

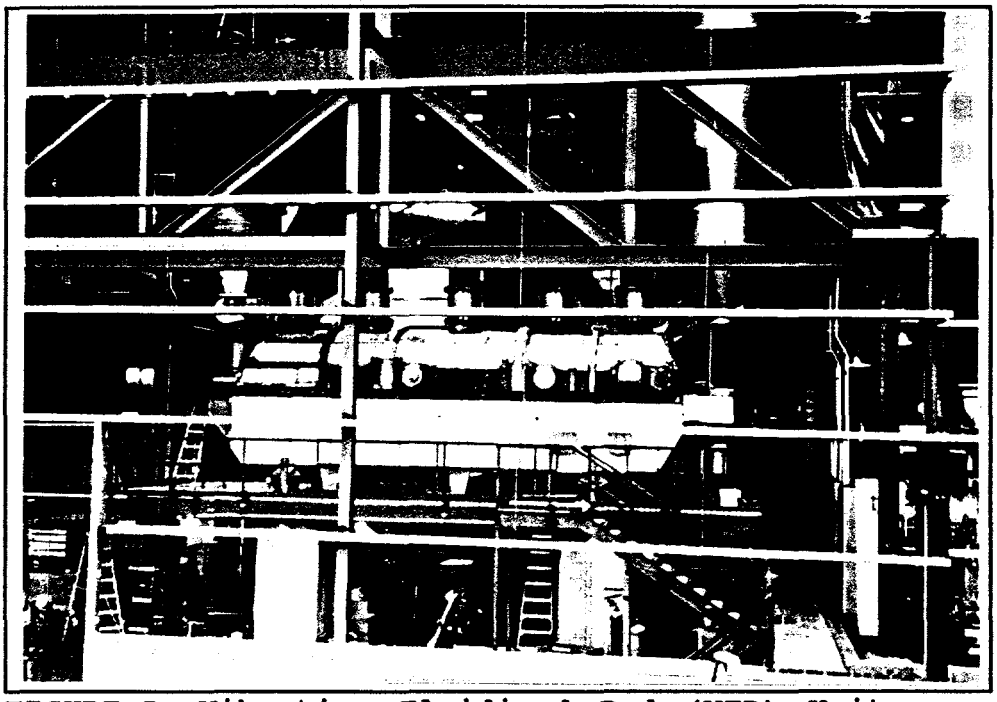


FIGURE 5: Vibrating Fluidized Bed (VFB) Unit *(November 18, 1993)*.

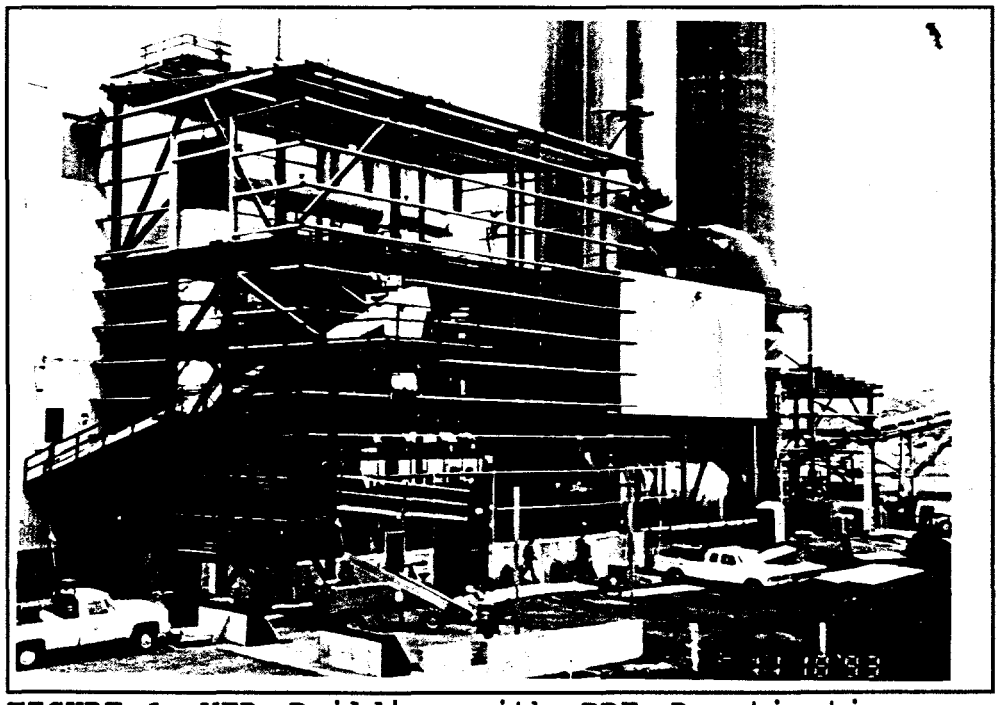


FIGURE 6: VFB Building with PDF Deactivation Equipment *(November 18, 1993)*.

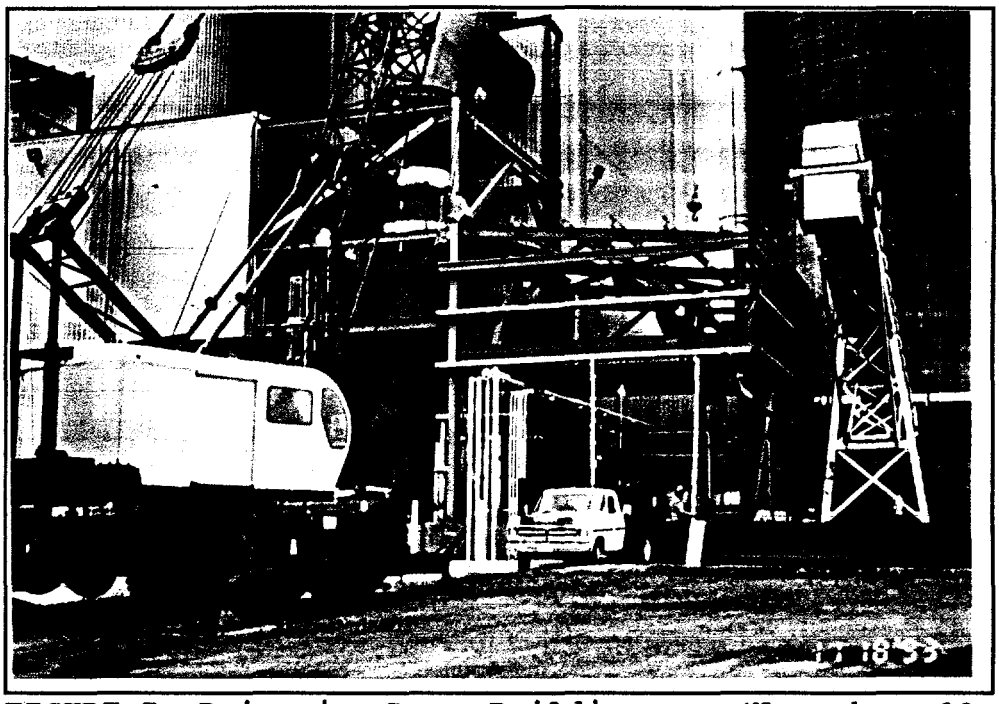


FIGURE 7: Drive-in Sump Building *(November 18, 1993).*

ENCOAL modified the plant instrument air system to be more reliable during large temperature fluctuations. Occasional problems with condensed water in the instrument air system in past runs delayed start-up and hindered plant operation. The problem was found to be in the regeneration of the instrument air dryer desiccant. The original dryer used "warm dry air" for desiccant regeneration, and the efficiency of this dryer was therefore greatly dependant upon the temperature of the purge air. If the purge air was too cool, the desiccant would remain "damp" and the instrument air would not be dried thoroughly. A new heated air dryer was installed in October 1993 that uses electric heat coils instead of "warm dry air" for desiccant regeneration. This system of regeneration is more reliable and consistently keeps the instrument air dry.

Originally, the seal between the hot gas plenum (underside of grate) and the cold gas plenum (above grate) in the pyrolyzer was made by a stationary blade in a rotating tub of sand. As reported previously, ENCOAL decided to replace this internal sand seal with an external water seal due to severe operating problems with the sand seal. Figure 8 shows both seal designs. Installation of the new pyrolyzer water seal was completed in mid-December. The pyrolyzer was rotated for clearance checks and the water trough was checked for leaks. Only minor problems were encountered and were easily corrected. The new water seal has eliminated the operability problems and plant shut-downs associated with the old pyrolyzer sand seal design.

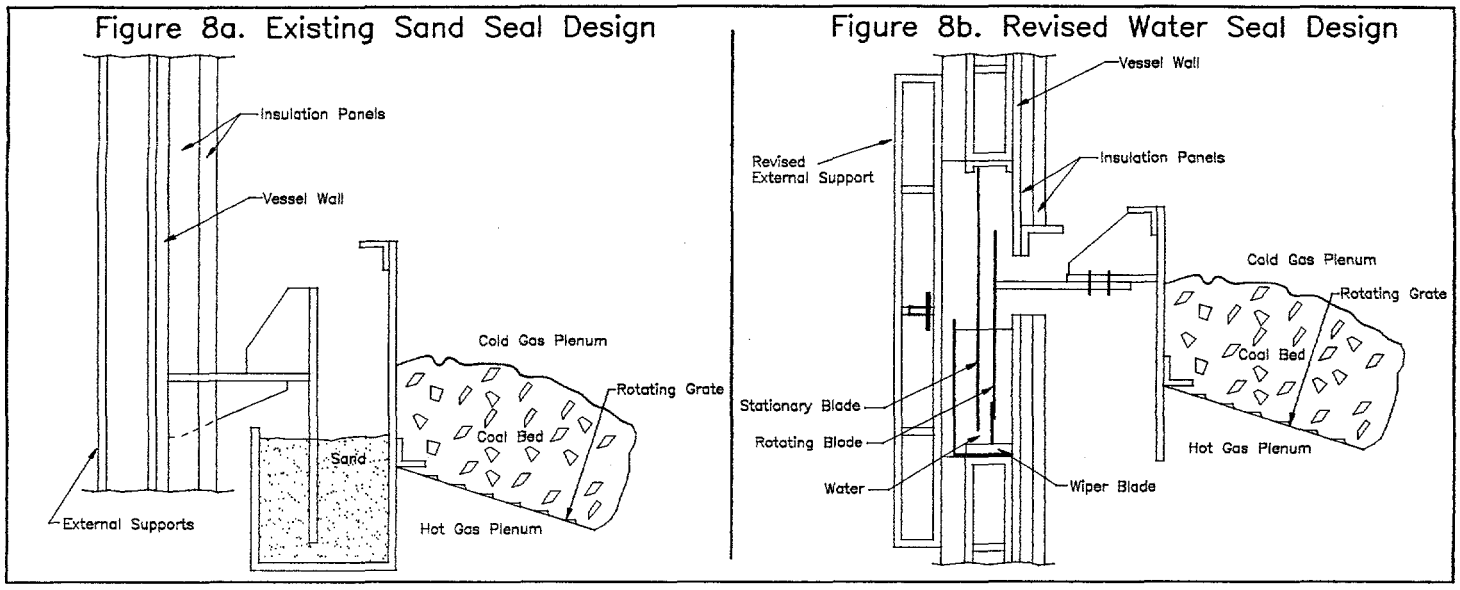


Figure 8: Comparison Of Seal Designs.

ENCOAL completed modifications on the two plant S-belts during the quarter. Both belts experienced excessive coal spilling in past runs, and clean-up under the belts was very difficult. Coal build-up between the belt, conveyor housing and concrete floors would eventually either cause the belts to mis-align, or cause the belts to be shut down for clean-up. Several individual projects were initiated to reduce the S-belt spilling and clean-up problems. Some of the major projects are:

1. Concrete Clean-out Basins - The concrete floors under both belts were lowered and sloped to drain toward collection areas more accessible to plant operators for spillage removal. A water spray system was installed in these basins to flush any spilled material from under the belt to the collection areas. Any coal spillage may now be removed from under the belt without shutting down or endangering personnel. This work was done by the VFB foundations contractor in conjunction with the pouring of the concrete for the VFB building.

2. PDF S-belt Dribble Chute - A dribble chute was installed on the top horizontal section of the PDF S-belt to funnel coal spillage directly into the PDF silo. This dribble chute gathers spillage from the full horizontal length of the conveyor.

3. Coal Feed S-belt Clean-up Screw Conveyor - A clean-up screw conveyor and dribble chute was designed for the top horizontal section of the coal feed S-belt. Coal spillage is collected by the

dribble chute and then carried to the dryer surge bin by a short screw conveyor. The dribble chute and screw conveyor were both installed and commissioned by ENCOAL personnel in November 1993.

Several other improvements made to both S-belts were; (1)feed chute modifications, (2)installation of clean-up V-plows, (3)relocation of dust collection suction points, and (4)changes to the elevation of the PDF S-belt to allow more room under the belt. These modifications were all completed by the end of December 1993.

A process water fines handling system was also installed during the quarter. The system was installed in series with the existing process water system and was designed to remove the solids and cool this stream prior to recirculation. The system includes a new slurry tank, pump, hydroclones, and a cooling water/process water heat exchanger. The solids removed from the stream are blown down periodically to a sludge hopper and the effluent is gravity drained back to the process water tank. The process water fines handling system was commissioned in December 1993.

Monthly, Quarterly Technical Progress, and Quarterly Environmental Monitoring reports continue to be routinely submitted. ENCOAL has now formalized the practice of organizing plant test data into "run" books. The run books contain the following information for each plant run;

1. Start-up and shut-down procedures
2. Commissioning activities
3. Valve alignment and pre-start checklists
4. Test plans, data sheets and test results
5. Computer trending information and actual records of the major operating variables from the run
6. Objectives and operating parameters

Information recorded in these books may be used as a reference for future plant projects and commercial plant design work. These books may also be used for creating reports on the overall plant performance and to create a summary of significant plant operating data. *(See Table 1: Run Data)*

ENCOAL received informal approval from the WDEQ for the construction of an on-site land farm to biologically treat process coal fines. Earthwork and underground piping installations for the farm were completed in November, and final piping and commissioning of the farm is scheduled for mid-January. The purpose of the land farm is to eliminate the presence of possible hydrocarbons in process fines prior to disposal on site. Ultimately it is planned to recover these

fines as part of the PDF product, so the land farm is a temporary facility. A permit application has been submitted for formal approval.

Significant visitors to the project this quarter included two representatives from the Japanese Institute for Energy and Environment (IEE), a representative from Mitsui, and James McAvoy (President of the National Coal Council). All three groups were given a presentation and site tour of the ENCOAL facilities.

There were no lost time or reportable accidents on the project this quarter, and ENCOAL achieved 352 days without a lost time accident (LTA).

II. SECOND QUARTER ACCOMPLISHMENTS - *January through March 1994*

3.0 PHASE III -- OPERATION, DATA COLLECTION, AND REPORTING

ENCOAL resumed plant operations this quarter following completion of the planned equipment modifications and installation of the new PDF deactivation facilities. Commissioning was completed on all twenty-one plant subsystems by mid-January, including final checks on the VFB and associated deactivation equipment. On January 18th, all subsystems were integrated and the plant achieved operation at 50% of design rate (100% of the VFB design). Operation of the plant in general was fairly smooth with the exception of flow problems experienced in the pyrolyzer and deactivation gas loops, and fines build-up in the process water system. Shakedown of the VFB and associated equipment identified several other minor problems that were easily corrected. Three separate runs were completed during the periods of January 18th-26th, February 2nd-14th, and March 8th-13th. Approximately 4300 tons of coal were processed and plant equipment was run for a combined 572 hours, producing nearly 2200 tons of PDF and 81,000 gallons of CDL.

CDL product quality showed excellent improvement in all three runs. The pour point had dropped to an average of 75°F and the flash point had increased to 230°F, both within the proper range. Water content was 1% to 2%, and solids content was 2% to 4%. With these results, the plant made near specification CDL for the first time. The better quality of CDL was attributed to the changes in plant operating conditions since the April and June 1993 runs. *(Those changes in operation being primarily lower pyrolysis temperatures and much higher pyrolysis gas flow rates achievable due to the new pyrolyzer water seal).* Six more tank cars of CDL were loaded and shipped to Dakota Gasification during the quarter, making a total of eight cars sent to that facility since November 1993. Dakota Gas blends the CDL with their plant produced fuel on a 10:1 ratio and burns it in their boiler for process heat. They have been very pleased with the test burn results. The tank cars will continue to be shipped in pairs as CDL is available.

Achieving design gas flow during the January 1994 run presented a problem in the deactivation loop. A higher than expected pressure drop across the VFB unit restricted the gas flow of the entire deactivation loop. Over 100,000 holes in the VFB deck were redrilled to a larger diameter which reduced the pressure restriction and increased the gas flow for the February 1994 run. Problems with temperature control also occurred in the deactivation loop. Widely variable coal temperatures into the VFB caused temperature excursions in the gas stream. Additional temperature measurement devices were installed to get more accurate coal inlet temperature readings and control loops were tuned. The temperature control was much improved in the February and March 1994 runs.

Speed control problems on the VFB feed conveyor were experienced during the entire February run. The speed of the conveyor was designed to be variable in order to hold a leg of processed coal under the quench table. However, when a leg of coal would begin to develop, the conveyor would trip out on overload. The problem was discussed with the conveyor manufacturer and the symptoms indicated that the conveyor was being "overloaded" with coal. Changes were made to the conveyor loading point, and a "striker" plate was mounted with a ½" clearance of the moving flights. These changes were successfully tested in March and the conveyor was able to hold a standing leg of coal.

One major plant upset was experienced when a 30-inch butterfly valve went completely closed due to a bent bracket. The closed valve would not let gases vent from the pyrolyzer loop and one of the pyrolyzer water seals was therefore blown, relieving the system pressure. As a result, the plant filled with smoke and gases before the plant could be shutdown and the water seal restored. The plant was evacuated during the incident and exposure of personnel to gases was avoided. Following repair of the damaged bracket, an inspection of all similar valves was made. The plant was ramped back up to temperature and coal was reintroduced. However, it was soon learned that the holes in VFB unit were plugged and the plant was completely shut down. The plugging material was found to be very wet processed coal, dampened by water seals and condensation during the plant upsets. The unit was cleaned out by hand and the VFB inlet feed chute was modified to include a flop gate and rotary valve to by-pass wet coal, and thus prevent future VFB plugging during start-up, shut-down, and upset conditions. The by-pass was installed in February and was successfully used during March for start-up and shut-down.

Excessive fines buildup in the process water system was a major cause for plant upsets during the March 1994 run. Although a recently installed process water fines handling system cooled the water well, it was being overwhelmed with a high concentration of fines from the pyrolyzer water seals and quench water systems. As a result, modifications to the various water seals were made to reduce the amount of fines entering the process water system, and a more

efficient fines removal system was designed and installed in April. The seal modifications included close tolerance covers that reduced the area for fines to come in contact with the water in the seal. For removal of the fines, a temporary process water clarifying tank was added to settle fines out prior to recirculating the water back to the system. The collected fines are periodically cleaned out and stored in the land farm holding area.

Flow restriction in the pyrolyzer was a problem during the February run. With the gas flow restricted, the ability to devolatize the coal uniformly was hindered. Inspection of the grate after shutdown showed that the slots were severely plugged with a build-up of fine carbonatious material. The pyrolyzer manufacturer was contacted and it was decided to increase the size of the slotted openings to reduce the chances of plugging. Shims were added to the grate to give the same opening as the dryer which had not experienced plugging problems, and the unit was put back into operation on March 8th. The increased grate spacing, however, did not stop the grate from plugging and the plant was again shut down for cleaning on March 13th. Samples of the build-up were taken and sent for analysis to help determine its origin. Results of the analysis were inconclusive and provisions for cleaning the pyrolyzer grate during plant operation were implemented. One such provision was a new steam blaster to flush the grate while in hot stand-by condition, thus removing the build-up from the back of the grate. Other designs for on-line grate cleaning were discussed for possible installation in April.

Inspection of the dryer grate in March also indicated that it experienced a minor build-up of fine carbonatious material. However, no pressure drop was occurring across the dryer beyond normal operating conditions. Since the degree of build-up was much less in the dryer, on-line grate cleaning was not believed to be necessary.

A Technical Review meeting was held on March 23rd and 24th 1994 to discuss the status of the PDF stabilization efforts, and the effectiveness/operation of the deactivation loop. Attendees of the meeting included representatives of SGI International, the ENCOAL technical staff and plant operators. Fifteen test piles of PDF were made during runs just prior to the meeting, and while some piles showed good signs of suppressing PDF self-heating, the PDF remained unsuitable for test burn shipment. Based upon the analysis of the run data and bench model tests, it was determined that the deactivation loop was being operated with insufficient oxygen, which is believed to be a primary constituent for PDF deactivation. Test plans for future runs were subsequently developed to include better oxygen control and an increased concentration in the deactivation loop, coupled with a stringent control on solids temperatures in the VFB unit. In addition to the changes to the operation of the deactivation loop, provisions were made to laydown PDF on the ground to "finish" the oxidative deactivation of the solids outside the plant if necessary. By spreading out the PDF for short periods

of time in layers less than 12 inches thick, the PDF particles react with oxygen in the air and become stable. After the layer is stabilized, usually 2 to 3 days, an additional layer can be placed on top of the stable material. Building a stockpile in this manner is referred to as "pile layering." All plans were made with the primary objective being the continuous production of stable PDF for test burn shipments.

There were no lost time and two reportable accidents on the project this quarter. A recognition dinner was held on January 14th to celebrate 1 year without a lost time accident (LTA) and ENCOAL achieved 442 days without a LTA on March 31.

III. THIRD QUARTER ACCOMPLISHMENTS - *April through June 1994*

3.0 PHASE III -- OPERATION, DATA COLLECTION, AND REPORTING

ENCOAL resumed plant operations this quarter following completion of the planned equipment modifications and installation of the process water fines clarifier. Plant operations resumed on May 8th and it remained on line for the remainder of the quarter, achieving a record of 54 days of continuous operation. Operation of the plant in general was exceptionally smooth with the exception of some instrument failures and solids plugging in the CDL recirculation pump strainers. The new PDF deactivation equipment accomplished most of the PDF deactivation, however, the PDF still required additional "finishing" outside the plant using pile layering. Over 9600 tons of PDF was deactivated and stored using this method.

A total of twenty different operating conditions have been evaluated to date in an attempt to completely deactivate PDF in the new VFB equipment. The PDF has not been able to pass an un-compacted pile stability test as of yet, however, higher rehydration rates have been used to assist in stabilizing the product. Handling of the product was also modified to hold it in the ENCOAL PDF silo for a period of 36 to 48 hours prior to loadout. This combination of longer silo retention times and higher rehydration seemed to have a good effect on stabilizing the PDF. Approximately 2000 tons of this PDF was successfully transferred to a permanent storage silo and was held for over two weeks prior to being added to the layered pile.

Other significant tests accomplished during the quarter included preliminary efficiency tests on the wet gas scrubber, fines collection cylinder tests on the process water circulation system, and PDF handling tests for transportation purposes. Other testing activity included shipment of various cyclone dust and PDF samples for explosivity testing by the Bureau of Mines.

Changes made to the process flow rates, temperatures, and ESP operation in the pyrolyzer gas loop seemed to alleviate the problem of pyrolyzer grate plugging that was experienced in March 1994. No measurable increase in differential

pressure was detected across the grate during the entire 54 day run period. In the event that an increase is detected, a recently installed nitrogen cannon or steam blaster may be used to combat any material build-up. The nitrogen cannon was designed to blast any build-up of material from the back of the grate while the plant is in operation. The nitrogen cannon also has the capability of cleaning the grate on a continuous basis using a pulse of compressed nitrogen. The steam blaster was also designed to clean the grate, but requires the plant to be at hot standby in order to operate.

Modifications made to the process water system and water seals in April were successful in controlling and removing the excessive fines in the process water. These modifications included covers to limit the area of the water seals exposed to process gas containing coal fines and a process water clarifying tank to settle out fines prior to recirculating the water back into the existing system. Cylinder tests for chemical separation of fines were also conducted on the settling tank in June. As a result, a plant scale trial was initiated to chemically settle oily fines. Preliminary results were encouraging and the development of a permanent fines collection system is proceeding. The fines loading in the process water was significantly reduced.

Another Technical Review meeting was held on June 14th and 15th to discuss the status of the PDF stabilization efforts, and the effectiveness/operation of the deactivation loop. Attendees of the meeting included representatives of SGI International, the ENCOAL technical staff, and plant operators. Results of the discussions indicated that additional laboratory and plant testing was necessary in order to determine the optimum operating conditions for producing stable PDF. A test plan was developed for varying PDF rehydration rates and layered pile retention time in future runs. Further attempts to define an indicator for PDF stability were also being pursued by the SGI Development Center, in Ohio.

There were no lost time or reportable accidents on the project this quarter, and ENCOAL achieved 531 days without a lost time accident (LTA).

EXECUTIVE SUMMARY -- FOURTH QUARTER - *July through September 1994*

ENCOAL concentrated on plant operation, PDF stabilization and plant operability projects during the quarter; mainly equipment maintenance, PDF stabilization testing, and design of a permanent process water fines handling system. The run in progress at the end of the 3rd quarter ended on July 14th, bringing the total time for this record setting run to 68 days. Two additional runs were achieved during the period, the last of which was still in progress on September 30th. Optimization of plant operating parameters continued in both runs in pursuit of deactivating PDF within the plant equipment. Plant run PDF has not been able to pass an un-compacted pile stability test to date, but the PDF produced continued to be stabilized by pile layering. PDF has also been successfully stored in silos for extended periods. Blending plant run PDF with run-of-

mine Buckskin coal or with PDF from the layered piles has also produced a stable product, although the heat content is reduced somewhat. Approximately 15,600 tons of neat PDF and PDF blends has been stockpiled or stored in silos for shipment to utilities for test burns.

ENCOAL shipped its first train containing PDF on September 17, 1994. The shipment was made to Western Farmers Electric Cooperative in Hugo, Oklahoma, and consisted of 5,500 tons of 15% PDF and 85% ROM coal for a test burn. The PDF delivered was stable and not dusty. The blend handled well in Western Farmer's system and preliminary boiler results look very promising. Discussions were initiated with two other midwest utilities for additional PDF sales. Shipments of CDL were made to two new customers this month; 3M Corporation in Minnesota, and The Kiesel Company in St. Louis. CDL shipments continued to Dakota Gas in North Dakota, and additional customers are being developed.

An extension request for two years additional operation with joint funding was submitted to the DOE by ENCOAL in July along with an Evaluation Report and Extension Plan. DOE granted ENCOAL a 30 day, no cost extension to October 17, 1994 while the extension request was being evaluated.

PLANNED SCOPE OF WORK

Plant operation and maintenance were the major planned activities for the ENCOAL Project this quarter. An alternate coal test was scheduled for the period in the original Statement Of Work as well as the completion of the DOE phase of the Project. However, under ENCOAL's Extension Plan, the primary objective for the 4_{th} quarter was the continuous production of stable PDF for test burn shipments. Several PDF stabilization tests were to be completed, and ENCOAL was to make its first shipment of PDF. Designs for a permanent process water fines handling system were to be developed, and an updated draft of the Project Management Plan, the Public Design Report, and an Evaluation Report were to be completed. Candidates for alternate coal testing were to be chosen, and an annual Operations Review was to be conducted in September 1994.

ACCOMPLISHMENTS

3.0 PHASE III -- OPERATION, DATA COLLECTION, AND REPORTING

3.1 Operation and Maintenance

Optimization of the plant operating parameters continued in hopes of deactivating PDF in the plant using the VFB equipment. Two runs were initiated during the period; one on August 9th, and one on September 7th. Plant operation was smooth overall, but PDF produced had to be stabilized by pile layering or, using a new concept for ENCOAL, blended with stable material. Blending plant run PDF with run-of-mine Buckskin coal was first tested this quarter as a means to produce a stable product. Various blends up to 50% PDF and 50% ROM coal were made and passed the uncompacted pile tests with no self heating problems. Pile tests

of blends of plant run PDF with stable PDF from the layered pile storage area were also very successful. Based on these test results, ENCOAL has modified its PDF production methods to include blending as a means of stabilization.

Approximately 15,600 tons of PDF and PDF blends has now been stockpiled or stored in silos for shipment to utilities for test burns. Changes to the rehydration rate, silo retention times, and laydown area times were made to determine the best method of stabilizing plant run PDF for shipment or blending. Another laydown spread deactivation test was completed in September; this time using higher rehydration rates on the plant run PDF and laying the material down for up to 96 hours prior to re-piling. All three test piles exhibited self heating and it was determined that the higher levels of water inhibited the oxygen take-up rate, causing the self heating problems. Additional laydown deactivation tests are planned for October using lower rehydration rates to further optimize the PDF stabilization efforts.

ENCOAL shipped its first train containing PDF on September 17, 1994. The shipment was made to Western Farmers Electric Cooperative in Hugo, Oklahoma, and consisted of 5,500 tons of 15% PDF and 85% ROM coal for a test burn. The PDF delivered was stable and not dusty. The blend handled well in Western Farmer's system and preliminary boiler results look very promising. A second shipment of 20% PDF and 80% coal was made on September 24th. Subsequent shipments will be increased by 5% until a mutually agreeable maximum concentration of PDF is reached. *(See Figures 9 and 10: First PDF Train Shipment)*

ENCOAL also shipped 6 tonnes of PDF to Japan for an EPDC, *(Electric Power Development Company)*, test burn. EPDC plans to burn the PDF in their test facility in order to conduct a fuel evaluation for electric power generation in Japan. A successful EPDC test burn could lead to export markets for PDF.

Shipments of CDL were made to two new customers this quarter; 3M Corporation in Minnesota, and The Kiesel Company in St. Louis. The 3M Corporation will be taking a one time shipment of 300,000 gallons, while Kiesel is anticipating monthly shipments if their test burns are successful. CDL shipments are being routinely made to Dakota Gas in North Dakota, and additional customers are being developed.

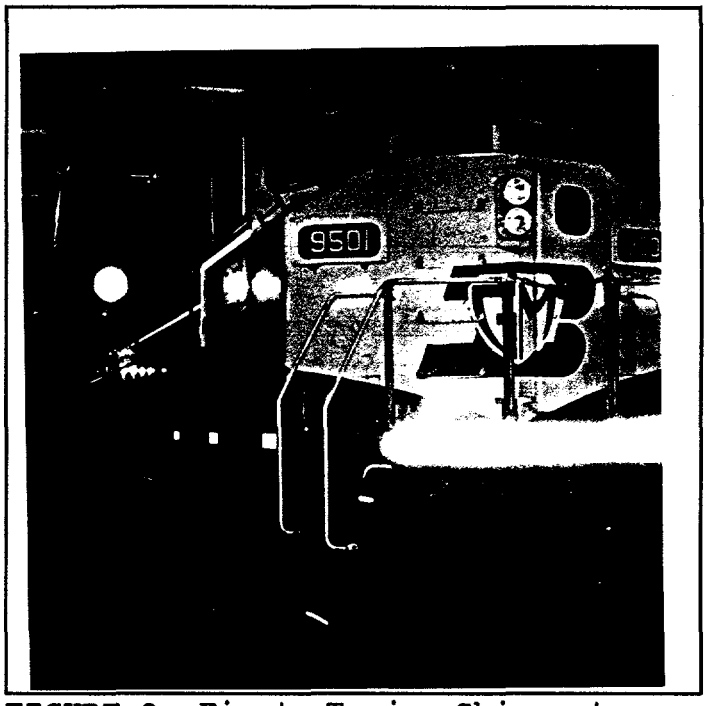


FIGURE 9: First Train Shipment Containing PDF *(September 17, 1994)*.

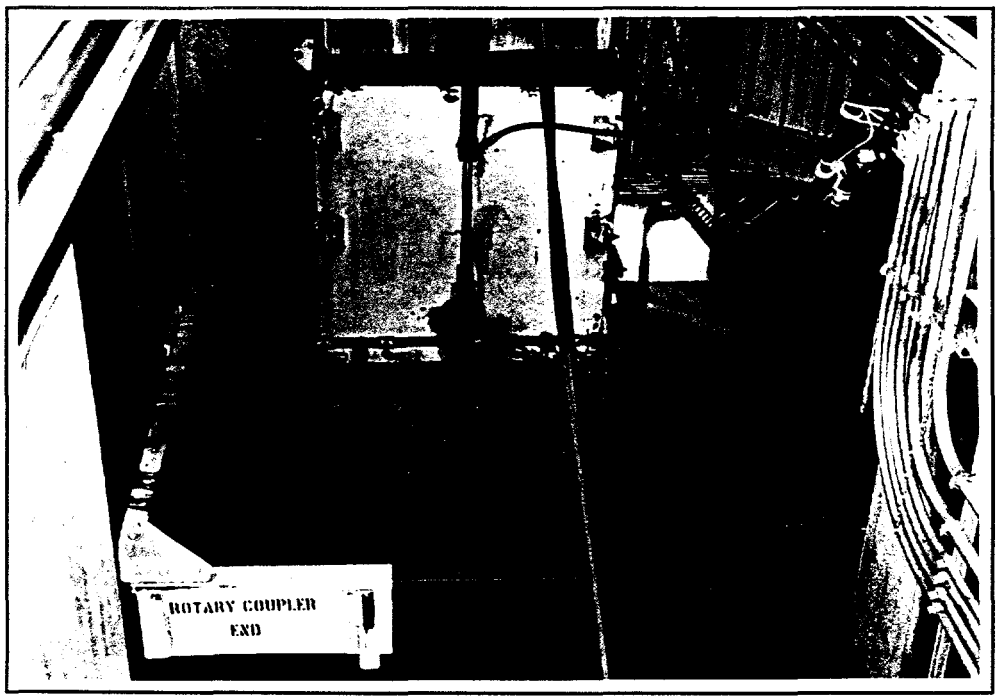


FIGURE 10: Coal and PDF Blend Being Loaded *(September 17, 1994)*.

The mechanical maintenance contractor continued with plant operability improvement projects and operations assistance; namely safety improvement projects, miscellaneous piping installation, and installation of a portable MK dust suppressant applicator for re-treatment of laydown area PDF.

Specifications for the expansion of the ENCOAL control room were finalized and sent out for bid in September. The expansion is needed for a larger training/lunchroom area, additional office space, storage for plant safety equipment, a maintenance office/library, and a personnel changing area. Bids are due back on October 12th, and preliminary construction of the facilities is expected to commence soon thereafter. Bids were also solicited and received for the material for the dryer water seal. A fabricator located in Salt Lake City was awarded the bid with a scheduled delivery of December 1, 1994.

There were no lost time or reportable accidents on the project this quarter, and ENCOAL achieved 625 days without a lost time accident (LTA). A safety picnic celebrating 600 days without a LTA was also held, with all ENCOAL and contract personnel invited. Contractor and operations safety meetings continue to be held to help ensure safety awareness.

3.2 Data Collection and Reporting

Monthly, Quarterly Technical Progress, and Quarterly Environmental Monitoring reports were submitted. A draft of the updated Project Management Plan for Phase III activities reflecting the corporate ownership changes was submitted in July 1994, along with an Environmental Information Volume Update. A revised Final Design report was drafted to include civil design and construction of the project, and was submitted to the DOE in September 1994. The final ENCOAL Evaluation Report was also submitted in September. Plant operation and test data continues to be collected and Table 1 summarizes significant run data for the year.

3.3 Alternate Coal Testing

Alternate coal testing was not done during this period. As shown in Phase III of the Milestone Log, alternate coal tests are scheduled for October 1994, but ENCOAL's extension plan calls for the first test to occur in August, 1995. Subbituminous coal from the North Rochelle mine and a North Dakota lignite from the Knife River Mine were chosen for the first two alternate coal tests. Other candidates such as Texas lignite and Alaskan subbitumminous coal are still being considered depending on logistics and costs.

TABLE 1: RUN DATA *(October 1, 1993 through September 30, 1994)*

RUN START DATE	RUN DURATION (HRS)	TONS OF RAW COAL FEED	BARRELS OF ACCEPTABLE CDL PRODUCED	TONS OF PDF PRODUCED	REASON FOR FINAL PLANT SHUTDOWN
Jan. 18, 1994	190	800	450	350	VFB and Pyrolyzer grate plugging
Feb. 2, 1994	286	2440	920	1700	Solids plug in VFB unit
Mar. 8, 1994	96	1100	600	500	Pyrolyzer grate plugging and excessive process water fines
May 8, 1994	1556	25370	13131	11145	Utility power failure and solids plugging problems
Aug. 9, 1994	384	5365	2620	1911	Heat exchanger fouling
Sept. 9, 1994	605	8100	5000	3640	Run in progress
Cumulative totals *(year/or to date)*	3117	43175	22721	19246	

3.4 Administration

ENCOAL is moving ahead with the permitting of the exhaust for the process water containment vapor collection system. The vapor collection system uses a small blower and an activated carbon filter to collect and filter nuisance odors from the existing process water containment areas prior to exhausting the filtered air outside the building. While a permit for the exhaust is not specifically required by current regulations, it was agreed that a permit would be prudent. Data has been collected from recent runs to support a permit application. ENCOAL also received final approval for the land farm in August 1994.

Significant visitors to the site during the quarter included the following:

- Three representatives of the DOE Pittsburgh Energy Technology Center
- A group from Tampa Electric
- A group from Muscatine Power
- Representatives of USASEAN and an Indonesian Mining and National Electric Power Group
- A Japanese group representing MITI and EPDC Thermopower
- A representative of PTBBA of Indonesia

All groups were given a presentation and a tour of the project.

ENCOAL submitted an application for a two-year extension of the Cooperative Agreement on July 17, 1994. Due to the delays caused by construction of the PDF deactivation facilities and other plant modifications, it became apparent that the primary objectives of the project would not be accomplished by the end of the original Cooperative Agreement on September 17, 1994. These key objectives are the collection of cost and design data for commercial plants, the testing of alternate coals, and the test burns to support commercial contracts. These objectives must be met to achieve commercialization of the LFC technology. ENCOAL is currently awaiting final approval of the two-year extension.

ENCOAL attended both the Chicago Clean Coal Technology Conference, and the Western Coal Transportation Association Conference, (Denver), in September. Presentations were given on the project in both cases. Other administrative activity included the ENCOAL/DOE Annual Operations Review conducted on August 23rd and 24th, 1994. The purpose of the meeting was to discuss the current status of the project and the extension request.

3.5 Equipment Modifications

Chemical settling of oily fines in the process water system has had encouraging results, and the development of a permanent fines collection system is proceeding. Conceptual design of the permanent system includes the use of the chemical injection in series with a clarifier/thickener, vacuum filter, and pumping systems to gather the process water slurries, separate out the oily fines, and recirculate clear process water back to the plant. The concept closely follows the existing 50% plant capacity, temporary collection and removal system. However, it includes a new structure, and "winterized" pumping systems to allow for the fines removal operation to function during the winter months at 100% plant capacity. This conceptual design is currently undergoing an internal review prior to procurement and construction later this fall.

A conceptual design for the removal and collection of fines from the clean water seal circulation and cyclone push water systems was also developed. This design uses a collection tank, clarifier/thickener, and pumping systems to gather all the coal slurries, chemically settle out fines to be pumped to waste, and recirculate clear water back to the plant. The design reduces the overall water consumption of the plant and decreases the number of man-hours required to operate the existing collection system. This project is currently undergoing an internal review prior to possible procurement and construction in 1995.

An on-line spare cooling water booster pump and a larger capacity process water pump were installed in July 1994. Both are currently in operation and have improved both availability and operability. Other projects completed during the quarter included rebuilding of the plant UPS (Uninterruptable Power Supply) system and installation of new insulators in ESP B. Problems with attaining full ESP voltage during the plant operation led to an inspection and the discovery of broken insulators. A failed heat blanket temperature controller that allowed CDL to condense on the insulators is the suspected cause.

TECHNICAL IMPACTS ON SCHEDULE AND MILESTONES

Technical problems and plant modifications dealt with so far have affected ENCOAL's preferred schedule. Plant modifications and installation of the new PDF deactivation facilities have caused delays in completing several primary objectives by the end of the Cooperative Agreement. ENCOAL has requested a two-year extension in order to accomplish these goals, and adjustments to the baseline schedule are detailed in the Updated Project Management Plan. However, the milestones for the project will remain as listed on the Phase III Milestone Log until final DOE approval on the two-year extension is granted. *(See Table 2: Phase III Milestone Log)*

TABLE 2: PHASE III MILESTONE LOG

ID. No	Description	Planned Completion Date	Actual Completion Date	Comments
1	First Sale of CDL	31-Oct-92	17-Oct-92	
2	Updated Project Management Plan	31-July-94	21-July-94	
3	First Delivery of PDF	31-Aug-94	17-Sept-94	
4	Plant Performance Tests	31-July-94	15-June-94	
5	Operations Review - 50%	28-Sept-93	28-Sept-93	
6	Select Candidates for Alternate Coal Testing	31-July-94	31-July-94	
7	Technical Performance and Economic Evaluation Report	17-Oct-94		Revised
8	Alternate Coal Testing	17-Oct-94		Revised
9	Operations Review - 100%	17-Oct-94		Revised
10	Complete Deactivation Modifications	1-Nov-93	12-Dec-93	

CONCLUSIONS AND LOOK AHEAD

Several of the major objectives of the ENCOAL Project have now been achieved. The LFC Technology has been essentially demonstrated. Significant quantities of specification CDL have been produced from Buckskin coal. Plant operation in a production mode with respectable availability (approaching 90%) has been demonstrated. Capacity has been limited to 50% of design, or 500 tons per day largely due to the limits in the VFB loop. In the next two years, increasing the throughput to near design levels is planned to uncover any other bottlenecks

affecting commercial applications. Reliability of the individual pieces of equipment making up the LFC process has proved to be very good, especially the dryer, pyrolyzer, quench table, dryer blower, oil pumps and glycol pumps.

PDF stabilization has been very elusive, but two methods have now been successful, layered pile deactivation and blending. Expanding on this knowledge, ENCOAL plans to design and install equipment that will accomplish deactivation and rehydration, the key elements in stabilization, in the plant at near design capacity. The first trains containing PDF have now been shipped and continuing shipments to additional customers is planned. Neat PDF shipments to Wisconsin Power and Light are now expected to commence by the middle of next year. Following successful deliveries of neat and blended PDF for test burns, it is planned to perform alternate coal tests. One test is scheduled for mid 1995 and a second one in mid 1996.

Several plant modifications are planned for the next few months. In mid December it is expected that the plant will be shut down for 6-8 weeks for replacement of the sand seal in the dryer with a water seal. During this shut-down, installation of the permanent process water cleanup system and a replacement dual heat exchanger for the quench table steam condenser (R_2D_2) are also planned. A week of operator training is scheduled for December during the shut-down.

Next month, ENCOAL anticipates approval will be received for the two year extension of the Project. The Public Design And Construction Report should be ready to publish in the next quarter. Work should begin on the design of the replacement for the temporary precipitate storage reservoir in the next quarter and a permit application submitted for the process water vapor collection system discharge. All other routine operations activity will continue.

GLOSSARY

BACT	Best Available Control Technology
CDL	Coal Derived Liquid
DOE	U.S. Department of Energy
EMP	Environmental Monitoring Plan
ENCOAL	ENCOAL Corporation, a wholly-owned subsidiary of SMC Mining Company
EPA	U.S. Environmental Protection Agency
EPC	Engineering, Procurement, and Construction
ESP	Electrostatic Precipitator
FGD	Flue Gas Desulfurization
HazOp	Hazardous Operation
HVAC	Heating, Ventilation and Air Conditioning
Kellogg	The M.W. Kellogg Company
LFC	Liquids From Coal
LTA	Lost Time Accident
MCC	Motor Control Center
MSDS	Material Safety Data Sheet
MSHA	Mine Safety and Health Administration
NEPA	National Environmental Policy Act
PDF	Process Derived Fuel
PLC	Programmable Logic Controller
PMN	Pre-Manufacture Notice
PMP	Project Management Plan
PRB	Powder River Basin
P&ID	Piping and Instrumentation Diagram
QA/QC	Quality Assurance / Quality Control
R_2D_2	Quench Table Steam Condenser Heat Exchanger
RTD	Resistance Temperature Detector
ROM	Run-of-Mine coal
S-belt	Flexible wall vertical bucket type conveyor
SGI	SGI International, LaJolla, CA
SMC	SMC Mining Company, a wholly-owned subsidiary of Zeigler Coal Holding Co.
UPS	Uninterruptable Power Supply
VFB	Vibrating Fluidized Bed
WDEQ	Wyoming Department of Environmental Quality
ZCHC	Zeigler Coal Holding Company