Technical Progress Report

For the Period:

July 13, 1990 through March 31, 1991

Prepared For:

Rosebud SynCoal Partnership
Advanced Coal Conversion Process Demonstration
Colstrip, Montana

DOE Contract
DE-FC22-90PC89664

Prepared by:

Western Energy Company
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LEGAL NOTICE

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References

1 Monthly Project Reports

1.0 Introduction and Purpose

This report contains a description of technical progress made on the Advanced Coal Conversion Process Demonstration Project (ACCP).

The project is a U.S. Department of Energy Innovative Clean Coal Technology Project. The cooperative agreement defining the project is between DOE and the Rosebud SynCoal Partnership RSCP. The RSCP is a partnership between Western Energy Company (WECo), a subsidiary of Entech, Montana Power's non-utility group, and NRG, a subsidiary of Northern States Power. The ACCP is a method of upgrading low ranked coals by reducing the moisture and sulfur content and increasing the heating value. The facility is being constructed at WECO's Rosebud No. 6 coal mine, west of Colstrip Montana.

This report contains both a history of the process development and a report of technical progress made since the beginning of the Clean Coal I cooperative agreement.

2.0 Project Progress Summary

The project is currently midway through the design stages and in the early stages of construction. Design work is approximately 54% complete and construction is approximately 6% complete. Facility startup and initial production is currently projected to occur before the end of the calendar year. The project is currently three weeks behind the partnership's accelerated schedule and nearly one year ahead of the cooperative agreement schedule as shown in Figure 1. Costs are being carefully monitored and the project is currently within its budget (Reference 1).

The facility has been designed to produce 300,000 tons per year with a nominal input of 2,278 pounds/min of raw coal.

3.0 Pre-Cooperative Agreement Project History

The initial concept of thermally processing coal with low-pressure, supper-heated recycled gas was presented to WECo by an independent consultant in 1981. Under contract to WECo, the consultant continued to develop the conceptual ideas necessary to show the potential benefits of this approach to coal upgrading technology. As those benefits were defined and explored, WECo developed an initial laboratory conceptual design. Equipment was procured, installed, and operated to substantiate the theoretical concepts in a bench-scale, batch-mode. The results were positive enough to warrant further development. This led to a contract between WECo and the Montana College of Mineral Science and Technology (Montana Tech) to construct and operate a 200 lb/hr continuous pilot plant. the plant was constructed in 1984 at

Montana Tech's Mineral Research Center in Butte Montana. The primary purpose of the experimental work was to develop a method of thermally processing subbituminous and lignite coal using low pressure, superheated recycled gas derived from the feed coal to produce a clean, stable product. The process shrinks the moisture-holding capillaries, and thermally destroys the carboxylic acid groups in the low rank coal. As the coal particles shrink, ash and sulfur mineral (pyrites) are released from the coal and can be easily separated. Some organic sulfur is also removed. The result is significant reduction in sulfur dioxide emission potential for the coal.

Approximately 12 different coals have been tested in the pilot plant (Reference 2). The combined processing experience is in excess of 300 tons of coal and 4,000 operating hours. The product has been tested for storage, handling, transportation, and combustion characteristics. Most of the testing has been performed with Rosebud subbituminous coal.

In addition to the above testing, Combustion Engineering, Inc has performed comprehensive analytical characterizations of WECo's processed Rosebud coal. The results indicate that the processed coal improved by reduction of moisture content ash slagging potential, coal abrasiveness, and coal sulfur content.

The ACCP will produce a high-quality, cost-effective, stable synthetic fuel from low quality coal using a continuous low pressure, moderate temperature treatment. The physical and chemical changes combine to produce a cleaner and drier coal product.

In 1986 WECo began pursuing construction of a demonstration or commercial scale ACCP facility. A private consulting firm produced numerous conceptual designs for facilities at different locations and throughputs. On April 15, 1986, WECo made a submittal for Clean Coal I moneys. ACCP was selected as an alternate in the first round of the selection process. WECo resubmitted the project to DOE during the Clean Coal II solicitation. In December 1988, after several selected CCI projects withdrew, ACCP was selected to proceed. The cooperative agreement for the project was finalized July 13, 1990.

In 1987, Stone and Webster Engineering Corporation made an agreement with WECo to do preliminary design work on the ACCP. Their work was halted in early 1988 because the project was not immediately selected as a CCII project.

In December 1990, NRG, a subsidiary of Northern States Power, joined in the venture with WECo.

4.0 Process Description

The best-to-date description of the ACCP technology is contained in a technical paper written for a Low Ranked Fuels Symposium held in Billings, MT in May 1991. The paper is attached for reference.

5.0 Technical Progress

5.1 Facility and Equipment Design Engineering and Procurement

In September of 1990, after final negotiations on the cooperative agreement were complete, SWEC resumed design of the ACCP facility. In September and October of 1990, design work focused on finalizing the design criteria, updating the material and energy balance, preparation of preliminary arrangement drawings, preparation of the plant control system approach, and preparation of long lead time equipment specifications.

In November of 1990, work continued on arrangement drawings and preparation of equipment specifications. Specifications for the vibrating fluidized beds, process gas fans, process furnace, coal screen, coal cleaning equipment, and the main transformer were issued for bid. Work began on preparing piping and instrumentation drawings (P&IDs) and general arrangement drawings. One subcontract was let for the design of the concrete product storage silos.

In December of 1990, contracts were placed for vibrating fluidized beds, fans, and the coal screen. The specification for the direct contact cooler was issued for bid. Work continued on general arrangement drawings and P&IDs. Work began on structural steel drawings.

In January 1991, contracts were placed for the main transformer, coal cleaning equipment, process furnace, and the cooling tower. The specifications for the emissions controls equipment, vibrating feeders, silo mass flow gates, service air equipment, and the belt conveyors were issued for bid. Work continued on general arrangement drawings, P&IDs, and structural steel drawings. Work began on logic diagrams for the plant control system (PCS).

In February 1991, a contract was placed for the plant control system. The specification for the control panels was issued for bid. Work continued on general arrangement drawings, P&IDs, structural steel drawings, and PCS programming.

In March 1991, contracts were placed for the bucket elevators, vibrating feeders, bin dischargers, direct contact cooler, emissions control equipment, process water pumps, service air equipment, electrical equipment, and the control panels. Work continued on general arrangement drawings, P&IDs, structural steel drawings, PCS programming.

The Purchase Order Schedule through March 31, 1991 is attached. Its summarizes all procurement activities to date.

5.2 Process Design Topics

Several especially important or unique process designs efforts were undertaken since the beginning of the project.

Water Inventory and Heat Rejection.

The initial design of the process called for a closed heat rejection system for removing heat from the second stage drying and cooler gases. The design resulted in high capital costs and an undesirable positive water inventory from the process. An alternate design including a direct contact cooler and a process heater that could combust high moisture, low heating value gases was developed, resulting in a negative water inventory.

SO_2 Controls

Although the amount of SO_2 released from the process was relatively small, the goal of further commercialization necessitated designing an SO_2 capture system into the demonstration plant. The change in the heat rejection design, space, and capital limitations lead to selecting an in-duct sorbent injection system. Sodium Bicarbonate was selected as the sorbent; better than 60% SO_2 capture is expected.

5.3 Site Construction

In anticipation of construction initiation, WECo performed the initial site preparation in January of 1991. The preparation consisted of clearing and grading the construction site.

The contract for piling was awarded in January 1991. Actual work began on February 7, 1991 and continued through the end of the reporting period. Construction work on the substructure (concrete foundations and underground piping) and the product storage silos will begin in April 1991. The remaining construction work will not begin until the third quarter.

5.4 Permitting

Permitting actually began in 1987 with an initial submittal for an alteration to the existing mine air quality permit. Approval for the alteration was received in late 1987. Twice since the initial approval, because of design changes, additional alteration requests have been submitted. Approval of for the first was received in 1988 and approval for the second is expected within the second quarter of 1991.

In January 1991, an application for an alteration to the existing mine permit was made requesting approval for deep-pit burial of the coal cleaning process slack. Approval for this alteration is expected within the third quarter of 1991.

5.5 Facility Startup and Testing

Initial operations of the facility are projected for December 1, 1991. Initial startup will be performed by Stone and Webster Engineering.

As part of the initial production period, baseline testing of the process will be performed including compliance monitoring of the particulate removal systems. A test plan will be prepared in the third and fourth quarters.

5.6 Production and Product Testing

Product production for 1992 is predicted to be 300,000 tons. The product will be sold to utilities and used in controlled test burns. Some initial sales are already ensured and the process for test burns is being formulated.

6.0 Problem Areas

No major technical problems are known at this time.

7.0 Future Work Areas

Work continues on award the remaining contracts for equipment and construction. WECo is formulating an operations plan and will begin hiring operators in the third quarter of 1991. Operations and Maintenance (O&M) manuals will be written prior to startup. Methods of obtaining test burn data from the product coal will also be formulated before the end of the year.

Attachment A

Advanced Coal Conversion Process
Technical Paper

WESTERN ENERGY COMPANY
ADVANCED COAL CONVERSION PROCESS

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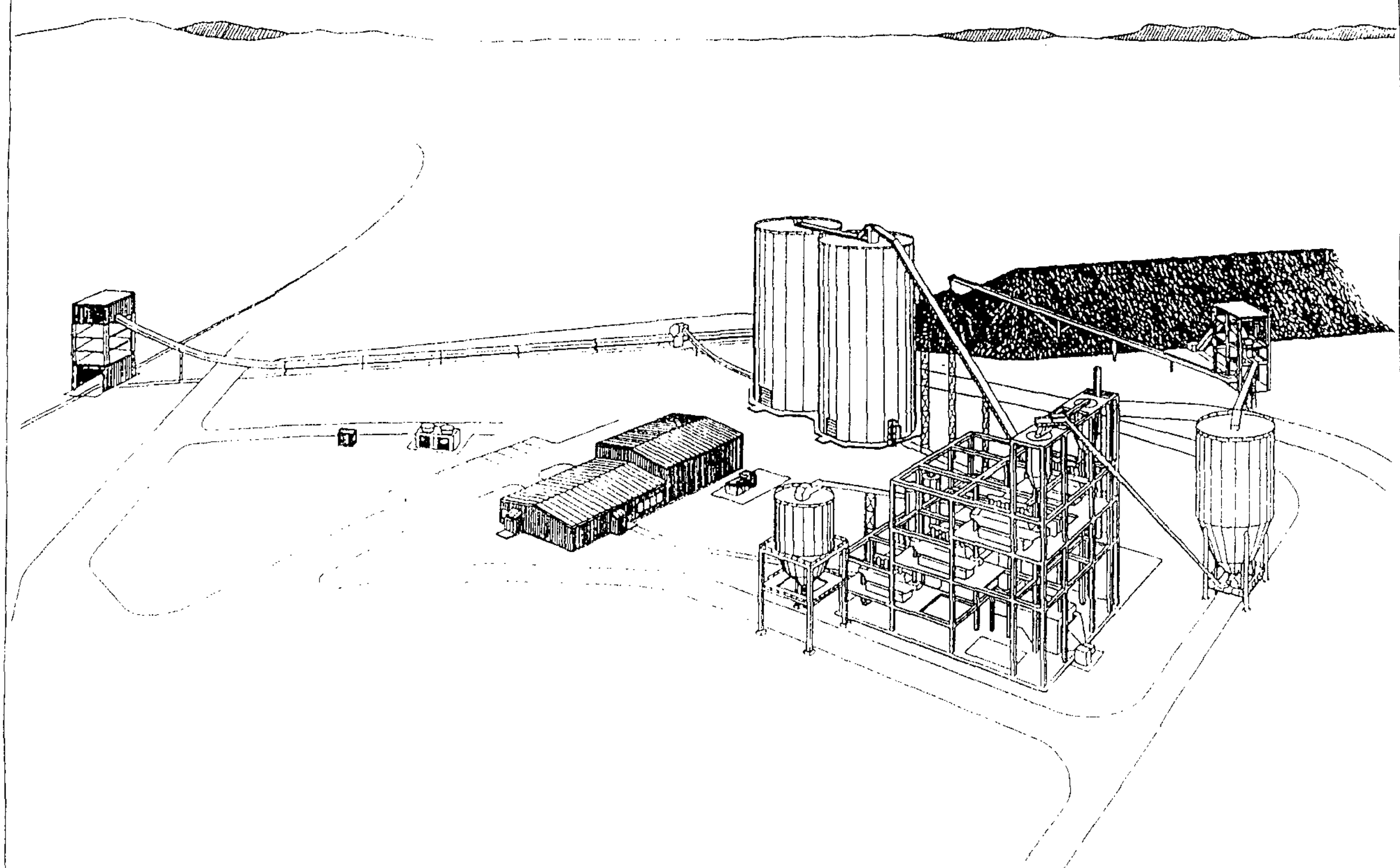


ADVANCED COAL CONVERSION PROCESS
DEMONSTRATION PROJECT

INTRODUCTION

Since 1968, Western Energy has been investigating methods of upgrading low ranked coals to reduce shipping costs and mitigate safety hazards associated with storage of such coals. In the early 1980's an MSE process engineer, consulting for Western Energy developed the basic ACCP concept. Western Energy developed and patented the process and is currently engaged in its commercialization with Northern States Power under the auspices of the Rosebud Syncoal Partnership. Presented herein is a description of the demonstration plant being built as a clean coal project with the DOE and Rosebud Syncoal Partnership.

STATUS OF DEVELOPMENT

Much of the ACCP development work has been performed using a small, 150 pound per hour pilot plant located at the Mineral Research Center, south of Butte, Montana. Up to 100 ton lots have been produced to assess stability during shipment and handling as well as chemical characteristics. Engineering and construction are currently under way for the 300,000 ton per year demonstration plant at the Western Energy Rosebud Mine near Colstrip, Montana. The official groundbreaking was held March 28, 1991 and orders for major, long lead equipment have been placed. This installation is expected to be operational by approximately January 1992.

Demonstration Plant Description

The plant is located inside the Rosebud Mine near the unit train loadout, occupying an area approximately 400 feet by 600 feet. The normal throughput of the demonstration plant will be 1,632 tons per day (tpd) of raw coal, providing 982 TPD of coarse coal product and 130 TPD of coal fines (minus 20 mesh). The fines will be collected and briquetted, giving a combined product rate of 1,112 TPD of high-quality, clean coal product.

The heating value of the raw coal fed to the process is 28.0 billion Btu/Day; other energy inputs to the process are from natural gas (or propane) burned in the process furnace (2.2 billion Btu/Day) and from electric power for the motors (245 million Btu/Day), for a total energy input of 30.5 billion Btu/Day. The heating value of the product coal totals 26.1 billion Btu/Day. The resulting process efficiency of the process (energy input compared to useful product) is 26.1/30.5 or 86 percent.

The energy from the natural gas (or propane) and electricity required by the process is nine percent of the heating value of the raw coal. The waste coal discarded from the process contains 2.28

billion Btu/Day, or eight percent of the energy of the raw coal.

PROJECTIONS FOR THE FUTURE

The ACCP partners (Western Energy and Northern States Power also called the Rosebud Syncoal partnership) intend to commercialize the process by both preparing coal in their own plants and by licensing to other firms. The target markets are primarily the U. S. utilities, the industrial sector and Pacific Rim export market. Current projections suggest the utility market for this quality coal is approximately 60 million tons per year. The partnership's goal is to start construction on three facilities designed to produce 3 million tons per year each by 1995.

PROCESS DESCRIPTION

The Advanced Coal Conversion process (ACCP) consists of three process steps: drying, cooling and cleaning. These steps are described below for the demonstration plant being built in Colstrip.

Coal is taken from the Rosebud Mine unit train loadout stock pile with an underpile vibratory feeder. The coal is then screened to 1/2" X 2" and the oversize and fines sent back to the stockpile. The sized coal is conveyed to a surge hopper preceeding each train of dryers and coolers.

The plant consists of two identical trains of dryers and coolers. The operation of one train is described.

Drying

Coal from the surge hopper is fed at a rate of 1,139 lb/min. through a rotary feeder to the first stage vibrating fluidized bed dryer. The coal is contacted by flue gas at 675°F. The flue gas entering the first stage dryer is generated in the process furnace by combustion of natural gas or propane. Prior to being ducted to the 1st stage dryer, the flue gas exchanges heat with recycled gas from the second stage dryer.

The action of the first stage dryer is to remove surface moisture from the coal, dropping total moisture to about 15%. The dryer has an active length of 30 feet and a width of 5 feet. It vibrates with about a 1/4" amplitude to move the coal through it and help fluidize the coal. The bed has six inlets along the side for flue gas to enter, and six outlets along the top.

The coal is fed through rotolocks from the first stage into the second stage; both stages are physically the same size. Recycle gas, raised to 900°F by heat exchange with the process furnace flue gas, contacts the coal in the second stage dryer. The recycle gas is about 95% water vapor.

Coal is dried to approximately 1% moisture in the second stage. Additional reactions occur which decrease the pore volume and surface area of the coal, thus inhibiting reabsorption of moisture. CO_2 and H_2S, as well as light hydrocarbons, are driven off the coal in this stage, at a rate of about 0.3 lbs dry gas per 100 pounds of coal fed to the process.

Dry make gas and the water dried from the coal in the second stage are fed to the process furnace for incineration. The SO_2 formed by incineration is removed by addition of Nahcolite ($NaHCO_3$) into the 1st stage baghouse.

Cooling

As the coal exits the 2nd stage dryer, it falls into a vertical coal cooler where process water is sprayed on it to reduce the temperature to about 350°F. The water vaporized during this operation is drawn back into the second stage dryer to exit by means of the make gas stream to the furnace.

After water quenching, the coal enters the vibratory cooler through a rotary airlock. In the cooler, the coal is contacted by 100°F inert gas and cooled to about 150°F. The cooler gas that exits the vibrating cooler is then itself cooled by water sprays in a contact cooler prior to recycle to the cooler bed.

Product Cleaning

The converted coal product entering the cleaning system is separated by vibrating screens into four streams: plus 1/2 inch, 1/4 by 1/2 inch, 6 mesh by 3 mesh, and minus 6 mesh (3mesh = .265 inch, 6 mesh = .132 inch). These streams of coal are then fed in parallel to four deep-bed stratifiers (stoners), where a rough specific gravity separation is made using air and vibration. The light or upper streams from the stoners are sent to the Coal Product conveyor; the heavy or lower streams for all but the minus 6 mesh stream are sent to trapezoidal fluidized bed separators. The heavy fraction of the minus 6 mesh stream goes directly to the solid waste conveyor. The fluidized bed separators, again using air and vibration to effect a further gravity separation, split the coal into three streams. The light or upper steam is the Product; the two heavy, lower streams are combined and sent to solid waste handling.

The coal product from the cleaning system is then sent to two-

6000 ton concrete silos for unit train load out. The waste is either trucked to an offsite user or a disposal site in the mine.

Process Furnace

The heat required to process the feedstock is provided by burning natural gas or propane in a process furnace. This system is sized to provide a heat generation rate of 74 MM Btu/hr. By attemperating the flue gas with recycle from the first stage dryer, a maximum temperature of 1700°F is maintained in the furnace. The 1700°F flue gas exchanges heat with the recycled gas from the second stage dryer, bringing its temperature back up to 900°F. After further attemperation with first stage recycle gas, the 675°F flue gas enters the first stage dryer.

In addition to burning natural gas, the furnace also incinerates make gas from the second stage dryer. Since the make gas contains enough sulfur compounds to require a flue gas desulfurization system, a dry sorbent in-duct system will be used. The emission control philosophy is based on injecting dry sorbents into the duct work to minimize the release of sulfur dioxide to the atmosphere. Sorbents, such as calcium carbonate, hydrated lime or nahcolite, will be injected into the ducts of the ACCP at selected points to maximize the potential for sulfur dioxide removal while minimizing reagent usage. The sorbents will be removed from the gas streams in the particulate removal system, briquetted with the coal fines, and returned to the product stream.

Heat Rejection

Most heat rejection from the ACCP will be accomplished by releasing water vapor and flue gas to the atmosphere through an exhaust stack. The stack design will allow for vapor release at an elevation great enough that, when coupled with the vertical velocity resulting from a forced draft fan, dissipation of the gases will be maximized. Additional heat rejection will be accomplished using an induced-draft cooling tower.

PRODUCT CHEMISTRY

Rosebud Syncoal's Advanced Coal Conversion Process yields a synthetic solid fuel that represents an evolutionary step in the coalification process: sized, raw western lignite and subbituminous coals (which are coals that have experienced a low-temperature environment while evolving) are, through chemical changes induced by the thermal environment of the ACCP, upgraded in rank to a fuel which has the characteristics of a coal that evolved in a higher temperature environment for a long period of time. Thus, the ACCP product is a synthetic fuel with characteristics of a higher grade bituminous coal.

The ACCP effects changes in the coal feedstock by changing the chemical composition and structure of the coal. The changes result in: 1) a product that has a higher heating value than the coal feedstock; 2) a stable, hydrophobic product with a much lower equilibrium moisture content that is less likely to spontaneously combust due to rehydration; and 3) a product that is readily transportable in open rail cars. The chemical changes effected by the ACCP include the following:

- Increased aromaticity;
- Increase fixed carbon;
- Decreased hydrogen to carbon ratios;
- Decreased oxygen to carbon ratios; and
- Decreased oxygen functional groups.

The balance of this section will explain how the above changes, which are the result of the thermo-chemical reactions induced by the ACCP, result in the upgrade synthetic coal product.

Chemical Composition Changes

The analyses of the coal feedstock and upgraded product from one particular pilot plant run are shown in Table 1. This run, numbered WR-1, occurred in October, 1986. The pilot plant operating conditions achieved during this run represent those targeted for the commercially sized fluidized beds of the demonstration plant. The first section of Table 1 showns standard proximate and ultimate coal analyses of the coal feedstock and the synthetic coal product. Table II gives similar proximate analysis information for a Dominy Lignite run.

Proximate Analysis

The proximate analysis demonstrates that moisture is essentially eliminated from the coal during the ACCP. This moisture removal is due to thermal dehydration of the coal particle and the chemical condensation reactions which the feedstock experiences during its residence in the high temperature environment of the second-stage reactor bed.

The moisture-free proximate analysis of the feedstock and the upgraded product also shows that, to a large extent, both their volatile matter and their fixed carbon content stay within a few percentage points of each other. This phenomenon is significant and desirable, because normally raw coal, when subjected to the temperatures of the ACCP, would undergo devolatilization and substantial gasification. However recent work has shown that devolilization of low rank coals is very dependant on heat up rate

(Ref. 1, 2.). In the ACCP, the coal is heated slowly, which, as described in the above references, favors dehydration and decarboxylation over devolatilization.

Ultimate Analysis

The ultimate analysis of the upgraded product compared with the Rosebud coal feedstock shows the result of the chemical reactions which have occurred: there is an increase in carbon, a decrease in both hydrogen and oxygen, and a decrease in both total and organic sulfur. Nitrogen, which is not affected by the ACCP, increases in percentage terms while staying constant in absolute terms.

Oxygen is removed by the ACCP to the greatest extent of any of the coal elements. The oxygen removal is from decarboxylation reactions which drive off both carbon dioxide and water, dehydration reactions which drive off chemically bound water, and decarbonylation reactions which drive off carbon monoxide.

The increase in fixed carbon and decrease in hydrogen in the upgraded product results from chemical reactions which cause structural changes in the coal. These changes are a result of the coal becoming more aromatic and repolymerizing into a tighter ring structure. The reactions causing these changes result in pore destruction, shrinkage and fracture release of the pyrites and ash that are characteristics of the synthetically upgraded Coal Product.

The reductions in total and organic sulfur are due to two mechanisms. Most of the sulfur removal results from the mechanical removal of pyrites during the cleaning step. However, the ability to remove these pyrites is a result of the chemical repolymerizaiton and consequent shrinkage of the organic components of the coal, which causes fracture release of the ash or mineral components.

Chemical sulfur removal caused by the ACCP is due to the rearrangement of the organic molecules which release heteroatom sulfur. The minor amounts of carbon disulfide (CS_2), carbonyl sulfide (COS) and methyl mercaptan (CH_3SH) which appear in the make gas result from these heteroatom removal reactions.

Petrographic Analysis

The petrographic analysis of the feedstock and upgraded product in Table 1 measures characteristics of the organic matter from which the coal evolved. As organic matter changes into coal, several of the different types of organic matter form "macerals" known as huminite, exinite and inertinite. These macerals are comparable to various minerals in the ash-forming components of the coal. In general, exinites have a higher hydrogen-to-carbon ratio than huminities, which have a higher hydrogen-to-carbon ratio than inertinities.

The maceral composition from the petrographic analysis indicates an increase in the coal rank of the upgraded product. Since the changes in the maceral composition are close to the accuracy limits of this analysis method, the conclusion of increased rank can not be based solely on maceral composition analysis. However, the last entry in the petrogrpahic analysis, the reflectance measurement, shows a very significant change between the feedstock and the upgraded product.

The reflectance analysis is considered to be one of the most reliable indicators of coal rank. A reflectance value of 0.42 indicates a subbitumiunous C coal. The upgraded product's reflectance of 0.51, however, indicates that the Company's synthetic fuel product is similar to a subbituminous A coal or a high volatile bituminous C coal. The increase in reflectance further indicates an increase in the aromaticity of the upgraded product in comparison to the feedstock. The above conclusions are supported by a confidential report prepared for the Canada Centre for Mineral and Energy Technology by Axelson, Munoz, Mikula, Michaelian and Leung entitled Evaluation of Processed Rosebud Coal (October, 1985).

Other Analysis

The "Other Analysis" section of Table 1 shows several physical and chemical analysis results. As indicated, the surface area decreases from 288 cm^2/g for the coal feedstock to 55 cm^2/g for the upgraded product. This shrinkage is the most direct evidence of the destruction of the coal's pore structure through the ACCP. The reduced surface area is one reason why the equilibrium moisture content of the upgraded product is significantly reduced; the smaller surface area of the upgraded product cannot hold or attract as much water as the larger surface area of the feedstock. Furthermore, the water content of the upgraded product is also reduced because of the reduction of oxygen-containing functional groups. Since the upgraded product has less oxygen-containing functional groups, chemisorption of water through hydrogen bonding is retarded.

The "Other Analysis" section also shows that the hydrogen-to-carbon ration (H/C) and the oxygen-to-carbon ration (O/C) are reduced in the upgraded product as a result of chemical reactions which increase the aromaticity of the coal and reduce its oxygen composition through decarboxylation reactions. The fact that these reactions occur is shown by the increase in apparent aromaticity (0.46 to 0.66 from feedstock to coal product) and the decrease in carboxyl group content (0.74% to 0.53%).

CONCLUSION

ASTM coal classification standards demonstrate that the subbituminous C coal feedstock is converted by the ACCP to a synthetic fuel classified as a high volatile bituminous C coal. As noted above, the synthetic upgraded coal product exhibits the characteristic of reduced pore volume, reduced oxygen, reduced hydrogen and increased aromaticity. The coal product has a reduced equilibrium moisture level and increased heating value; it retains a majority of its volatile matter with favorable ignition characteristics.

References

1. "Kinetic Of Volatile Product Evolution From The Argonne Premium Coals", Michael A. Serio, Peter R. Solomon, Syvie Charpenay, Zhen-Zhone Ug, and Rosemary Bassilakis, Advanced Fuel Research, Inc. 87 Church Street, East Hartford, CT 06108

2. "General Model of Coal Devolatilization", P. R. Solomon, D. G. Hanblen, R. M. Carangelo, M. A. Serio, and G. V, Deshpande, Advanced Fuel Research, Inc. 87 Church Street, East Hartford, Connecticut 06108

TABLE 1

FEEDSTOCK AND COAL PRODUCT ANALYSES

ROSEBUD MINE

Proximate Analysis	Coal Feedstock	MF #	Coal Product	MF #
% Moisture	24.07	____	0.96	____
% Volatile Matter	27.40	36.1	37.64	38.0
% Fixed Carbon	37.15	48.9	51.64	52.0
% Ash	11.38	15.0	9.76	9.85
Btu/lb.	8,421	____	11,832	____
% Increase in Btu/lb.			40.51%	
Ultimate Analysis				
% Carbon	49.18		67.71	
% Hydrogen	6.57		5.20	
% Oxygen	30.99		15.78	
% Nitrogen	0.69		1.04	
% Sulfur	1.18		0.48	
% Organic Sulfur	0.50		0.40	
Petrographic Analysis				
Huminite	77%		81%	
Exinite	5%		2%	
Inertinite	18%		14%	
Reflectance (R%)	0.42		0.51*	
Other Analysis				
Surface area (cm_2/g)	288		55*	
H/C Ratio	1.60		0.92*	
O/C Ratio	0.24		0.09*	
Apparent Aromaticity	0.46		0.66*	
% COOH	0.74		0.53*	
Classification				
ASTM	Subbituminous C		high-volatile bituminous C	

MF indicates moisture free proximate analysis of feedstock and Coal Product

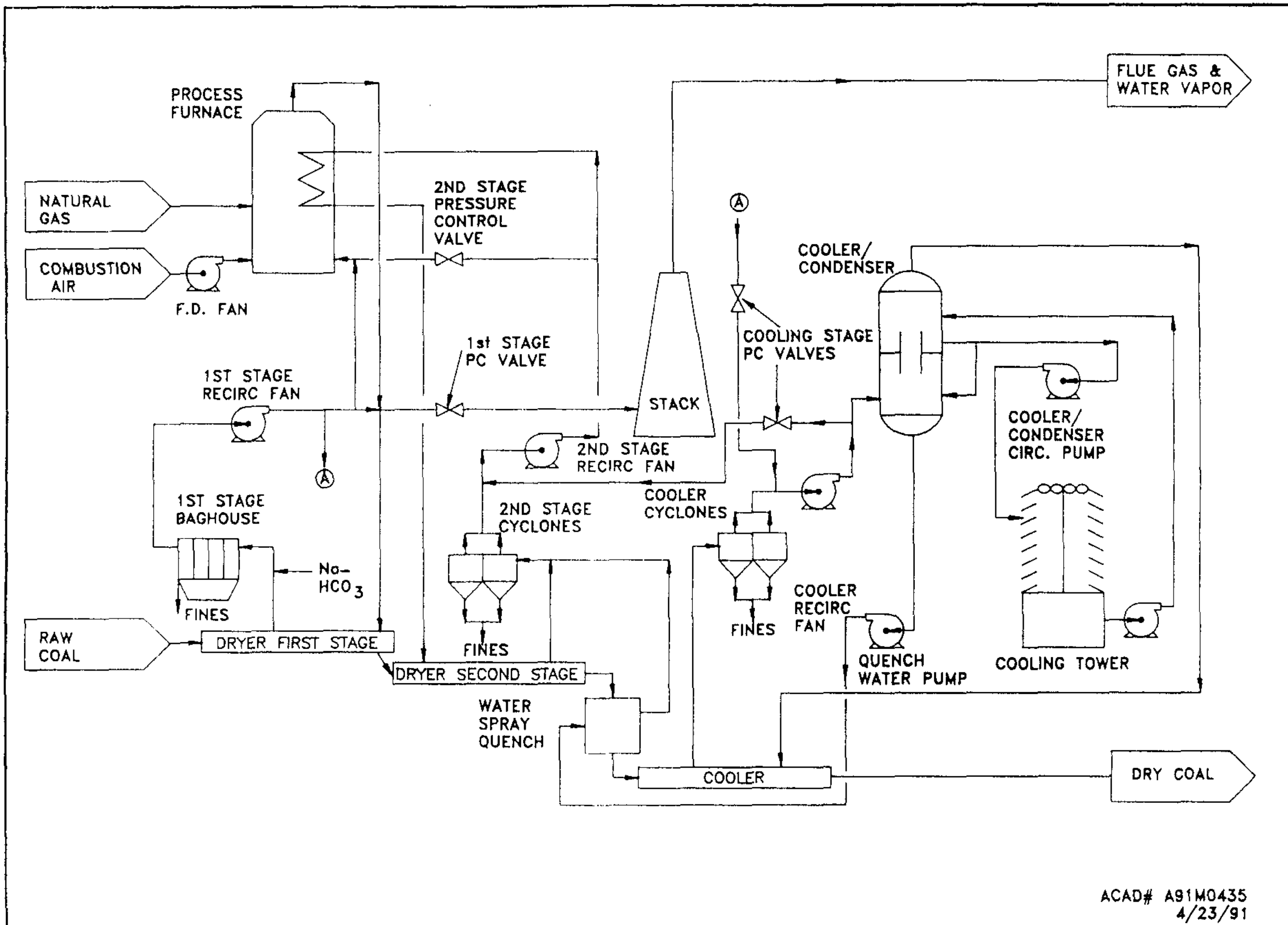
* indicates increased coal rank of Coal Product

TABLE 2

FEEDSTOCK AND COAL PRODUCT ANALYSIS

DOMINY MINE

Proximate Analysis	Coal Feedstock	MF =	Coal Product	MF =
% Moisture	34.2		2.6	
% Volatile Matter	25.8	39.[illegible]	43.2	44.3
% Fixed Carbon	33.4	50.[illegible]	44.3	45.5
% Ash	6.6	10.[illegible]	9.9	10.2
H.V. (Btu/lb)	7140		10650	
% Increase in HV			49.2	



ROSEBUD SYNCOAL
ADVANCED COAL CONVERSION PROCESS
DEMONSTRATION PROJECT PROCESS FLOW SCHEMATIC

Attachment B

Purchase Order Schedule

DEMONSTRATION PROJECT
ADVANCED COAL CONVERSION PROJECT
WESTERN ENERGY COMPANY
J.O. NO. 01845

PURCHASE ORDER SCHEDULE
STONE & WEBSTER ENGINEERING COPRORATION
DENVER, COLORADO

STATUS AS OF: APRIL 1, 1991
REVISION 3

WORK GROUP	WORK PACKAGE	ACTIVITY DESCRIPTION SPECIFICATION NO.	START SPEC	ISSUE FOR WECO REVIEW	RECEIVE WECO COMMENTS	ISSUE FOR BIDS	RECEIVE BIDS	AWARD	INITIAL VENDOR DRAWINGS	START DELIVERY	NOTES
1.2.1	2	COAL SCREEN P231A-2	S21-Sep-90 A21-Sep-90	S12-Oct-90 A12-Oct-90	S25-Oct-90 A25-Oct-90	S06-Nov-90 A16-Nov-90	S27-Nov-90 A26-Nov-90	S14-Dec-90 A21-Dec-90	S11-Jan-91 A18-Jan-91	S29-May-91	
1.2.1	2	BELT CONVEYORS P231A-1	S26-Oct-90 A26-Oct-90	S09-Nov-90 A07-Dec-90	S26-Nov-90 A12-Dec-90	S14-Dec-90 A01-Feb-91	S04-Jan-91 A05-Mar-91	S25-Jan-91 A01-Apr-91	S22-Feb-91 F29-Apr-91	S17-Jun-91 F15-Jul-91	
1.2.1	2	BUCKET ELEVATORS P231A-4	S02-Nov-90 A02-Nov-90	S26-Nov-90 A29-Nov-90	S10-Dec-90 A12-Dec-90	S17-Dec-90 A16-Jan-91	S07-Jan-91 A29-Jan-91	S25-Jan-91 A08-Mar-91	S22-Feb-91 F08-Apr-91	S17-Jun-91	
1.2.1	2	PELLETIZER(DUST DISPOSAL SYS) P231A-6	S25-Jan-91 A01-Feb-91	S08-Feb-91 F15-Apr-91	S22-Feb-91 F19-Apr-91	S01-Mar-91 F25-Apr-91	S20-Mar-91 F17-May-91	S01-Apr-91 F03-Jun-91	S01-May-91 F03-Jul-91	S01-Jul-91 F16-Sep-91	
1.2.1	2	LOADING SPOUTS P231A-5	S25-Jan-91 A14-Nov-90	S08-Feb-91 A04-Jan-91	S22-Feb-91 A18-Jan-91	S01-Mar-91 A04-Mar-91	S20-Mar-91 A20-Mar-91	S01-Apr-91 F09-Apr-91	S01-May-91 F09-May-91	S01-Jul-91 F08-Jul-91	
1.2.1	2	DUST COLLECTORS P231T	S03-Dec-90 A01-Feb-91	S04-Jan-91 A20-Mar-91	S18-Jan-91 A22-Mar-91	S25-Jan-91 F05-Apr-91	S15-Feb-91 F26-Apr-91	S01-Mar-91 F06-May-91	S01-Apr-91 F14-Jun-91	S17-Jun-91 F19-Aug-91	
1.2.1	2	COAL CLEANING EQUIPMENT P231A-3	S28-Sep-90 A28-Sep-90	S30-Oct-90 A30-Oct-90	S07-Nov-90 A08-Nov-90	S12-Nov-90 A19-Nov-90	S03-Dec-90 A17-Dec-90	S31-Dec-90 A25-Jan-91	S01-Feb-91 A26-Mar-91	S17-Jun-91	
1.2.1	2	VIBRATING FEEDERS P231R-2	S09-Nov-90 A09-Nov-90	S30-Nov-90 A29-Nov-90	S14-Dec-90 A12-Dec-90	S21-Dec-90 A18-Jan-91	S11-Jan-91 A01-Feb-91	S01-Feb-91 A22-Mar-91	S01-Mar-91 F15-Apr-91	S17-Jun-91	
1.2.1	2	BIN DISCHARGERS P231R-1	S09-Nov-90 A09-Nov-90	S30-Nov-90 A29-Nov-90	S14-Dec-90 A12-Dec-90	S21-Dec-90 A18-Jan-91	S11-Jan-91 A01-Feb-91	S01-Feb-91 A14-Mar-91	S01-Mar-91 F15-Apr-91	S17-Jun-91	
1.2.1	2	SILO MASS FLOW GATES P231A-7	S03-Dec-90 A14-Nov-90	S17-Dec-90 A29-Nov-90	S31-Dec-90 A12-Dec-90	S04-Jan-91 A23-Jan-91	S18-Jan-91 A13-Feb-91	S01-Feb-91 A01-Apr-91	S01-Mar-91 F01-May-91	S17-Jun-91 F22-Jul-91	
1.2.1	1	COAL DRYER/COOLERS R-100	S14-Sep-90 A14-Sep-90	S26-Sep-90 A26-Sep-90	S11-Oct-90 A11-Oct-90	S05-Nov-90 A05-Nov-90	S26-Nov-90 A03-Dec-90	S14-Dec-90 A21-Dec-90	S25-Jan-91 A20-Feb-91	S15-Jun-91	
1.2.1	3	PROCESS GAS HEATER F-100	S21-Sep-90 A21-Sep-90	S23-Oct-90 A09-Nov-90	S30-Oct-90 A15-Nov-90	S09-Nov-90 A21-Nov-90	S30-Nov-90 A14-Dec-90	S21-Dec-90 A25-Jan-91	S01-Feb-91 A22-Feb-91	S17-Jun-91 F01-Jul-91	
1.2.1	4	DIRECT CONTACT COOLER X-200	S21-Sep-90 A21-Sep-90	S09-Nov-90 A30-Nov-90	S26-Nov-90 A03-Dec-90	S30-Nov-90 A18-Dec-90	S21-Dec-90 A14-Jan-91	S14-Jan-91 A06-Mar-91	S15-Feb-91 F02-Apr-91	S17-Jun-91 F01-Jul-91	
1.2.1	5	EMISSIONS CONTROL EQUIPMENT F/E PRS-100	S14-Sep-90 A14-Sep-90	S26-Sep-90 A26-Sep-90	S11-Oct-90 A11-Oct-90	S12-Nov-90 A04-Jan-91	S30-Nov-90 A05-Feb-91	S21-Dec-90 A08-Mar-91	S01-Feb-91 F05-Apr-91	S22-Jun-91 F01-Jul-91	
1.2.1	5	SORBENT INJECTION SYSTEM N-100	A13-Feb-91 A13-Feb-91	S27-Feb-91 A27-Feb-91	S06-Mar-91 A06-Mar-91	S08-Mar-91 A08-Mar-91	S29-Mar-91 A25-Mar-91	S19-Apr-91	S17-May-91 F10-May-91	S15-Aug-91	
1.2.1	7	FANS K-100	S14-Sep-90 A14-Sep-90	S26-Sep-90 A26-Sep-90	S11-Oct-90 A11-Oct-90	S05-Nov-90 A06-Nov-90	S26-Nov-90 A30-Nov-90	S14-Dec-90 A21-Dec-90	S25-Jan-91 A22-Feb-91	S01-Jul-91 F01-Aug-91	

S = SCHEDULE DATE   A = ACTUAL DATE   F = FORECAST DATE

DEMONSTRATION PROJECT
ADVANCED COAL CONVERSION PROJECT
WESTERN ENERGY COMPANY
J.O. NO. 01845

PURCHASE ORDER SCHEDULE
STONE & WEBSTER ENGINEERING COPRORATION
DENVER, COLORADO

STATUS AS OF: APRIL 1, 1991
REVISION 3

WORK GROUP	WORK PACKAGE	ACTIVITY DESCRIPTION SPECIFICATION NO.	START SPEC	ISSUE FOR WECO REVIEW	RECEIVE WECO COMMENTS	ISSUE FOR BIDS	RECEIVE BIDS	AWARD	INITIAL VENDOR DRAWINGS	START DELIVERY	NOTES
1.2.1	7	PUMPS P-100	S03-Dec-90 A12-Dec-90	S04-Jan-91 A08-Jan-91	S18-Jan-91 A16-Jan-91	S25-Jan-91 A25-Jan-91	S15-Feb-91 A12-Feb-91	S01-Mar-91 A07-Mar-91	S01-Apr-91 F05-Apr-91	S01-Jun-91	
1.2.1	7	FIRE PUMPS (DIESEL) P402B	S15-Jan-91 A15-Jan-91	S01-Feb-91 A15-Feb-91	S15-Feb-91 A04-Mar-91	S22-Feb-91 A18-Mar-91	S15-Mar-91 F08-Apr-91	S01-Apr-91 F22-Apr-91	S01-May-91 F22-May-91	S01-Sep-91	
1.2.1	7	AIR COMPRESSORS/DRYERS K200	S03-Dec-90 A03-Dec-90	S31-Dec-90 A08-Jan-91	S14-Jan-91 A16-Jan-91	S21-Jan-91 A21-Jan-91	S11-Feb-91 A12-Feb-91	S25-Feb-91 A06-Mar-91	S25-Mar-91 F05-Apr-91	S01-Jul-91	
1.2.1	8	STEEL SILOS/TANKS (F & E) S204V	S26-Nov-90 A03-Dec-90	S19-Dec-90 A17-Jan-91	S04-Jan-91 A24-Jan-91	S11-Jan-91 A31-Jan-91	S01-Feb-91 A12-Feb-91	S22-Feb-91 F12-Apr-91	S22-Mar-91 F19-Apr-91	S22-May-91 F22-Jul-91	
1.2.1	9	MAIN TRANSFORMER E015A	S28-Sep-90 A28-Sep-90	S12-Oct-90 A12-Oct-90	S22-Oct-90 A22-Oct-90	S05-Nov-90 A15-Nov-90	S26-Nov-90 A05-Dec-90	S14-Dec-90 A04-Jan-91	S08-Feb-91 A22-Feb-91	S15-Aug-91	
1.2.1	9	ELECTRICAL EQUIPMENT E015B-1	S26-Nov-90 A26-Nov-90	S17-Dec-90 A17-Dec-90	S31-Dec-90 A31-Dec-90	S14-Jan-91 A15-Jan-91	S04-Feb-91 A01-Feb-91	S18-Feb-91 A14-Mar-91	S18-Mar-91 F26-Apr-91	S01-Jul-91 F22-Aug-91	
1.2.1	9	ELECTRICAL EQUIPMENT E015B-2	S26-Nov-90 A26-Nov-90	S17-Dec-90 A17-Dec-90	S31-Dec-90 A31-Dec-90	S14-Jan-91 A15-Jan-91	S04-Feb-91 A01-Feb-91	S18-Feb-91 A15-Mar-91	S18-Mar-91 F26-Apr-91	S01-Jul-91 F07-Aug-91	
1.2.1	9	ELECTRICAL EQUIPMENT E015B-3	S26-Nov-90 A26-Nov-90	S17-Dec-90 A17-Dec-90	S31-Dec-90 A31-Dec-90	S14-Jan-91 A15-Jan-91	S04-Feb-91 A01-Feb-91	S18-Feb-91 A14-Mar-91	S18-Mar-91 F26-Apr-91	S01-Jul-91 F07-Aug-91	
1.2.1	10	PLANT CONTROL SYSTEM C091X	S01-Nov-90 A01-Nov-90	S07-Dec-90 A07-Dec-90	S21-Dec-90 A04-Jan-91	S02-Jan-91 A04-Jan-91	S23-Jan-91 A25-Jan-91	S01-Feb-91 A08-Feb-91	S01-Mar-91 A06-Mar-91	S15-Jul-91 F15-Jun-91	
1.2.1	10	CONTROL VALVES C053X	S03-Dec-90 A03-Dec-90	S21-Dec-90 A25-Jan-91	S07-Jan-91 A01-Feb-91	S14-Jan-91 F08-Apr-91	S01-Feb-91 F26-Apr-91	S15-Feb-91 F27-May-91	S15-Mar-91 F18-Jun-91	S01-Jul-91 F01-Aug-91	
1.2.1	10	CONTROL PANELS C092X	S02-Jan-91 A02-Jan-91	S18-Jan-91 A25-Jan-91	S01-Feb-91 A01-Feb-91	S08-Feb-91 A07-Feb-91	S22-Feb-91 A23-Feb-91	S01-Mar-91 A08-Mar-91	S01-Apr-91	S15-Jul-91	
1.2.1	10	CONTROL DAMPERS C073B	S21-Jan-91 A21-Jan-91	S25-Jan-91 A25-Jan-91	S31-Jan-91 A31-Jan-91	S15-Feb-91 A13-Mar-91	S01-Mar-91 A27-Mar-91	S08-Mar-91 F05-Apr-91	S05-Apr-91 F01-May-91	S31-Jul-91 F14-Aug-91	
1.2.1	10	COOLING TOWER X-200	S26-Oct-90 A26-Oct-90	S16-Nov-90 A30-Nov-90	S30-Nov-90 A03-Dec-90	S10-Dec-90 A14-Dec-90	S28-Dec-90 A09-Jan-91	S22-Jan-91 A01-Feb-91	S22-Feb-91 A22-Feb-91	S15-Jun-91	
1.3.6	5	CONCRETE SILOS DESIGN - SUBCONTR S210V	S15-Nov-90 A15-Nov-90	--	--	--	--	S03-Dec-90 A30-Nov-90	S30-Jan-91 A17-Jan-91	S01-Mar-91 A06-Mar-91	

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DEMONSTRATION PROJECT
ADVANCED COAL CONVERSION PROJECT
WESTERN ENERGY COMPANY
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PURCHASE ORDER SCHEDULE
STONE & WEBSTER ENGINEERING COPRORATION
DENVER, COLORADO

STATUS AS OF: APRIL 1, 1991
REVISION 3

WORK GROUP	WORK PACKAGE	ACTIVITY DESCRIPTION SPECIFICATION NO.	START SPEC	ISSUE FOR WECO REVIEW	RECEIVE WECO COMMENTS	ISSUE FOR BIDS	RECEIVE BIDS	AWARD	INITIAL VENDOR DRAWINGS	START DELIVERY	NOTES
1.3.2	1	MECHANICAL CONTRACT P275A	S07-Jan-91 A01-Feb-91	S15-Feb-91 F08-Apr-91	S28-Feb-91 F11-Apr-91	S08-Mar-91 F15-Apr-91	S01-Apr-91 F29-Apr-91	S15-Apr-91 F15-May-91	S31-May-91 F15-Jun-91		START CONSTRUCTION: 01-JUL-91 F17-JUN-91
1.3.6	6	PILING CONTRACT S236A	S03-Dec-90 A05-Dec-90	S11-Dec-90 A11-Dec-90	S12-Dec-90 A12-Dec-90	S17-Dec-90 A19-Dec-90	S28-Dec-90 A08-Jan-91	S07-Jan-91 A22-Jan-91			START CONSTRUCTION: 25-JAN-91 A11-FEB-91
1.3.3	1	STRUCTURAL STEEL CONTRACT (F&E) S204A	S17-Dec-90 A21-Jan-91	S11-Jan-91 A08-Feb-91	S25-Jan-91 A25-Feb-91	S01-Feb-91 F05-Apr-91	S25-Feb-91 F30-Apr-91	S11-Mar-91 F10-May-91	S05-Apr-91 F31-May-91	S01-Jun-91 F15-Jul-91	START CONSTRUCTION: 01-JUN-91 F15-JUL-91
		TESTING CONTRACT S203H	S21-Jan-91 A21-Jan-91	S04-Feb-91 A13-Feb-91	S18-Feb-91 A01-Mar-91	S25-Feb-91 A18-Mar-91	S08-Mar-91 F02-Apr-91	S15-Mar-91 F12-Apr-91			START CONSTRUCTION: 01-APR-91 F15-APR-91
1.3.1	1	SUBSTRUCTURE CONTRACT S203C	S02-Jan-91 A02-Jan-91	S25-Jan-91 A28-Jan-91	S11-Feb-91 A14-Feb-91	S18-Feb-91 A22-Feb-91	S11-Mar-91 A19-Mar-91	S22-Mar-91 F05-Apr-91			START CONSTRUCTION: 15-APR-91 F22-APR-91
1.3.4	1	ELECTRICAL/I&C CONTRACT E061A	S01-Mar-91 A22-Mar-91	S01-Apr-91 F22-Apr-91	S15-Apr-91 F29-Apr-91	S22-Apr-91 F10-May-91	S22-May-91 F31-May-91	S15-Jun-91 F21-Jun-91			START CONSTRUCTION: 01-JUL-91 F15-JUL-91
1.3.6	5	CONCRETE SILOS INSTALL CONTRACT S210K	S14-Dec-90 A28-Jan-91	S07-Jan-91 A08-Feb-91	S21-Jan-91 A04-Mar-91	S28-Jan-91 A13-Mar-91	S18-Feb-91 F02-Apr-91	S11-Mar-91 F12-Apr-91			START CONSTRUCTION: 01-APR-91 F13-MAY-91
1.3.6	1	ADMINISTRATION BUILDING CONTRACT S301B	S05-Oct-90 A05-Oct-90	S09-Nov-90 A09-Nov-90	S26-Nov-90 A29-Nov-90	S03-Dec-90 A07-Dec-90	S08-Jan-91 A08-Jan-91	S25-Jan-91 A29-Jan-91	S01-Mar-91 F05-Apr-91	S15-May-91	START CONSTRUCTION: 15-APR-91
1.3.6	2	ABOVE GRD FIRE PROTECT CONTRACT P402A	S17-Jan-91 A17-Jan-91	S15-Feb-91 F01-Apr-91	S01-Mar-91 F15-Apr-91	S08-Mar-91 F22-Apr-91	S29-Mar-91 F13-May-91	S15-Apr-91 F24-May-91	S15-May-91 F24-Jun-91	S15-Jul-91 F05-Aug-91	START CONSTRUCTION: 15-JUL-91 F05-AUG-91

SUMMARY OF PROCUREMENT STATUS:	ACT/PLAN
1. TOTAL SPECIFICATIONS:	39
2. NO. STARTED:	39/39
3. NO. ISSUED FOR BIDS:	32/38
4. NO. AWARDED:	24/35