DOE/PC/93157-T3

FINAL

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

Contract No. DE-AC22-93PC93157

QUARTERLY TECHNICAL PROGRESS REPORT NO. 7

Covering the Period July 1, 1995 to September 30, 1995

**Prepared for:
U.S. Department of Energy
Pittsburgh Energy Technology Center
P. O. Box 10940
Pittsburgh, PA 15236-0940**

**Submitted by:
Energy International Corporation
135 William Pitt Way
Pittsburgh, PA 15238**

**March 14, 1996
Revised: August 22, 1996**

**U.S./DOE Patent Clearance is not required
prior to publication of this document**

RECEIVED
USDOE/PETC
36 AUG 28 AM 10: 09
ACQUISITION & ASSISTANCE DIV.

DISTRIBUTION OF THIS DOCUMENT IS UNLIMITED

MASTER

DISCLAIMER

Portions of this document may be illegible in electronic image products. Images are produced from the best available original document.

TABLE OF CONTENTS

	<u>Page No.</u>
1.0 PROJECT SUMMARY	1
1.1 Background and Objectives	1
1.2 Project Overview	1
2.0 PROJECT TECHNICAL WORK PLAN	4
3.0 TECHNICAL PROGRESS	5
3.1 Overview	5
3.2 Product Evaluations from Production Demonstration	5
3.2.1 Quality Control	5
3.2.2 Reagent Consumption	7
3.2.3 Special Samples	10
3.2.3.1 Product Losses	10
3.2.3.2 Air Drying Effect	15
3.3 Shipment Demonstration	17
3.3.1 Background	17
3.3.2 Stockpile Coal Temperature	17
3.3.3 Stockpile Condition Prior to Shipment	17
3.3.4 Hauling Arrangements	18
3.3.5 Loading	18
3.3.6 Dumping and Handling at the Gorgas Station	18
3.3.7 Conclusion	20
4.0 SUMMARY	21

LIST OF TABLES

<u>Table No.</u>	<u>Title</u>	<u>Page No.</u>
I	Product Reconstruction Test	11
II	Screen Bowl Centrifuge Product Analyses	13

LIST OF FIGURES

<u>Figure No.</u>	<u>Title</u>	<u>Page No.</u>
1	Schematic Flow Diagram	3
2	Quality Control Test Results	8
3	Reagent Usage	9
4	Particle Size Stratification in Froth Concentrate Line	14
5	Air Drying Effect	16
6	Power Station Coal Receiving Setup	19

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, and 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 was 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 an 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 will be 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	11-26-94	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 PLAN

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 plan at the beginning of the project with mechanisms for adding detail and updating the plan 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

The production operations of the demonstration circuit were completed during the previous quarterly period. The circuit was then disassembled and the facility was decommissioned. During this current reporting period, the major technical activities were the technical and economic evaluations and the shipment of product.

During this period, the data that had been collected and retained during the shakedown and production operations were reduced to usable formats and the analysis of the information gathered was begun. Some of the information regarding the quality of the product and the air drying effects on the product moisture had been gathered during the previous period, but were further assessed and made available for reporting. This information constitutes the primary content of this report. In addition, shipment of the product was conducted during the period and is included in this report.

3.2 Product Evaluation from Production Demonstration

3.2.1 Quality Control

Mulled Coal quality was measured in the field at least on a daily basis, and more often if there was a visible change in quality. The quality control test procedure was a modified uniformity test. The uniformity test is a widely recognized procedure used to evaluate the flow characteristics of dry bulk solids. We adapted the test procedure and interpretation of results to wet fine coal products, and over the years we have found the modified procedure to be a reliable indicator of Mulled Coal quality.

In the field uniformity test, 250 grams of freshly produced Mulled Coal is placed on the top deck of a stack of three screens which had deck openings of 6 mesh, 14 mesh and 28 mesh, respectively. The material is dry screened for 5 minutes, after which the amount of material retained on each screen is weighed. Results are reported as the size distribution percentages of:

+6 Mesh
6M x 14M
14M x 28M
28M x 0

In terms of Mulled Coal, the test is an indicator of whether or not agglomerated coal particles are completely covered with a thin membrane of reagent. If the mulling process is incomplete, the agglomerated particles remain "sticky", and they tend to form marble sized balls when they pass over vibrating screen decks (this is very common behavior for wet fine coal). When the mulling process is complete, agglomerates are not "sticky", balls do not form, and a greater percentage of the sample freely flows through the screens to the bottom decks.

When a uniformity test is run on dry coal, virtually 100% of the material reports to the 14M x 0 size fraction. When the test is run on Mulled Coal the amount of material reporting to the 14M x 0 size fraction is considered to be the Handleability Index for that sample - where 100 equals the Handleability Index for dry coal.

Listed below are uniformity tests results for three forms of the Chetopa fine coal product:

Wet cake feed at 23% moisture (unmulled)
 Mulled Coal at 23% moisture
 Wet cake feed at 0% moisture (unmulled dry coal)

These samples all represent Chetopa fine coal at the same size distribution and the same starting moisture, but they are not three splits of the same sample. Field quality control samples were used only for Mulled Coal. Unmulled coal and dry coal were only tested a few times during the project, and test results were only considered as markers. Test results are listed here only to illustrate the relative differences in the Handleability Index for the three products.

COMPARATIVE UNIFORMITY TESTS

	<u>UnMulled Coal</u>	<u>Mulled Coal</u>	<u>Dry Coal</u>
+6 Mesh	49.02	10.94	0.00
6M x 14M	50.01	4.98	0.24
14M x 28M	0.39	58.52	9.61
28M x 0	0.58	25.56	90.15
Handleability Index	0.97	84.08	99.76

From past testing experience we know that wet fine coal with a Handleability Index of under 25 will almost definitely cause handling problems. Mulled Coal with an index in the 25-45 range is marginal, and it could cause problems in certain situations. An index of over 45 generally means that the material is "free flowing", and it will not cause problems in conventional coal handling, storage and transportation systems. An index of over 60 places the Mulled Coal in the excellent category, and handling characteristics will approach those for dry coal (without the dust problems normally associated with dry fine coal).

It should be noted that these interpretations are very subjective, and they have not all been tested in the real world, but they continue to be the best method we have of grading Mulled Coal. This project was the first time Mulled Coal was tested on a full scale basis in a real world coal handling environment. It passed with flying colors, and nothing about the demonstration would cause us to change our interpretation of uniformity test results.

From the first test run in the shakedown operation, through the last ton produced for the project, Mulled Coal quality was maintained in the excellent category. Quality control tests (uniformity tests) were run on a daily basis plus any time there was either a significant change in moisture or a significant change in the visible appearance of the Mulled Coal.

There was very little change in Mulled Coal quality from day to day or even hour to hour. There were some changes when we were experiencing rapid and wide swings in feed moisture, but the lowest Handleability Index recorded for the project was only 61.26. There were only two QC samples under 70, and the average index was over 80.

Figure 2 shows the average Handleability Index for all of the QC tests run at each moisture level in the target range of 20%-27%.

3.2.2 Reagent Consumption

The level of reagent dose required to produce excellent quality Mulled Coal over the target moisture and feed rate ranges proved to be the greatest and most pleasant surprise in the project. Based on all previous laboratory experience with the Mulled Coal process, and the results of preliminary sampling for this project, we estimated that we would be using reagent doses in the 1.7% to 3.5% range (that is 1.7%-3.5% of the weight of dry coal in the slipstream feed). In fact we used only 0.4% to 2.0% doses, and we actually tested the process over a wider moisture range than originally anticipated (design range of 20% to 26% versus the actual range tested of 19% to 28%).

For the entire production phase of the project, we produced about 775 tons of dry coal and consumed just over 5 tons of reagent. Pre-project design calculations would have called for a reagent consumption of about 13 tons.

Figure 3 shows the projected versus actual reagent doses throughout the target moisture range.

The relationship between reagent dose and feed moisture is not linear for 28M x 0 wet cakes which have an overall ash in the 9%-13% range, and which have a size distribution which includes 18% to 25% in the 325M x 0 size fraction. There is a breakover point at about 23% moisture. Moisture increases above 23% require a greater percentage increase in reagent dose than equal moisture decreases below 23%.

In Figure 3, it is indicated that the actual reagent dose set point curve becomes completely flat at moistures below 22%. Reagent dose requirements at moistures under 22% were probably less than those indicated on the curve, but the system was not capable of efficiently delivering reagent flow rates of under 5 GPH (doses below 0.4%). We designed for flow rates in the 10 GPH to 30 GPH range. At flow rates of under 5 GPH the system would not deliver enough pressure to atomize the reagent at the spray nozzle. Proper reagent droplet size is equally as important as flow rate.

Figure 2

QUALITY CONTROL TEST RESULTS

Reagent cost accounts for over 80% of the total ownership and operating costs of a Mulled Coal circuit. The discovery that actual reagent doses for this project were less than half of projected requirements has a major impact on the commercial viability of the process.

3.2.3 Special Samples

In addition to routine moisture and quality control samples, there were 23 special samples taken during the production phase of the project. All special samples were shipped to EI's Pittsburgh laboratories for analysis. Special sampling was concentrated in two areas:

- Determining product losses which result from using a screen bowl centrifuge.
- Evaluating moisture and heat value changes which result from open ground storage.

3.2.3.1 Product Losses

There is always a certain amount of 325M x 0 coal lost to effluents when using a screen bowl centrifuge to dry fine coal. Under normal circumstances, losses increase as one attempts to lower product moisture (effluent drains wide open/moderate feed rate). In this project we were not attempting to produce the lowest possible moisture. In fact, we were attempting to run at an arbitrarily high product moisture (effluent drains restricted/dams at highest possible setting). We expected lower product loss than normally experienced with the operation of screen bowl centrifuges.

On several occasions we attempted to quantify product losses by simultaneously sampling effluents, the centrifuge product and the normal Chetopa vacuum filter product. At the same time we recorded feed rate, water flow rates and percent solids in the effluents. The vacuum filter product represented the feed before product losses. The effluents represented the losses, and the centrifuge product represented the material after losses to effluent. With all flow rates, % solids in the effluents, and feed rates, we could then run a size distribution analysis for each product and calculate material and hydraulic balances for the circuit. The results of these tests were mixed and inconclusive.

There were four separate sample points, and three of the four samples required two operators. We could not actually get simultaneous samples. There was a gap of at least 15 minutes between the first and last sample, and we had to assume that there were no significant changes in feed conditions or the operation of the froth cells during the 15 minute time span. In order to calculate product losses, effluent samples had to be timed. Effluent samples were collected in four grabs. Sample weights were averaged, and the fourth grab was retained for percent solids and size distribution analysis. Samples were collected in 5-gallon buckets, and due to the high flow rate in the solid bowl drain, the duration of the sample was only 12 seconds. There is room for error in trying to cut a full stream with a 5-gallon bucket and remove it in exactly 12 seconds.

Table I entitled Product Reconstruction Test, represents the closest we came to reaching a material balance for this type of sampling. The test indicated an 11.41% product loss which was primarily in the 325M x 0 size fraction. However, the measured amount in the 325M x 0 size fractions for the vacuum filter (feed) and centrifuge (after product loss) do not jibe with an 11.41%

Table I

PRODUCT RECONSTRUCTION TEST

Date: 5-17-95

Time: 11:45 AM

Conditions

G V Pos	55
SBC Amps	27
TPH Production	4.2

Sample No	5-17-4	5-17-5	5-17-6	5-17-7
Sample ID	Solid Bowl Effluent	Screen Effluent	SBC Product	Filter Cake
Duration	12 sec. Grabs	30 sec. Grabs	Simultaneous	Simultaneous
Flow Rates				
Water (GPM)	31.23	2.28	3.02	N/A
Coal (Dry TPH)	0.114	0.329	3.44	N/A
Dry Ash	26.76	12.67	11.6	12.1
Size Distribution				
+16M	0.00	0.00	0.23	0.08
16M x 28M	0.00	0.46	8.43	3.46
28M x 0	100.00	99.54	91.34	96.45
+16M	0.00	0.00	0.23	0.08
16M x 28M	0.00	0.46	8.43	3.46
28M x 100M	0.00	36.83	57.74	39.44
100M x 200M	0.00	18.46	13.58	16.46
200M x 325M	1.60	12.10	7.14	10.95
325M x 0	98.40	32.15	12.88	29.61
	100.00	100.00	100.00	100.00

Product Loss Through Centrifuge

To Solid Bowl Drain	2.95%
To Screen Drain	8.46%

Combined Effluents & Product

Total Water (GPM)	36.53
Total Coal (Dry TPH)	3.88
Total Wet Feed (TPH)	13.02
Total Wet Product (TPH)	4.20
% Solids In Feed	29.82
Cum. Dry Ash	12.14

product loss. Assuming that the figure is correct for the vacuum filter, the centrifuge product should have contained over 16% in the 325M x 0 fraction instead of the 12.88% actually measured.

Table II is a summary of all of the size distribution analyses run on the centrifuge product. The average 325M x 0 size fraction amounted to 17% of the total sample. The average for the 325M x 0 size fraction in the numerous filter cake samples analyzed for this project was 20% of the total. Comparing these average figures would indicate that there was an average product loss of about 4% during the project. Based on visual observations and numerous effluent grab samples, a product loss of 4% is much more realistic than the 11.41% calculation in the Product Reconstruction Test.

The wide range in the 325M x 0 size fraction (8.34% to 29.61%) in the summary of centrifuge product analyses (Figure 78) suggests that there may have been another problem. We ran numerous size distribution analyses on both froth concentrate and filter cake. The 325M x 0 size fraction averaged 20% of the total product, and the range for all of the samples was very narrow (from a low of 18% to a high of 22%). We were constantly opening the centrifuge effluent sample ports to make sure that flow rates and solids content were visibly in the proper ranges. We definitely were not experiencing wide enough swings in effluent losses to cause the 325M x 0 size fraction in the centrifuge product to range from 8% to 30%.

One possible explanation is that we were getting some particle size stratification in the pipe line running from the flotation cells to the vacuum filter, and from time to time the slipstream was not receiving a full cut of froth concentrate. The slipstream take-off was tapped into the bottom side of a 50 ft pipe line which ran from the flotation cells to the vacuum filter. The pipe line was 14" in diameter and had a drop of only about 12" from the froth cells to the filter. Froth concentrate only filled the pipe about half way, and because of the short drop, velocity in the pipe line was low. Froth concentrate moved gently through the pipe line for a distance of about 40 feet before the slipstream take-off point. It is possible that, in this distance, smaller particles could work their way toward the top of the slurry stream.

Since the slipstream take-off was tapped from the bottom of the pipe line, and it was taking only about 10% of the flow, it is possible that the slipstream was biased with larger size particles. Figure 4 is a schematic representation of what may have been happening if stratification was taking place. We could not verify that there was stratification in the main pipe line without going to a great deal of time and expense. If stratification was taking place, sample results indicate that the extent of it changed from day to day.

We were not able to precisely define product losses, but whatever they may have been, they did not have any effect on overall project objectives. Centrifuge effluents were recycled, so there actually was no product loss. The process consistently converted a feed which was missing about 15% of the 325M x 0 size fraction into an excellent quality of Mulled Coal. We know that Mulled Coal quality improves as the mean particle size of the wet cake diminishes. If there were no 325M x 0 losses to centrifuge effluent, Mulled Coal quality would only have improved.

Table II

Screen Bowl Centrifuge Product Analyses

Date	4/28/95	4/28/95	5/1/95	5/4/95	5/8/95	5/17/95
Sample No.	4-28-1	4-28-2	5-1-2	5-4-1	5-8-1	5-17-6
Time	8:30 AM	2:35 PM	1:20 PM	2:30 PM	12:30 PM	11:45 AM
Conditions						
Feed Source	Mary Lee	Blend	Blend*	Blend	Mary Lee	Blend
G V Pos.	48.00	52	53	57	54	55
SBC Amps	27.00	28	27	27	25	27
Prod. (TPH)	3.44	3.51	3.74	2.27	1.86	4.20
Test Results						
Ash (Dry)	12.40	12.20	12.83	12.80	12.11	11.60
Moisture	26.00	19.00	17.40	19.00	19.00	18.00
Size Dist.						
+16M	0.12	0.43	0.31	0.35	0.31	0.23
16M x 28M	8.07	10.63	8.97	9.33	10.92	8.43
28M x 0	91.81	88.94	90.72	90.32	88.77	91.34
+16M	0.12	0.43	0.31	0.35	0.31	0.08
16M x 28M	8.07	10.63	8.97	9.33	10.92	3.46
28M x 100M	50.02	53.19	53.57	45.85	61.54	39.44
100M x 200M	13.11	12.82	15.10	17.41	12.29	16.46
200M x 325M	8.02	8.34	7.90	11.33	6.60	10.95
325M x 0	20.66	14.59	14.15	15.73	8.34	29.61
	100.00	100.00	100.00	100.00	100.00	100.00

Figure 4

PARTICLE SIZE STRATIFICATION IN FROTH CONCENTRATE LINE

14" Concentrate Pipeline From Froth Cells To Vacuum Filter

3.2.3.2 Air Drying Effect

Another major surprise in this project was the rapid rate of air drying which took place during the period in which Mulled Coal was in open ground storage. We knew from some early lab work that Mulled Coal air dried at a more rapid rate than unmulled Coal of the same quality. But we were totally unprepared for what happened in this project. Mulled Coal went onto the ground at just under 23% moisture. By the time it was shipped, moisture had decreased to 8%, and the majority of the moisture loss occurred within three weeks.

The Mulled Coal stockpile was started on April 5, 1995, and, by June 16th, there was 966 tons of coal on the ground. Trucks were dumped along the base of the pile, and coal was stacked with a front end loader on a daily basis. We attempted to maintain the shape of the pile as triangular prism with a height of 18 feet and a width across the base of 40 feet. By the end of the production phase, the pile was just over 50 feet long.

Coal was shipped on August 30th. Between April 5th and August 30th there was 14" of recorded rainfall, and mean temperatures increased from 51°F in April to 85°F in August. Although we did not keep statistics on humidity it seemed relatively high during the period. There was nothing about weather conditions which would have promoted air drying. In fact almost 11" of the 14" of rainfall came in April, May and June while we were building the pile and constantly exposing new surfaces with the coal stacking operation. And it was during this same wet period that most of the air drying took place.

It would not have been practical to do a comparative study of air drying for unmulled coal and Mulled Coal for this project. The figures for unmulled coal would have been meaningless unless there was a stockpile of unmulled coal which was built at the same rate and in the same shape as the Mulled Coal stockpile. We do know that, in normal weather conditions, unmulled filter cake will air dry down to the 18%-20% moisture range at a fairly rapid rate. In dry weather the outer shell of a filter cake pile will become crusty and dry to below 10% moisture. But down in the pile a few feet, the moisture will not get below 18%, and the outer shell of the pile will rewet in heavy rains.

We took composite stockpile samples from time to time to keep track of changes in quality. Figure 5 is a graphic representation of moisture losses over a four month period. The time line on this graph is a bit misleading. The figure of 20% moisture on day one actually represents the weighted average of all Mulled Coal produced between April 15th and May 18th. The data points at days 21, 27, and 125 are composite stockpile samples taken on the dates indicated. Not all of the coal had been on the stockpile for 21, 27, or 125 days. Only the coal produced on the first day of the project would have been on the stockpile that long. The composite samples represented most of the coal produced between day one and the date of the sample, but we did try to avoid sampling Mulled Coal which had been on the stockpile for less than one week.

When it became apparent that Mulled Coal was air drying at an unusually rapid rate, a special test was set up where we kept a small pile of known moisture Mulled Coal separated from the main stockpile and took moisture samples on four occasions over the course of one month. We could not precisely age the Mulled Coal for the composite samples from the main stockpile. Freshly produced

Air Drying Effect

Main Stockpile

Date Produced/Sample Date	4/27/95	5/18/95	5/24/95	8/30/95
Sample No.	N/A	5-18-1	5-24-1	N/A
Type Of Sample	Wt. Ave. Moist.	Stockpile Comp.	Stockpile Comp.	Gorgas Analysis
Days Following Production	1	21	27	125
Moisture	19.95	9.20	7.57	7.86

Mulled Coal was deposited on and stacked into the main stockpile each day. We attempted to avoid sampling coal which had been on the stockpile for less than one week, but there was no way to assign an accurate age to the coal which was sampled.

On May 11th, we produced about 10 tons of Mulled Coal at 28% moisture. This coal was dumped and stacked into a separate small stockpile. The test stockpile was sampled two weeks, three weeks, then four weeks after the date it was produced. Moisture went from 27.8% on the day it was produced, to 12.76%, to 9.20% and finally to 7.86%. After four weeks moisture was about the same as the main stockpile, so the test pile was comingled with the main stockpile.

The air drying phenomenon was, to say the least, very intriguing. However, we cannot use data from this one test condition to jump to any universal conclusions about the air drying characteristics of all Mulled Coal under all commercial circumstances.

3.3 Shipment Demonstration

3.3.1 Background

Alabama Power, a subsidiary of The Southern Company, operates a coal fired power plant which is located about 25 miles from the project site. The power plant is a 1200 MW station which burns about 3,400,000 tons of coal per year. This particular plant was considering a proposal to burn a rewash fine coal product which was to be recovered from a nearby slurry impoundment. It was felt that experience with our Mulled Coal product would give them an indication of how reprocessed pond fines might behave in their truck receiving and fuel handling system. Arrangements were made to ship 12 truckloads, or about 300 tons, on the morning of August 30, 1995.

3.3.2 Stockpile Coal Temperature

There was some concern at the power station that, after ground storage of about three months, a medium sulfur fine coal stockpile would develop hot spots. Based on laboratory testing, we feel that the Mulled Coal process would inhibit oxidation and spontaneous combustion, but to be on the safe side, we decided to test the stockpile temperature prior to shipment.

A thermocouple with a remote readout device was mounted on the end of a 12' section of 1/2" diameter pipe. On August 29th (the day before the Alabama Power shipment), coal temperatures were taken around the perimeter and at the center of the stockpile. Temperatures around the perimeter (in about 4') were in the 123-126°F range, and temperatures at the center were in the 120-122°F range. Air temperature at the time of the test was 95°F, and for the previous 30 days, high temperature ranged from 89-103°.

3.3.3 Stockpile Condition Prior to Shipment

There were some obvious signs of sheet erosion prior to shipment. There were a number of small (a few inches wide and a few inches deep) erosion "gullies" scattered around the perimeter of the stockpile. It is thought that this type of erosion occurs only when coal on the outside of the

stockpile air dries to the point where it is almost bone dry and begins to slump slightly from its own weight. When this happens, the dry coal is almost fluid. Even a slight rain can cause small erosion gullies down to a depth where the coal has not lost all of its surface moisture.

This type of sheet erosion never occurred when the Mulled Coal on the outside of the stockpile was freshly produced (in the 18% to 30% moisture range). With fresh Mulled Coal on the outside of the pile, there was no sheet erosion -- even during heavy downpour conditions.

3.3.4 Hauling Arrangements

The coal was to be hauled by a local truck contractor who had experience in hauling from Drummond sites into the Gorgas station. Six tractor trailers making two rounds each were used for the shipment. The six loads for each round were bunched up so that the trucks could be dumped one right after the other. Because the Mulled Coal was so dry, it was decided to tarp each load.

3.3.5 Loading

Coal trailers for the shipment measured 8' wide x 34' long x 5 1/2' high and were rated at about 1500 cu ft capacity at level full. Since the Mulled Coal had a relatively shallow angle of repose, and since it had a lower bulk density than coarser clean coal, we attempted to completely load each truck to level full capacity. Trucks were loaded in three passes with a front end loader which was equipped with a 20 cu yd bucket. Truck loads averaged 27 1/2 tons -- indicating an average bulk density for Mulled Coal of about 37 lbs per cu ft. This compares favorably with laboratory bulk density tests run on the Mulled Coal product.

3.3.6 Dumping and Handling at the Gorgas Station

There was no problem whatsoever with trucks dumping or the coal passing through the fuel handling system at the Gorgas Station. Figure 6 is a schematic representation of the truck coal receiving system. EI representatives were permitted to observe and videotape the Mulled Coal loads as they were dumping, and we were stationed so that we could follow the movement of the coal from the truck dump through two bins and onto the stockpile.

There were two small differences between the behavior of Mulled Coal and the behavior of the regular baseline 1 1/4" x 0" coals as they dumped and moved through the system. The trailer beds for some of the Mulled Coal loads had to be tilted at a slightly sharper angle before the load began to dump. But as soon as the load started to move, it dumped quickly and completely. It is thought that this may have resulted from our efforts to get "level full equivalent" loads. In some cases the front end loader operator actually tamped down the load with the bottom of the loading bucket. The loads which were tamped down had to be tilted at a sharper angle to dump. There was no coal under the belt head of the stacking belt, so the coal dropped a distance of about 30' from the belt head to the ground. When the Mulled Coal dropped this distance, it caused more dust than the coarser baseline coal, but substantially less dust than would have been experienced with a coal that had not been mulled. This result is consistent with the circumstance that the Mulled Coal has been prepared from a -28 mesh stream and the moisture had been reduced to about 8%.

Figure 6

3.3.7 Conclusion

Mulled Coal was produced at the 23% moisture level for the shipment demonstration, but, by the time we were ready to ship, moisture was only 8%. A total of 300 tons of the 8% moisture material was successfully shipped by truck, unloaded, and handled with the conventional equipment available at the electric utility. The fact that the Mulled Coal process promoted very rapid air drying was unexpected and is now considered to be one of the most advantageous features of the process. Unmulled fine coal at 8% moisture would be extremely dusty; however, this did not translate into a problem for the mulled product at 8% moisture level used in the 12 truckload shipment, as the mulled product exhibited significantly reduced dusting. Also, we know from lab testing that there was very little difference in the handling characteristics of Mulled Coal at 23% moisture and Mulled Coal after it air dried to 8% moisture, and we know that Mulled Coal would easily have passed through this system right after it was produced (while it was still high in moisture). Additionally, we know that unmulled wet cake at 23% moisture would never have passed through this system, and it never would have air dried to a point where it could be handled at the Gorgas Station.

4.0 SUMMARY

During this seventh quarterly period of the contract, activities were underway under Tasks 6, 7, and 8 of the Work Statement. The major activities of the period were the product shipment of Task 6, the data reduction and technical evaluations of Task 7, and the beginning of preparation of graphics and tables of information that will be usable for the final report.

A shipment of the Mulled Coal product was made to the Gorgas Power Station of Alabama Power near Birmingham, Alabama. The loading of the Mulled Coal at the site onto the trucks, the movement of trucks to the power station, and the unloading at the power station all went smoothly and no untoward effects were noted. The Mulled Coal product had dried during the storage at the site so that the coal was very near to normal moisture specification levels during the shipment and acted very much as would be expected for a specification product.

The modifications to the plant structures 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 the production period over a range of operating conditions. The production was completed 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.