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FINAL

**IMPROVEMENT OF STORAGE, HANDLING,
AND TRANSPORTABILITY OF FINE COAL**

Contract No. DE-AC22-93PC93157

QUARTERLY TECHNICAL PROGRESS REPORT NO. 6

Covering the Period April 1, 1995 to June 30, 1995

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1.0 PROJECT SUMMARY

1.1 Background and Objectives

Fine coal production is on the rise in the U.S., and it will continue to increase as underground mining companies invest in more productive equipment. Fine coal cleaning technologies have been developed which can efficiently and economically separate coal from clay and other mineral matter in the fine size fractions, but they have not gained universal acceptance in the coal industry because the product is considered too wet by most coal users.

Historically, coal producers take one of two approaches in dealing with fine coal production. On the one hand, they may wash it and recover it as a wet cake which must be thermally dried prior to shipment. On the other hand, many operators make to attempt to recover fine coal, and dispose of it as a wet cake or slurry in refuse piles, slurry impoundments and abandoned deep mines. There are environmental problems related to both of these practices.

The Mulled Coal process was developed as a means of overcoming the adverse handling characteristics of wet fine coal without thermal drying. The process involves the addition of a low cost, harmless reagent to wet fine coal using off-the-shelf mixing equipment. Based on laboratory- and bench-scale testing, Mulled Coal can be stored, shipped, and burned without causing any of the plugging, pasting, carryback and freezing problems normally associated with wet coal. On the other hand, Mulled Coal does not cause the fugitive and airborne dust problems normally associated with thermally dried coal.

The objectives of this project are to demonstrate that:

- The Mulled Coal process, which has been proven to work on a wide range of wet fine coals at bench scale, will work equally well on a continuous basis, producing consistent quality at a convincing rate of production in a commercial coal preparation plant.
- The wet product from a fine coal cleaning circuit can be converted to a solid fuel form for ease of handling and cost savings in storage and rail car transportation.
- A wet fine coal product thus converted to a solid fuel form, can be stored, shipped, and burned with conventional fuel handling, transportation, and combustion systems.

1.2 Project Overview

It is useful to describe the project in groups of activities in order to fully understand the interactions between activities and to better understand the information flow and decisions of the project. The project is organized around two major demonstrations: (1) the production of Mulled Coal in a commercial operating setting, and (2) the delivery of the Mulled Coal product through existing commercial storage, transport, and handling systems.

The initial project activities were performed largely at the EI facilities and were conducted to produce the formulations, test procedures, and design packages required to procure and install the Mulled Coal circuit at the Drummon Company, Inc., Chetopa Preparation Plant in Graysville, Alabama. The installed circuit will be used for the demonstration of Mulled Coal production. The second set of demonstrations will be the shipment and handling of Mulled Coal in existing coal transportation systems. Data collected from all phases of production and delivery will then be analyzed, evaluated, and reported.

The Mulled Coal circuit has been installed in the operating preparation plant located at the Chetopa Mine site. The Chetopa Plant processes 360 to 450 tonnes/hr (400 to 500 tons/hr) of raw coal to produce 250 to 320 tonnes/hr (275 to 350 tons/hr) of clean coal for shipment to the steam coal market. Approximately 45 to 55 tonnes/hr (50 to 60 tons/hr) of fine coal is cleaned in froth cells to produce 40 to 45 tonnes/hr (45 to 50 tons/hr) of a fine clean coal that is 10-14 percent ash. Froth concentrate reports to a vacuum filter where a 24-27 percent moisture filter cake is discharged to a collecting belt. In current operations, the wet filter cake is combined with the coarser size fractions of clean coal for storage and delivery to market. The wet filter cake comprises about 15 to 18 percent of the total clean coal product from the plant.

The proof-of-concept (or POC) circuit was designed to process a 2.7 tonnes/hr (3 tons/hr) slipstream of froth concentrate from the existing froth cells in the Chetopa Plant as feed to the Mulled Coal circuit. The froth concentrate was dewatered in a centrifuge to prepare a wet fine coal feed material for conversion into a free-flowing granular material. The Mulled Coal product was directed to a 450 tonne (500 ton) open storage pile. The POC unit is of a design that can be scaled up to 135 tonnes/hr (150 tons/hr). Figure 1 shows the key components of the Chetopa Plant cleaning circuit and the Mulled Coal circuit that has been installed.

The Mulled Coal circuit was installed in an empty bay at the Chetopa Plant. This area is convenient to the discharge location from the froth cells and at a lower elevation. The use of gravity feeds minimized field fabrication. Equipment has been installed to divert a 2.7 tonnes/hr (3 tons/hr) slipstream of the froth concentrate to a dewatering centrifuge. The concentrated wet coal fines from the centrifuge dropped through a chute directly into a surge hopper and feed system for the Mulled Coal circuit. The Mulled Coal product was gravity discharged from the circuit to a truck or product discharge area from which it was hauled to a stockpile located at the edge of the active clean coal stockpile area.

During the 3-month operating period, the facility produced 870 tonnes (966 tons) of the Mulled Coal for evaluation in various storage, handling, and transportation equipment and operations. Immediately following the production demonstration, the circuit was disassembled and the facility was decommissioned.

Figure 1

ENERGY INTERNATIONAL

POC PROJECT
SCHEMATIC FLOW DIAGRAM

DATE: JULY 5, 1994

1	8-15-94	REDIRECTED CENTRIFUGE EFFLUENT TO FLOTATION SUMP
2	10-4-94	ADDED KNIFE GATE VALVE FOR SLIP STREAM TAKE OFF
3	11-28-94	ELIMINATED SLURRY ANALYZER
4	1-15-95	REVISED SLIP STREAM TAKE OFF POINT
5	5-15-95	ELIMINATED ON-LINE MOISTURE MONITOR
NO.	DATE	REVISION

2.0 PROJECT TECHNICAL WORK PLANS

This project focuses on achieving two demonstrations of the Mulled Coal technology: (1) Production in a commercial operating environment, and (2) Delivery of product in existing storage, transportation, and handling systems. To successfully complete these demonstrations, the project has been organized into a series of task activities which lead to the demonstrations, support the engineering and management needs of the project, and assess and report the activities and results. The development of the design basis and assessment of Mulled Coal technology application are direct parallels to activities that would be needed in any specific individual commercial application.

The technical approach is comprised of the following:

1. Prepare work plans at the beginning of the project with mechanisms for adding detail and updating the plans as new information is generated.
2. Collect and evaluate information specific to the coal and plant operations at the host site that is needed to complete the circuit design, equipment selections, installation plans, and production scheduling and plans.
3. Use the evaluation results to complete the design, equipment selection, and production planning.
4. Procure, install, and start-up the Mulled Coal circuit at the host site.
5. Conduct the demonstration of production operations.
6. Select delivery destinations and develop specific plans for monitoring dumping, fuel handling, etc. at each unique destination. Final decisions and detailed plans will be made when coal deliveries are ready to be scheduled, which in commercial practice is several months from the expected availability of product for shipment.
7. Conduct the demonstration of Mulled Coal technology in existing storage, transportation, and handling operations.
8. Prepare technical and economic assessment of the technology based on the data generated in the demonstration operations.

3.0 TECHNICAL PROGRESS

3.1 Overview

During this reporting period, the major on-going technical activity was production operation of the demonstration circuit installed in the Chetopa Preparation Plant near Graysville, Alabama. Specifics on the production phase of this project will be described in the following sections.

During the previous activities, the technical decision was made to design the circuit with the froth concentrate as the project feedstock. Based on that decision, a project schematic flow diagram for the Mulled Coal circuit to be installed at Drummond was developed and is shown in Figure 1. The initial concept as shown in this figure allows for the diversion of a slipstream of the froth concentrate from the discharge stream from the flotation cells. Modifications to the original plan and design for the slipstream take-off were made on-site when it was determined that it would be better to take the stream from a point in the horizontal run that was directly located above the Mulled Coal circuit.

During the shakedown operations of the equipment and circuit, a lot was learned about the design, specifications, and requirements for the equipment and the performance of the circuit for meeting the production needs of the project. By the end of the previous quarterly period, the installation and shakedown operations had reached near completion and the system was ready to begin the production operations in early April 1995. There were a number of remaining unanswered questions that were best addressed during the conduct of the production operations. These issues were all resolved in a satisfactory manner and it was demonstrated that the circuit was ready for producing a high quality Mulled Coal product over a range of operating conditions.

All of the production of Mulled Coal was completed during this quarterly period. A total of 870 tonnes (966 tons) were produced over the period of operations. The quality of the Mulled Coal product was consistently better than had been anticipated.

In order to meet the various commitments for the return of equipment that had been borrowed or leased, the Mulled Coal circuit and the demonstration facility were disassembled and decommissioned. The decommissioning operations began immediately following the completion of the production operations. By the end of the reporting period, the removal of equipment, restoration of the operating area of the plant, and delivery of equipment had been completed.

3.2 Production Operations

The production phase of the project began at 10:00 AM on April 5, 1995 and continued until 9:00 AM on June 16, 1995. Being in the "Production Phase" meant keeping accurate and detailed records of all operations, producing as much Mulled Coal as possible in the allotted time, loading and weighing trucks, and dumping all production on the Mulled Coal stockpile.

Originally, the production phase of the project was to start at the beginning of March and continue through the month of June. The schedule allowed for 60 production days; requiring an average production rate of 19.7 tons per shift. Because of construction delays and our commitment to have the screen bowl centrifuge out of the plant and ready to ship back to the manufacturer on June 19th, we were forced to compress the production schedule to 44 days. The new schedule required an average production rate of 22.7 tons per shift (a 36% increase) to reach the 1000 ton target.

We got off to a slow start, but, in general, the Mulled Coal circuit performed up to, or exceeded, our original expectations. A total of 966 tons of Mulled Coal was produced, Mulled Coal quality remained excellent throughout the period, we used far less reagent than originally anticipated, and there was virtually no lost production time due to failures in the circuit equipment or controls (99.6% availability).

A complete daily log of production operations was prepared and will be included as an Appendix in the Final Report. The daily log includes an elapsed time study of each production shift, a description of all lost time events, results of all field testing for moisture and quality control, minute by minute charts of the operation of each major machine in the circuit, and some detailed explanations of problems we were experiencing and solutions we were considering.

Tables I through IV on the following pages, are monthly and overall production and delay summaries which break down the scheduled hours of production into operating time, delays due to breakdowns in the Mulled Coal circuit, and other delays due to the Chetopa plant or the slipstream take-off system. Tables V through VII represent a more detailed breakout of delays with a description for each delay.

The following sections describe our efforts to maximize production while maintaining quality and other project objectives. It should be noted that many of the procedures and problem solutions which are described in this section of the report have very little bearing on the operation of a commercial Mulled Coal circuit. They were mostly directed at maximizing production within the framework of a slipstream feed, trying to operate a centrifuge at an arbitrarily high moisture content, and shutting down for one-half hour each time we loaded a 6.5 ton dump truck.

3.2.1 Feed Rate

When the screen bowl centrifuge was operated to produce low moistures (18%-20%) and maximum throughput (no effluent restrictions), it could handle up to 50 GPM of water plus whatever amount of coal happened to be in the froth concentrate. Depending on available raw coal and other plant operating conditions, the coal solids in the froth concentrate would range from 15% to 32%, but under normal conditions froth concentrate contained about 30% solids. With feed solids at 32%, we could produce up to 7 tons/hour of Mulled Coal at 20% moisture.

However, when the centrifuge was operated to produce high moisture (23% to 27%), a condition in which the effluent was restricted (effluent pool heights close to the screen elevation), the machine could only handle up to 25 GPM of water plus whatever amount of coal (% solids) was coming with the froth concentrate. With feed solids at 32% we could only produce about 3 TPH in

Table I

PRODUCTION & DELAY SUMMARY APRIL 1995														
Date	Production	Scheduled Hours Of Operation												
	(Tons)	Operations				Delays (Non Circuit)			Delays (Circuit)					Total Sch. Hours
		Run Time	Haul Coal	Svc. Equip	Tot. Oper.	Chetopa	Slip Stream	Total Non Cir	Feeder	Pug Mill	Electric Controls	Other	Total Circuit	
4/5/95	7.38	3.02	0.83	0.78	4.63									4.63
4/6/95	11.20	4.71	1.67		6.38	1.62		1.62						8.00
4/7/95	14.31	6.25	1.05		7.30		0.70	0.70						8.00
4/10/95	5.70	1.25			1.25	0.75	6.00	6.75						8.00
4/11/95	18.62	4.38	1.15		5.53		1.58	1.58						7.11
4/13/95	11.33	3.57	0.77		4.34		3.06	3.06						7.40
4/18/95	17.60	5.55	0.62	0.33	6.50	1.50		1.50						8.00
4/19/95	13.40	4.40	0.73		5.13	1.00	1.03	2.03						7.16
4/20/95	12.16	3.64	0.37		4.01	3.46	0.53	3.99						8.00
4/21/95	24.17	6.42	0.68		7.10		1.06	1.06						8.16
4/24/95	16.08	5.26	0.47		5.73	1.67	0.62	2.29						8.02
4/25/95	15.59	6.74	0.80		7.54			0.00				0.47	0.47	8.01
4/26/95	14.01	4.92	0.42		5.34			0.00						5.34
4/27/95	19.46	5.66	0.83	0.50	6.99		1.00	1.00						7.99
4/28/95	25.90	7.20	0.99		8.19	1.42	1.92	3.34						11.53
TOTAL	226.91	72.97	11.38	1.61	85.96	11.42	17.50	28.92	0.00	0.00	0.00	0.47	0.47	115.35
Scheduled Hours Of Operation				115.35					Available Circuit Hours				86.43	% Total
Available Plant Hours				103.93										
% Plant Availability				90.10					Run Time				72.97	84.43
Available Slip Stream Hours				86.43					Haul Coal				11.38	13.17
% Slip Stream Availability				83.16					Service Equipment				1.61	1.86
									Equipment Breakdowns				0.00	0.00
									Other Delays				0.47	0.54
									Totals				86.43	100.00

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PRODUCTION & DELAY SUMMARY MAY 1995														
Date	Production	Scheduled Hours Of Operation												
	(Tons)	Operations				Delays (Non Circuit)			Delays (Circuit)					Total Sch. Hours
		Run Time	Haul Coal	Svc. Equip	Tot. Oper.	Chetopa	Slip Stream	Total Non Cir	Feeder	Pug Mill	Electric Controls	Other	Total Circuit	
5/1/95	15.94	4.12	0.50		4.62	2.53	0.38	2.91					0.00	7.53
5/2/95	18.77	5.67	1.00	0.63	7.30		0.42	0.42				0.28	0.28	8.00
5/3/95	27.29	7.70	1.33	0.17	9.20	0.75	0.97	1.72				0.12	0.12	11.04
5/4/95	16.80	5.63	0.96		6.59		0.42	0.42					0.00	7.01
5/8/95	9.58	5.20	0.50		5.70		2.16	2.16				0.13	0.13	7.99
5/9/95	17.86	5.07	1.60	0.22	6.89		1.13	1.13					0.00	8.02
5/10/95	26.46	5.03	1.00		6.03	1.00		1.00					0.00	7.03
5/11/95	14.63	3.82	0.38		4.20	0.58	3.22	3.80					0.00	8.00
5/12/95	10.58	2.68	0.33		3.01		1.40	1.40					0.00	4.41
5/17/95	19.99	5.10	1.43		6.53	0.33	1.13	1.46					0.00	7.99
5/18/95	20.91	5.45	0.95		6.40		0.77	0.77					0.00	7.17
5/19/95	36.38	6.88	1.53		8.41			0.00					0.00	8.41
5/22/95	29.54	5.62	1.69		7.31	0.58		0.58					0.00	7.89
5/23/95	30.50	5.40	1.44		6.84	0.52		0.52					0.00	7.36
5/24/95	36.73	6.06	1.61	0.12	7.79			0.00					0.00	7.79
5/25/95	34.51	6.18	1.43		7.61	0.38		0.38					0.00	7.99
5/26/95	21.38	3.79	0.71		4.50		1.22	1.22					0.00	5.72
5/31/95	35.81	6.22	1.44		7.66	0.35		0.35					0.00	8.01
TOTALS	423.66	95.62	19.83	1.14	116.59	7.02	13.22	20.24	0.00	0.00	0.00	0.53	0.53	137.36
Scheduled Hours Of Operation				137.36			Available Circuit Hours						117.12	% Total
Available Plant Hours				130.34										
% Plant Availability				94.89					Run Time				95.62	81.64
Available Slip Stream Hours				117.12					Haul Coal				19.83	16.93
% Slip Stream Availability				89.86					Service Equipment				1.14	0.97
									Equipment Breakdowns				0.00	0.00
									Other Delays				0.53	0.45
									Totals				117.12	100.00

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PRODUCTION & DELAY SUMMARY JUNE 1995														
Date	Production	Scheduled Hours Of Operation												
	(Tons)	Operations				Delays (Non Circuit)			Delays (Circuit)				Total Sch. Hours	
		Run Time	Haul Coal	Svc. Equip	Tot. Oper.	Chetopa	Slip Stream	Total Non Cir	Feeder	Pug Mill	Electric Controls	Other	Total Circuit	
6/1/95	36.81	6.51	1.68		8.19			0.00					0.00	8.19
6/2/95	28.05	5.07	1.81		6.88	1.10		1.10					0.00	7.98
6/5/95	34.99	5.97	1.35		7.32	1.20		1.20					0.00	8.52
6/6/95	25.34	4.65	1.40	1.17	7.22	0.79		0.79					0.00	8.01
6/7/95	27.38	5.05	1.41		6.46			0.00					0.00	6.46
6/8/95	27.68	4.68	1.49	1.08	7.25	0.28		0.28					0.00	7.53
6/9/95	20.83	3.66	1.20		4.86			0.00		0.10			0.10	4.96
6/12/95	12.77	2.63	0.70		3.33	4.00		4.00					0.00	7.33
6/13/95	28.95	5.53	1.24		6.77	0.44		0.44					0.00	7.21
6/14/95	28.90	5.26	0.95		6.21	1.80		1.80					0.00	8.01
6/15/95	37.33	6.77	1.85		8.62			0.00					0.00	8.62
6/16/95	6.73	1.40	0.33		1.73			0.00					0.00	1.73
TOTAL	315.76	57.18	15.41	2.25	74.84	9.61	0.00	9.61	0.00	0.10	0.00	0.00	0.10	84.55
Scheduled Hours Of Operation				84.55				Available Circuit Hours					74.94	% Total
Available Plant Hours				74.94										
% Plant Availability				88.63				Run Time					57.18	76.30
Available Slip Stream Hours				74.94				Haul Coal					15.41	20.56
% Slip Stream Availability				100.00				Service Equipment					2.25	3.00
								Equipment Breakdowns					0.10	0.13
								Other Delays					0.00	0.00
								Totals					74.94	100.00

Table IV

PRODUCTION & DELAY SUMMARY APRIL, MAY & JUNE 1995														
Date	Production	Scheduled Hours Of Operation												
	(Tons)	Operations				Delays (Non Circuit)			Delays (Circuit)					Total Sch. Hours
		Run Time	Haul Coal	Svc. Equip	Tot. Oper.	Chetopa	Slip Stream	Total Non Cir	Feeder	Pug Mill	Electric Controls	Other	Total Circuit	
April	226.91	72.97	11.38	1.61	85.96	11.42	17.50	28.92	0.00	0.00	0.00	0.47	0.47	115.35
May	423.66	95.62	19.83	1.14	116.59	7.02	13.22	20.24	0.00	0.00	0.00	0.53	0.53	137.36
June	315.76	57.18	15.41	2.25	74.84	9.61	0.00	9.61	0.00	0.10	0.00	0.00	0.10	84.55
Totals	966.33	225.77	46.62	5.00	277.39	28.05	30.72	58.77	0.00	0.10	0.00	1.00	1.10	337.26
Scheduled Hours Of Operation				337.26				Available Circuit Hours					278.49	% Total
Available Plant Hours				309.21										
% Plant Availability				91.68					Run Time				225.77	81.07
Available Slip Stream Hours				278.49					Haul Coal				46.62	16.74
% Slip Stream Availability				90.07					Service Equipment				5.00	1.80
									Equipment Breakdowns				0.10	0.04
									Other Delays				1.00	0.36
									Totals				278.49	100.00

Table V
Non Circuit Delay Summary
Chetopa Plant

Date	Hours	Delay Description
4/6/95	1.62	Hole In Vibrating Screen
4/10/95	0.75	Sheared Pin In Vacuum Filter
4/18/95	1.50	Hole In Bottom Of Froth Cell
4/19/95	1.00	Vacuum Filter Overflow
4/20/95	3.46	Out Of Raw Coal
4/24/95	1.67	Out Of Raw Coal
4/28/95	<u>1.42</u>	Safety Meeting, Pile Up, Switching Feed
Total April	11.42	
5/1/95	2.53	Eimco Cells Plugged On Bottom
5/3/95	0.75	Raw Coal Belt
5/10/95	1.00	Clean Up Spill
5/11/95	0.58	Four Operators Off Sick
5/17/95	0.33	Clean Up Spill
5/22/95	0.58	Safety Meeting
5/23/95	0.52	Clean Up Spill
5/25/95	0.38	Out Of Raw Coal
5/31/95	<u>0.35</u>	Sheared Pin On Vacuum Filter
Total May	7.02	
6/2/95	1.10	Heavy Media Washer
6/5/95	1.20	Broken Belt
6/6/95	0.79	Out Of Raw Coal
6/8/95	0.28	Clean Up Spill
6/12/95	4.00	Vacuum Pump Down
6/13/95	0.44	Safety Meeting
6/16/95	<u>1.80</u>	Froth Cells & Screen Drive
Total June	9.61	
Summary		
	8.23	Vacuum Filter
	6.30	Out Of Raw Coal
	5.83	Froth Cells
	4.99	Conveyors & Screens
	<u>2.70</u>	Other
Total	28.05	

Table VI

Non Circuit Delay Summary
Slip Stream Take-Off

Date	Hours	Delay Description
4/7/95	0.70	Adjust Effluent Pool Height On Centrifuge
4/8/95	1.00	Adjust Effluent Pool Height On Centrifuge
4/8/95	5.00	Replace Blow Out Plug In Centrifuge Turbo Drive
4/11/95	1.58	Check & Repair Main Gasket On Centrifuge
4/13/95	1.00	Finish Replacing Main Gasket On Centrifuge
4/13/95	1.06	Adjust Effluent Pool Height On Centrifuge
4/13/95	1.00	Centrifuge Chute Plugged Up
4/19/95	1.03	Adjust Effluent Pool Height On Centrifuge
4/20/95	0.53	Adjust Effluent Pool Height On Centrifuge
4/21/95	1.06	Centrifuge Chute Plugged Up
4/24/95	0.62	Adjust Effluent Pool Height On Centrifuge
4/27/95	1.00	Centrifuge Chute Plugged Up
4/28/95	1.00	Centrifuge Chute Plugged Up
4/28/95	<u>0.92</u>	Adjust Effluent Pool Height On Centrifuge
Total April	17.50	
5/1/95	0.38	Adjust Effluent Pool Height On Centrifuge
5/2/95	0.42	Adjust Effluent Pool Height On Centrifuge
5/3/95	0.97	Centrifuge Chute Plugged Up
5/4/95	0.42	Adjust Effluent Pool Height On Centrifuge
5/8/95	2.16	Remove Scale From Centrifuge Feed Pipe
5/9/95	1.13	Adjust Effluent Pool Height On Centrifuge
5/11/95	1.00	Adjust Effluent Pool Height On Centrifuge
5/11/95	2.22	Centrifuge Chute Plugged Up
5/12/95	1.40	Check Centrifuge Feed Tube
5/17/95	1.13	Adjust Effluent Pool Height On Centrifuge
5/18/95	0.77	Centrifuge Chute Plugged Up
5/26/95	<u>1.22</u>	Slug Of Wet Coal Plugged Main Chute
Total May	13.22	
Total June	0.00	
Summary		
	10.34	Adjust Effluent Pool Height On Centrifuge
	8.02	Centrifuge Chute Plugged Up
	5.00	Replace Blow Out Plug In Centrifuge Turbo Drive
	2.58	Check & Repair Main Gasket On Centrifuge
	3.56	Remove Scale From Centrifuge Feed Pipe
	<u>1.22</u>	Slug Of Wet Coal Plugged Main Chute
Total	30.72	

Table VII

Circuit Delay Summary

Date	Hours	Delay Description
4/25/95	0.47	Blown 10 Amp Fuse On Surge Feeder
5/2/95	0.28	Blown 10 Amp Fuse On Surge Feeder
5/3/95	0.12	Blown 10 Amp Fuse On Surge Feeder
5/8/95	0.13	Replaced 10 Amp Fuse With 20 Amp Fuse On Surge Feeder
6/9/95	<u>0.10</u>	Pug Mill Shut Down - Operator Error
Total	1.10	

Summary

	1.00	* Surge Feeder Fuses
	<u>0.10</u>	Operator Error
Total	1.10	

* The surge feeder was supplied by the factory with a 3 HP DC gear motor which was controlled with a very sophisticated SCR/DC controller - more sophisticated than what was required for this project. When the machine was first connected, the motor would not start. The problem was traced to a faulty circuit board. The factory furnished a replacement board, and it was also faulty. We removed the factory controller and replaced it with a less complicated DC drive which was purchased locally. The machine started right up with the new drive, but the new drive, which was rated at 1 - 3 HP, was equipped with a 10 amp fuse which was only good for 1 HP. When the surge feeder fuse blew for the first time, we knew that we needed a heavier fuse, but it took over one week to get the 20 amp fuses which were required. In the meantime we used 10 amp replacement fuses which blew every time the load got up into the 2HP range.

the 23%-27% moisture range, and, even at that low feed rate, it was difficult to prevent moisture from shooting up over 30%.

The 3 to 7 TPH feed rate limits at various target moistures in the 20% to 27% range were only developed after about 6 weeks of experience in operating at various effluent pool depths and a variety of feed solids conditions.

With experience we were able to estimate current feed rate from motor loadings and visual observations, but we never knew the exact feed rate until a loading cycle was completed and the truck was weighed and dumped. By the middle of April (6 weeks into the production phase of the project) we had built up enough historical data to determine feed rate limits. Prior to mid-April, we had always gotten into trouble when a feed rate limit was exceeded. Either we lost control of product moisture, the centrifuge was overloaded, or excess wet coal caused the centrifuge chute to plug up. On some occasions all three problems occurred simultaneously. After mid-April, we completely eliminated these problems by maintaining feed rate within prescribed limits.

Feed rate for the entire project was 4.3 TPH of wet Mulled Coal, but as we gained more and more experience, we were able to operate just under the top edge of the feed rate limit. By the end of the project we had moved the average up over 5 TPH.

3.2.2 Daily Production

Between April 5, 1995 and June 16, 1995, there were 45 scheduled production shifts. Figure 2 shows a record of the production for each scheduled shift, and a cumulative production line shows the daily progress toward the 1000 ton production target. We missed the production target by 34 tons; producing a total of 966 tons during the period.

The Chetopa plant produced coal for 16 hours each day. Production was scheduled for the day shift and the afternoon shift. Maintenance was scheduled for the midnight shift. The day shift started at 7:00 AM. Normally, the plant was started and brought to full production by 7:30 AM.

The Mulled Coal circuit production shift was normally scheduled to begin at 7:30 AM and end at 3:30 PM. However, due to travel and visitor schedules, there were six shifts during the period where less than 6 hours of production was scheduled (short shift average production time was 4.5 hours). There were also two shifts where production time was scheduled for a little over 11 hours on each shift. For the balance of the scheduled shifts (37), production time averaged just under 8 hours per shift.

Figure 2 shows the daily production for only the 37 shifts which were scheduled for a full eight hours. It also shows the progression of the moving average daily production during the period. The final average for the full production shifts ended up at 22.6 tons per shift versus a target of 22.7 tons per shift.

As can be seen in Figure 2, production was way below average for the first five weeks and way above average for the last five weeks. The difference in daily production between the two

Figure 2

DAILY PRODUCTION RECORD

periods is primarily related to our going through a learning curve with the screen bowl centrifuge. The problems we experienced with the operation of the centrifuge will be explained in detail in Section 3.2.6 which deals with delays to production.

3.2.3 Manpower

Due to the experimental nature of the project, the operation of the Mulled Coal circuit was completely isolated from the rest of Chetopa plant operations. EI was responsible for furnishing all necessary manpower to operate and maintain the circuit and to haul the Mulled Coal product from the plant to the project stockpile.

The operation normally required two people. One was an EI representative who was scheduled to be present during all hours of scheduled operation. His duties included liaison with Drummond personnel, scheduling production and maintenance, starting and stopping the circuit, controlling moisture and reagent dose, analyzing quality control and moisture samples, and keeping accurate records of daily operations.

The second operator was a temporary employee from the Birmingham area who was also scheduled to be present during all hours of scheduled operations. His duties included opening and closing manual valves during start and stop sequences, advancing the haulage truck under the chute during the loading cycle, hauling Mulled Coal, changing reagent drums, gathering samples, servicing equipment and keeping the project bays clean and free of hazards. The temporary employee was also trained to do most of the control room duties of the EI representative (starting and stopping the circuit, etc.), and from time to time he controlled the circuit for short periods of time.

A second EI representative, who was fully trained and capable of performing all tasks in the operation of the circuit, was present at the job site for about 20% of the scheduled production days. During these periods, there would be three operators available during the morning hours, and we took advantage of the extra manpower by doing special sampling and maintenance projects which required a third set of hands. During the afternoon hours one of the EI representatives concentrated on off-site administrative activities such as purchasing parts and supplies, shipping samples, meeting with Drummond and compiling field data.

The operation of the circuit was a full time job for two people, but that should not be interpreted to mean that two people would be required to operate a commercial Mulled Coal circuit. One of our operators spent most of his time in the control room, and the other spent most of his time in the haul truck, gathering samples or doing other tasks which were strictly related to the experimental nature of the project. In a commercial installation, the circuit would be controlled from a central control room along with other plant equipment, and Mulled Coal circuit equipment (feeder, pug mill, reagent delivery system) is essentially designed to run unattended. One plant operator, such as a froth cell operator, would be assigned to watch over the circuit along with his other duties. Total manpower required to operate, service and maintain a commercial circuit would probably be less than one man shift per scheduled production shift.

3.2.4 Hauling Mulled Coal

The original plan was to use a 20 ton dump truck to haul Mulled Coal from the plant, across the Chetopa scales, and onto the stockpile. The round trip was about one mile.

To begin the project, the truck would hold almost a full shift of production. As soon as it was full it would be dumped and spotted back under the loading chute. Then the circuit would be started up and run for the balance of the shift, and the partial load would be left in the truck overnight. The normal procedure would be to dump one load each day, and gradually the partial load at the end of the day would increase. Eventually two loads would have to be dumped on the same day.

Original cost estimates for leasing a 20 ton truck were based on prevailing conditions in the Western Pennsylvania coal hauling market. It just so happened that the start of the project coincided with a small industrial boom in the Birmingham area. There were very few trucks in the 15-20 ton range available in the area, and the cost of the few which were available was prohibitive.

We finally settled on a month to month lease on a small dump truck which was rated at 10 tons for rock. The cost was less than 10% of the cost of a full size dump truck. Even with the addition of higher side boards, the haul truck topped out at about 7.5 tons for Mulled Coal.

The round trip from the loading chute, to the scales, to the stockpile and back to the loading chute was less than one mile. With no interruptions, the round trip should have taken less than 15 minutes. However, the Chetopa plant was shipping all of its production by truck. All coal hauling was done between the hours of 6:00 AM and 2:30 PM and they ran as many as 60 trucks; with each truck making multiple round trips each day. Inevitably queues would form at the scales, and we felt that our haul truck would routinely be held up.

We ended up hauling 149 trucks with an average of 6.4 tons per load. Average round trip haul time was just under 19 minutes per load. Using the smaller truck probably resulted in the loss of about 75 tons of production over the life of the project, but it created significant cost savings.

3.2.5 Stockpile

The Mulled Coal stockpile was located at an out of the way corner of the main Chetopa coal yard, and it was situated about midway between the loading chute and the scale house. Each day all truck loads of Mulled Coal would be dumped along the inside edge of the base of the stockpile. At least every other shift, one of the Chetopa end loader operators stacked the Mulled Coal up on to the stockpile. By the end of the production period there was 966 tons on the stockpile. It was in the approximate shape of a rectangular base with a triangular vertical cross-section - being about 18 ft. high, 40 ft. across the base and 50 ft. across the side.

3.2.6 Production & Delay Time

Over the production phase of the project, there was a total of 337.71 hours of scheduled production time. Obviously the Mulled Coal circuit could not have operated for 100% of the

available time. There were non-scheduled delays due to breakdowns, and there were scheduled delays due to the various elements of production such as hauling coal and servicing equipment. A breakdown of what actually transpired during the 337 hour period is as follows:

	<u>Hours</u>	<u>% of Total</u>
Plant Delays	28.05	8.31
Slipstream Delays	30.72	9.11
Mulled Coal Circuit Delays	1.10	0.33
Run Coal	225.77	66.96
Haul Coal	46.62	13.81
Service Equipment	<u>5.00</u>	<u>1.48</u>
	337.26	100.00

We produced at an average rate of 3.12 TPH when the Chetopa plant was running. When the slipstream was available as far as the surge feeder, we produced at an average rate of 3.46 TPH. When the mulling part of the circuit (surge feeder, pug mill, reagent delivery system) was actually running, production averaged 4.28 TPH. The difference between the 4.28 TPH and 3.12 TPH production rates results from lost production due to non-scheduled and scheduled delays.

The following is a brief description of each major time element, and some comments about its overall impact on the production phase of the project.

3.2.6.1 Plant Delays

Plant delays were totally beyond the control of project personnel. There were breakdowns and other delays which resulted in shutting off the raw coal feed to the plant. Table V is a description and summary of Plant Delays. There were 23 individual delay events resulting in 28.05 hours of down time. Plant availability on this basis was almost 92% which is acceptable, but real plant availability during the period was actually much higher.

Each time the plant was started, we allowed an additional 15 minutes for the solids content in the froth cells and froth concentrate to reach a state of equilibrium (we had problems with the centrifuge when we were shooting for a high moisture, and the solids content in the froth concentrate was low). The plant actually ran for 5.75 hours more than we credited.

Additionally, we have identified 6.5 hours of delays due to the plant being out of raw coal. While being out of coal was a delay from the standpoint of the project, it should not be counted against plant availability.

When these two figures are factored in, plant availability becomes 95%, which is a very respectable availability for a coal preparation plant - especially one that was built in 1966.

3.2.6.2 Slipstream Take-Off Delays

All production delays were assigned to either the plant, the slipstream take-off system or the Mulled Coal circuit. Plant delays did not involve project equipment and were beyond the control of project personnel. Delays assigned to the slipstream take-off system and the Mulled Coal circuit did result from equipment installed for the project, and were under the control of project personnel. However, the delay categories were separated because the slipstream take-off system was installed simply as a convenient means of supplying a reduced flow feedstock for the Mulled Coal circuit, and the slipstream take-off system which was used would never be part of a commercial Mulled Coal installation.

Table VI shows a breakout and summary of slipstream delays. The vast majority of all circuit delays resulted from the slipstream take-off system (slipstream system 31 hours versus 1 hour for the Mulled Coal circuit). The slipstream valves, slurry lines, water lines and sample ports were all well designed and were trouble free throughout the project. Most of the problems were related to the operation of the screen bowl centrifuge. They resulted from a combination of our own inexperience with the operation of a centrifuge, our attempts to operate a centrifuge to produce an arbitrarily high product moisture, and the fact that the centrifuge we were using was only a test machine, and it was not designed for permanent installation and continuous operation.

There were 13 individual delays assigned to adjusting effluent pool height. These adjustments were required to raise or lower the product moisture so that the Mulled Coal process could be tested over the full 20% - 27% moisture range. Adjusting effluent pool height involved removing guards, opening up the centrifuge and adjusting the height of four individual dams. The operation normally took between 30 and 45 minutes. Effluent pool heights were adjusted many more than 13 times. In fact, they were adjusted on almost a daily basis, but in most cases, the adjustments were made when the plant or circuit was down for some other reason. When there was any kind of delay that we expected would last up to 30 minutes, we normally opened up the centrifuge and adjusted the dams. It should be noted that every time the centrifuge was opened up for a pool height adjustment the other operator cleaned out the product discharge chute.

One of the most perplexing problems in the production phase of the project was coal plugging up the centrifuge discharge chute. The machine we were using was a test machine which was normally only used for short duration trial runs. It was not set up for permanent installation or continuous operation the way we were using it in our project. Coal hanging up in centrifuge discharge chutes is an age old problem, but the latest centrifuges have discharge chute designs which eliminate or greatly reduce the plugging problem.

The test machine we were using had a fairly restrictive discharge chute. From the condition of the machine when it arrived, we could see signs that plugging had been a problem in the past, so we removed the original steel and rubber chute liners and replaced them with a low coefficient of friction plastic.

We knew from shakedown testing that material would begin building up in the discharge chute immediately after the circuit was started. Very quickly a large portion of the chute would blind off,

but paddles on the centrifuge would impart a significant force which would move the coal down through the chute in a very restricted flow path. The machine would run this for quite some time, but eventually there would come a time when the chute would completely blind off. We would normally spot this happening because of a rapid rise in motor load. We would shut down, open up the centrifuge, clean out the chute and start up again.

Because of our inexperience, it took almost six weeks to figure out a way to operate the centrifuge with a minimum of lost time due to plugged chutes. We finally learned to interpret motor load signals which were telling us that a plugging problem was developing. And we learned that if the chute was cleaned out early enough and often enough, it was not necessary to open up the centrifuge to clean it out. It could be cleaned out from the bottom by reaching in through the gap between the centrifuge chute and the main verticle chute. This alone saved us at least 30 minutes every time the chute was cleaned. Finally, we completely eliminated plugging problems by cleaning out the chute after each load while we were shut down to haul the load to the stockpile. The time required to clean out the chute was not recorded as a delay, because it took place while the circuit was down to haul coal to the stockpile.

3.2.6.3 Mulled Coal Circuit Delays

As long as there was a slipstream available, the Mulled Coal circuit ran with virtually no interruptions for the entire production phase of the project. Table VII lists and summarizes Mulled Coal circuit delays which amounted to only a little over one hour out of a total of 228 hours. One hour was lost because one of the controllers was originally equipped with a fuse which was rated too low for the load on the machine, and we lost six minutes because an operator inadvertently leaned against a stop switch in the control room.

We expected nothing less than trouble free operation. Mechanically the Mulled Coal circuit was very simple. There were only two machines and a small pump - all of which were more than adequately designed to meet their respective duty cycles. We also went to great lengths in terms of redundancy and other safeguards to make certain that there would be no lost time related to the sophisticated control circuit.

3.2.6.4 Run Coal

When there was a slipstream available, and when there was a truck under the chute to be loaded, actual production operations ran very smoothly. But that does not mean that the operators sat down for 226 hours and watched a computer screen or watched a truck bed fill up. On the contrary, the operators were the busiest when the circuit was producing Mulled Coal. Routine tasks in a production cycle included constantly scanning real time data, constantly updating moisture and reagent data, gathering and analyzing samples, adjusting manual valves, changing reagent drums, advancing the haul truck under the loading chute, and observing the operation of individual machines. This frantic activity was routine for the project, but most of it would not be required for a commercial installation. It was mostly related to the facts that the project was isolated from other plant activities, circuit feed was a slipstream, and Mulled Coal was discharged directly into a small truck.

3.2.6.5 Haul Coal

The dump truck had a capacity of 7-1/2 tons of Mulled Coal. During the production phase of the project we were forced to shut down production 150 times to haul loads - as opposed to the 50 or so loads which would have been required had we used a full size (20 ton) dump truck. There is no question that hauling 100 extra loads resulted in lost production, but all of the time saved by 100 fewer round trips to the stockpile would not have been available as production time.

After the middle of May, we began cleaning out the centrifuge chute after each loading cycle (while the truck was away dumping). That meant cleaning out the centrifuge chute after every 1-1/2 hours of running time. It would have taken over five hours of running time to fill a 20 ton truck, but we would never have been able to run for 5 straight hours without cleaning out the centrifuge chute. At the very least the chute would have to have been cleaned out once in the middle of the load, and while the truck was away being dumped. Cleaning out the centrifuge chute required a 15 minute shutdown. Using a 20 ton truck would probably have resulted in an additional 15 hours of production time.

The greatest savings from using a 20 ton truck would have been time savings for the second operator. It was important to get the maximum amount of Mulled Coal on each one of the 7-1/2 ton truck loads. In order to get a full load, the small truck had to be precisely positioned under the loading chute, and it had to be advanced a few feet on four separate occasions for each load. Coming up a little short on a 20 ton load would not have been as important, and, because of the shape of the bed, positioning the truck under the loading chute would not have required nearly as much of the operator's time.

3.2.6.6 Service Equipment

There were only four pieces of circuit equipment which required routine servicing - the air compressor, the centrifuge, the surge feeder and the pug mill. During shakedown operations a service manual was prepared which set out servicing time, check points, grease and lube points, and oil and grease grades for each piece of equipment. For instance, the centrifuge was to be greased every 8 hours of operation, crank case oil in the compressor was to be checked twice per week, etc. We used only three different grades of gear oil and one grade of grease.

Servicing was a simple and straightforward task which required very little time. There were not very many grease points and gear oil levels rarely had to be replenished. Only 5 hours of delay was assigned to servicing equipment. In reality much more time was spent on servicing equipment, but most servicing was done while the circuit was down for some other reason.

3.3 Decommissioning Operations

After producing one final load of Mulled Coal on Friday morning, June 16, 1995, we began at 9:00 AM to dismantle the Mulled Coal plant addition. We fell 34 tons short of the 1000 ton production target, but we had an extremely tight schedule, and we were concerned that we would miss an important commitment to one of our equipment suppliers if we continued producing.

We had committed to having the screen bowl centrifuge out of the plant and ready to ship by the end of the work day on June 20th. The mechanical contractor, who had installed the heavy equipment back in February and March, was scheduled to move back on to the job with a crane on the morning of June 20th. The schedule allowed only 1-1/2 days for project personnel to disconnect, clean up and have all heavy equipment ready to be lowered down out of the plant.

This early part of the decommissioning plan went like clockwork. The contractor moved in as scheduled on June 20th. By the end of the day, all heavy equipment had been moved out of the plant and hauled to a staging yard, and early the following day, the screen bowl centrifuge was returned to the manufacturer. The contractor spent two more days on the job during which he dismantled chutes; lowered the remaining reagent drums down out of the plant; and patched holes in the floor decks at elevations of 458', 467' and 476'.

EI personnel did all of the other dismantling work including:

- Packed and shipped via UPS all computer, monitoring, and laboratory equipment, and the reagent spray system and miscellaneous control room equipment and supplies.
- Removed all valves, fittings, etc. and hauled them to the staging yard.
- Disconnected all electrical switches, E-Stops, etc. and hauled them to the staging yard.
- Cut out and scrapped all light steel framework and fabrications.
- Pulled and scrapped all control wire, lead lines, and bent conduit.
- Removed all usable conduit and fittings and hauled them to the staging yard.
- Plugged off the slipstream take-off point and the place where we tapped the centrifuge effluents into the vacuum filter drain.

With permission of the owner of the Host Site, we left in place the control room shell, the new steps, the hoist doors, the additional structural steel floor supports, and the electrical leads running from the Chetopa motor control center to the project control room. Upon removal, these items would only have been worth scrap value, and removal cost would have exceeded scrap value.

By June 28th all project equipment had been removed from the plant. It had either been shipped back to Pittsburgh via UPS or it was stacked in the staging yard awaiting shipment. The project bays were all in equal or better condition than they were in prior to the project.

We had employed a local specialty company to assist us with palletizing and packing heavy equipment, and making other insurance and shipping arrangements for the equipment being held in the Chetopa staging yard. The equipment was shipped on July 7th. It completely filled a full size flat bed trailer. On this shipment the pug mill was dropped off at the lessor's plant in Georgia, and the balance of the load was dropped off a few days later at EI.

All of the project equipment arrived in Pittsburgh undamaged. From Pittsburgh, leased equipment was forwarded on to lessors. All other equipment was cataloged and is in storage at EI.

4.0 SUMMARY

During this sixth quarterly period of the contract, activities were underway under Tasks 4 and 5 of the Work Statement. The major activities of the period were the production operations of the demonstration circuit at Drummond's Chetopa Preparation Plant. The modifications to the plant structure to accommodate the installation of the circuit, the installation of the circuit equipment, the integration and interfacing of the circuit with plant operations, and the shakedown operations had been nearly completed during the previous quarterly period. The demonstration circuit was in place and ready for the start of production operations to begin in early April 1995. It was clear from the shakedown runs that excellent quality Mulled Coal would be produced during this quarterly period and a total of 870 tonnes (966 tons) of Mulled Coal product was produced. As anticipated from the results of the shakedown runs, the quality of the product was consistently better than the acceptable level. Immediately following the completion of the production demonstration, the removal of equipment and decommissioning of the demonstration facility was undertaken. This was completed by the end of the reporting period and all of the equipment on loan or lease had been returned.